TEMPORAL CHANGES IN COMMUNITY STRUCTURE ON A ROCKY SHORE IN THE FIRTH OF CLYDE

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SUMMARY

Temporal changes in the structure of a trophically simple community were investigated by monitoring the species diversity in disturbed and undisturbed algal populations on a rocky shore. The disturbance involved seasonally denuding transects from 3.04m to 1.89m above Lowest Astronomical Tide. Changes in populations were measured by calculating a coefficient of similarity between samples. Factors which could influence structure through their effects on colonization were investigated in field experiments and by culturing littoral species in a simulated tidal regime.

In an undisturbed transect extending between the littoral fringe and top of the eulittoral zone, from one to three separated population weeks. Changes in species diversity were large enough to indicate in six that the same piece of substratum was used by several species withinate
that the same piece of substratum was used by several species within
a year. The vertical stratification in the top levels sampled was simple, and the dominant stratum was the algal crust. A canopy of seaweeds was poorly developed or absent. At these levels the stratification remained fairly constant with time, but in the lower levels sampled the relative amounts of substratum covered by a canopy, understory, and encrusting layer could change within a few weeks.

When determined by the similarity coefficients, strips cleared in the spring took only 12-14 months to entirely recover, whereas those cleared in the late summer and autumn took 18-20 months. After clearing it took longer for an algal cover to develop at the higher levels on the shore, but the populations here came to resemble those in the undisturbed control sooner than did the ones in the bottom levels. It was found that the algal diversity settling under a canopy was significantly different from that settling on open substrata, and the populations in the lower levels came to resemble those in the control only after the full canopy of <u>Fucus spiralis</u> was re-established, and comparable to that in the lower levels of the control.

of propagules, their distribution in the surface waters, the level on the shore, the nature of the algal canopy they must penetrate, and the environmental conditions prevailing immediately after settlement when the plants were found to be most vulnerable.

Zonation appeared with the first populations colonizing cleared strips but it was different from that in undisturbed areas. The initial zonation was probably determined by the factors mentioned above, rather than by the tolerances of individual species or by competition. After the populations in cleared strips came to resemble those in the control, the zonation in both were essentially similar except for local differences resulting from patchiness. A very small scale patchiness not readily visible in the field was found to be caused by amphipod grazing.

INTRODUCTION

Inspired significantly by the ideas of G. E. Hutchinson and R. A. MacArthur, ecologists have been working in the last two decades toward the development of a broad theory of community organization. In one approach to this problem the goal has been to understand the factors which affect community structure. Community structure is defined as those attributes of the community, such as patterns of species distributions, abundance, size, shape, or trophic relationships, which can be determined by static sampling procedures (definition after B. Menge, 1976).

Many different factors affecting community structure have been identified from the study of species diversity(where the term is defined in its broadest sense and includes the number of species and their abundances) in individual communities, but these can be grouped into six broad categories relating to (1) time, (2) spatial heterogeneity, (3) competition, (4) predation, (5) climatic stability, and (6) productivity (for reviews see Pianka 1966, 1974; Ricklefs 1973). On the basis of these different categories several theories have been developed to account for some of the patterns of community structure that have been observed. However none of these theories seem to be universally applicable because the relative importance of such factors has been found to differ with communities. Species richness in deep ocean bottom has been attributed to environmental stability (Sanders, 1969), in forests to climatic stability (Klopfer, 1969) or to spatial heterogeneities (Horn, 1975), and on rocky shores to selective predation (Paine, 1969; Dayton, 1971).

On rocky littoral shores discontinuities in species distributions are on a small scale and readily visible. Since the habitat is also easily accessible and the resident species small enough to manipulate, the experimental approach, as well as the descriptive one, has been successful in studies of community structure. As a result, the factors which influence the structure are probably better understood for this habitat than for most others. On rocky shores the physical factors associated with different degrees of exposure on low tides, Easily the most striking feature of community structure on rocky shores is the distribution of the organisms in narrow horizontal zones. This is a feature of the community which has been found in many parts of the world (Southward, 1958; Stephenson and Stephenson 1972). Early hypotheses on the cause of this zonation have emphasized the tide as the primary factor because the distributions of some species could be correlated with the 'critical' levels of mean spring and mean neap tides (Colman, 1933; Hewatt, 1937; Doty, 1946). However, the theory was not universally applicable because the limits of species distributions on some shores were found to vary with the topography and location. The Stephensons (Stephenson and Stephenson, 1949) then postulated that the regular zonation found on the shore is controlled by the environmental gradients that exist at the interface between air and water (i.e. gradients of humidity, temperature, salinity and sunlight). Individual species were considered to be limited to specific zones by their tolerances to these gradients. Differences in the zonation patterns between locations were attributed to differences in the gradients. This hypothesis has been successfully used to explain the upper limits of most species distributions for it has been observed that these limits can be raised by the amount of wave action (Lewis, 1961; 1964), the presence of sheltered crevices (Kensler, 1967; Dayton, 1971), or a source of additional moisture from points higher on the shore (Hatton, 1938; Frank, 1965; Dayton, 1970). However, it was also commonly observed that species did not extend downshore as far as would have been expected from their physiological tolerances to the different gradients. In the last decade it has become increasingly evident that these lower limits are determined by biological interactions such as predation, grazing, or competition (for reviews see Connell, 1972; Chapman, 1973; Menge and Sutherland, 1976; and also J. Menge, 1975; B. Menge, 1976; Schonbeck, 1976). At present, zonation is believed to result from a combination of these factors. The upper limits of a species' distribution on the shore is determined by its tolerances to the physical stresses of exposure, and its lower limits by interactions with other organisms in the community (Connell, 1972; Chapman, 1973; Schonbeck, 1976).

In addition to the patterns of zonation along the tidal gradient, small scale discontinuities in both plant and animal distributions have been found within a single zone. The term used to describe this structural feature of the community is 'patchiness' because different species are often found to be distributed side by side on the substratum in distinct patches. In algal populations patchiness seems to be a world wide phenomenon since it has been found in Hawaii (Randall, 1961), the Pacific Northwest coast of the United States (Vadas, 1968; Dayton, 1975), Britain (Russell, 1972) and the Mediterranean (Lipkin and Safriel, 1971; Boudouresque and Lück, 1972). In terrestrial plant communities much of the patchiness found can be attributed to small scale differences in habitats (reviewed by Lambert and Dale, 1964; Goodall, 1970; Whittaker, 1970), and the same argument has been extended to littoral populations (Hatton, 1938; Russell, 1973). However, recent investigations have shown that patchiness can also be caused by dynamic phenomena which remove organisms on a small scale from the shore. In algal populations the small scale removal of plants can be caused by grazing from fish (Randall, 1961), limpets (Southward, 1964), other algivorous gastropods (Huang and Giese, 1958), sea-urchins (Kitching and Ebling, 1961; Vadas, 1968; Dayton, 1971; 1975), crustaceans (Ravanko, 1969); or by physical phenomena such as log battering (Dayton, 1971).

Since such small scale removals can occur randomly in time Boudouresque and Lück (1972) have hypothesized that the mosaic structure in algal distributions, seen in both the littoral and sublittoral, result from the vegetational changes that occur in each cleared patch as it is being recolonized. Studies on the repopulation of cleared and artificial substrata have shown that the species involved are quite different from those normally associated with undisturbed areas. In locations where algal populations dominate, rapidly growing ephemeral species are the first to colonize a clear patch of substratum. These may be followed by a series of longer lived annuals or rapidly growing perennials before the final 'climax' population is established. It has been reported that differences in seasons, geographical location, level on the shore, substratum, or just random chance can determine the timing and diversity during recolonization (seasonal effects - Wilson, 1925; Bokenham and Stephenson, 1938; Rees, 1940; Northcraft, 1948; Boudouresque, 1973; Fry, 1975; Harlin and Lindbergh, 1977; geographical effects - Bokenham and Stephenson, 1938; Saito, 1976; effects of tide level - Rees, 1940; Northcraft, 1948; den Hartog, 1959; effects of substratum - Pomerat and Weiss, 1946; Pyefinch, 1950; Foster, 1976b; Harlin and Lindbergh, 1977; and the effects of random chance - Fager, 1971).

Another aspect of community structure that can be found on rocky shores is the vertical stratification of species above the substratum, especially among the algae. Since the multilayered algal vegetation on a shore is similar in structure to that in terrestrial forests the same terminology has been used to describe the different levels. Algal species which can grow to cover major areas of the substratum, even though they are attached only at one point, are called the canopy; and those that grow under this covering, and often extend only a very short vertical distance above the substratum, are called the understory.

Although the vertical stratification of sublittoral algal populations has been well studied (see papers in North, 1971, and also Norton and Burrows, 1968; Fager, 1971; Foster, 1975a;b), less is known about this aspect of structure in littoral populations. The observations that have been made indicate that species in different vertical levels can interact with each other. Hatton (1932) found that the germlings of Fucus vesiculosus will survive higher on the shore if they are covered by a canopy of Enteromorpha intestinalis, and Dayton (1975) found that the removal of the canopy species resulted in the death of some of the understory because it exposed them to the full extent of the physical stresses associated with low tides.

Investigations on rocky shores have shown that a variety of factors can affect community structure. Many of these factors are dynamic in nature, and therefore one can assume that their effects will not be constant with time. In situations where several factors determine species distributions, temporal differences in the relative importance of each could result in major structural changes in the community, especially in locations where the populations are in constant flux due to disturbance and recolonization. For example, in cases where patchiness is determined by the removal of organisms rather than habitat differences, it is possible that other aspects of community structure, such as zonation, could be influenced by the species involved in the repopulation process.

In previous investigations little attention has been given to the temporal changes in community structure, and the purpose of the research described in this thesis was to determine the magnitude of such changes and their importance to the patterns of community structure that could be found at any one time. To simplify the number of possible factors involved, a location was chosen where the dominant populations were at the lowest trophic level, and the total species diversity relatively low. Temporal changes in zonation and stratification were monitored during the recolonization of strips cleared on the shore, and in an adjacent undisturbed area. Possible factors involved in recolonization were investigated by observing the settlement and survival of algal propagules in the field, and in a simulated tidal regime in the laboratory.

CHAPTER I

TEMPORAL CHANGES IN THE STRUCTURE OF FIELD POPULATIONS

A. LOCATION

The investigations of a rocky shore community were undertaken on the northern tip of the Isle of Cumbrae near Tomont Point (Figure 1). Of the numerous locations examined in the Firth of Clyde this one was chosen for the following reasons:

(1) the site was easily accessible from Glasgow on a year-round basis,
(2) it was isolated from major population centers,
(3) the dominant organisms were algae, and thus at the lowest trophic level, and
(4) the substratum was a uniform slab of rock.

This last criterion severely limited the choice of locality, but was of paramount importance, since the temporal changes in species distributions that were to be investigated might have been masked by the effects of crevices in the substratum, or the different amounts of exposure associated with a shore of an uneven topography.

The slab of Devonian, Old Red sandstone and conglomerate was 25 m long by 4.5 m wide, facing East, and located at the top of the littoral. The top of the slab was approximately 4 m above the Lowest Astronomical Tide (L.A.T.) and the bottom was 2 m above it. The slope was 30°. A photograph of the slab is shown in Plate 1. The area was relatively free of most common large littoral herbivores which reduced the possible number of factors involved in the community srructure. Most of the slab was above the normal distribution of limpets, and the gastropods of the genus Littorina were almost totally absent (possibly due to predation by Eider ducks which were common in this area). The only herbivore present in any abundance was the small amphipod, Hyale nilssoni (Rathke).

Figure 1: The eastern part of the Firth of Clyde showing the Isle of Cumbrae and the experimental site at Tomont Point (T).

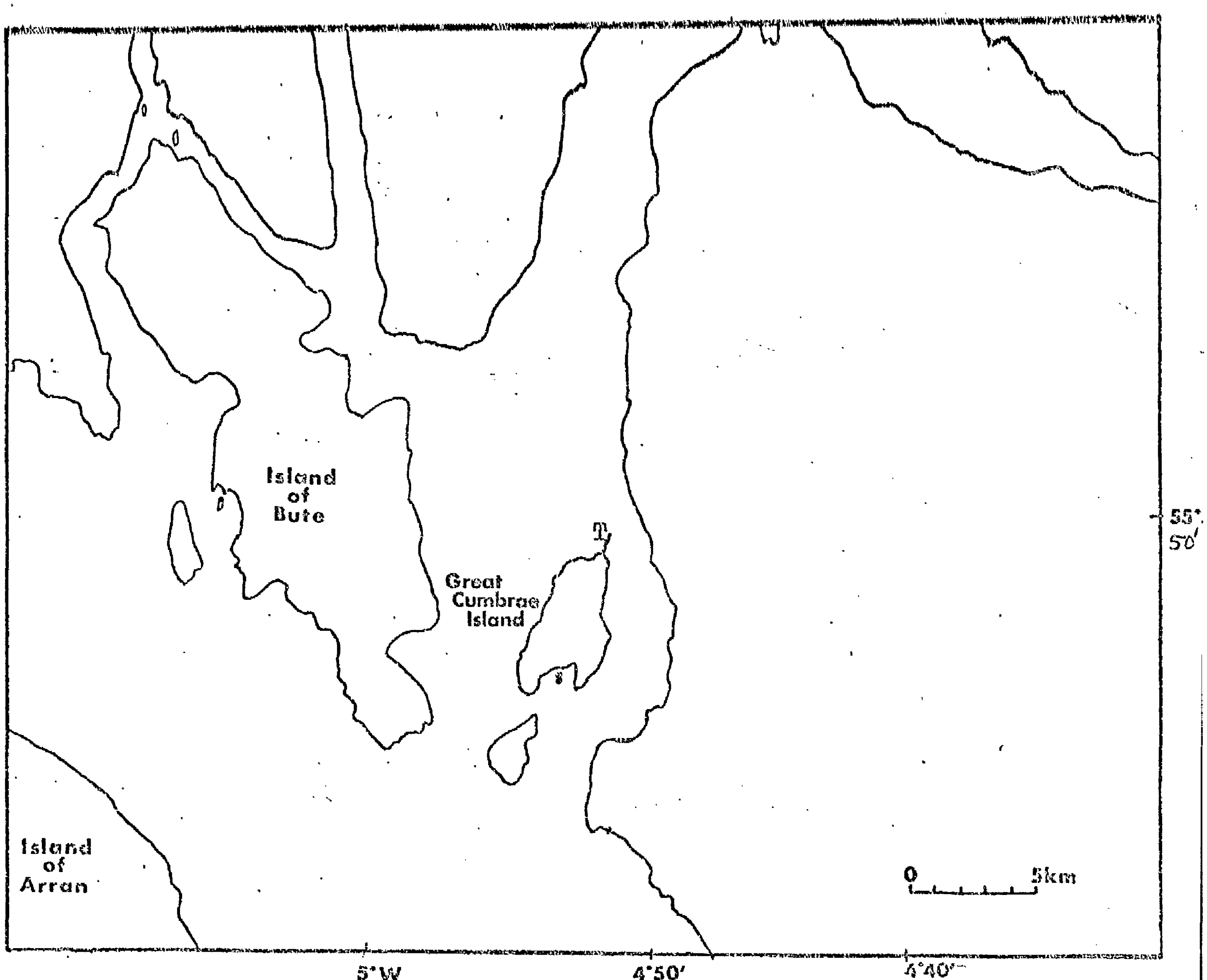


Plate 1: The experimental site near Tomont Point on the Isle of Cumbrae. Strips free of vegetation are areas cleared earlier which are in the process of being recolonized.

Recolonization on the rocky shore was monitored on 11 vertical strips cleared within the test site between August 1974 and January 1976. The strips were prepared by first cutting the larger algae from a strip 0.5 - 0.8 m wide on the slab. Within this strip a narrower one, 0.2 m wide, was burned using a blow torch. The charred organic remains were removed with a wire brush. Since the substratum at this location was highly friable, the brushing also removed the top layer of rock and exposed a clean surface. To make sure that nothing remained in the interstices of the rock, methanol was poured on the strip and set on fire. Successive strips were cleared on alternate sides of the test site, and on 2 September 1975, two strips were cleared on one day to determine the variability in recolonization that could occur within the site. The location of each strip within the site, and the time of its clearing are shown graphically in Figure 2. The third strip could not be completely cleared along its whole length because of a rainstorm, and the data on its recolonization were omitted from the general discussion because it could not be fully compared with that from the other strips.

B.2. Sampling:

The populations occupying the strips were sampled at 4-8 week intervals on 8 different levels chosen to include the different biological zones identified visually in the summer of 1974. The original dominant species found at different levels on the site, and the heights of the sampling levels used are given in Table 1. The vertical height above L.A.T. of the top and bottom levels were determined from the tidal gauge kept at the University Marine Biological Station, Millport which was 5 km from the site. On two separate occasions the time was noted at which a receding tide reached the marks on the shore, and the height of the tide for the appropriate

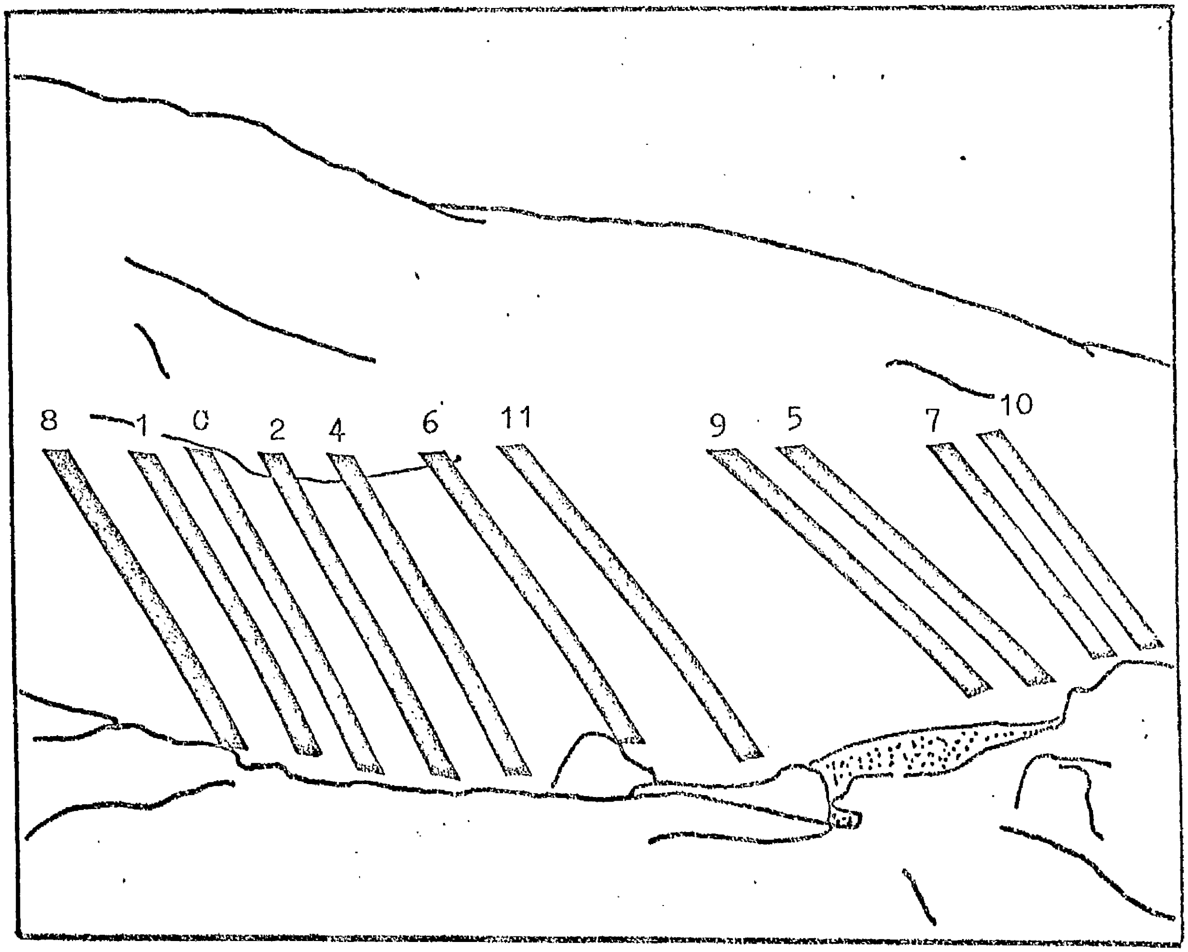


Figure 2: The location of the cleared strips and the control (C) on the sandstone slab in the experimental area on Cumbrae. The strips were cleared as follows:

Strip 1 - 9 August 1974
2 - 25 September 1974
4 - 10 December 1974
5 - 10 February 1975
6 - 8 April 1975
7 - 4 June 1975
8 - 18 July 1975
9 - 2 September 1975
10 - " "
11 - 15 January 1976

method did not provide an absolutely true determination of the heights of the levels at Tomont Point, but for the purposes of the present research it was adequate, since no comparisons with shores at other locations were attempted.

The populations were sampled in two stages. First, the organisms that could be seen in a small rectangle, 100mm x 300mm, centered on the appropriate level, were recorded. The area of substratum covered by each species was estimated on a scale of 1 - 4 corresponding to the following percentages:

(1) up to 24%,
(2) 25-49%,
(3) 50-74%,
(4) 75-100%.

After the initial observations were made, a small area of approximately 50mm^2 was scraped off, brought back to the laboratory in plastic repli-dishes, and fixed in a buffered 1.5% solution of formalin.

The scrape samples, and also any plants not identifiable _in situ_ were examined microscopically in the laboratory. All species found were identified as far as possible, and a note was made if plants were bearing reproductive bodies or there was evidence that spores were being released. The crust of blue-green algae found on this shore contained numerous species in irregular distributions, and often patches of one species were no bigger than 50 μ in diameter. Since this made it impossible to determine the relative cover of individual species, and because the taxonomy of the blue-greens is not well organized, all blue-greens were considered as one organism for this study. The list

Table 1: The height of the sampling levels above L.A.T., and the dominant species found at these levels in summer 1974, before any stripping began.

Sampling Level	Height above L.A.T.	Dominant species
1	3.04 m	Blue-greens, P. canaliculata
2	2.86 m	P. canaliculata, F. spiralis
3	2.70 m	F. spiralis
4	2.61 m	F. spiralis
5	2.49 m	F. spiralis, B. balanoides
6	2.37 m	F. spiralis, A. nodosum, B. balanoides
7	2.17 m	F. spiralis, A. nodosum, G. stellata, B. balanoides
8	1.89 m	F. spiralis, G. stellata, E. intestinalis, B. balanoides

turf of fucoid germlings until the plants were at least ...
When the germlings could be identified the turf had thinned out considerably. Although *Fucus spiralis* was the species which always grew out of the turf of germlings, the possibility exists that other species might have been present in the turf, before the germlings were thinned out. In several cases the separation of closely related species was not possible because the fruiting bodies, on which species separations depend, were absent. One group of plants could only be identified as 'creeping brown filaments' because the plants found on the shore with this characterization could have belonged to several different genera. Some of the creeping filaments fit the descriptions of *Kuetzingiella* or *Streblonema* in the Keys of Jones (1962) and G. Russell (unpublished), and R. Fletcher has suggested (personal communication) that some of the creeping filaments might be a young form of *Petalonia*.

The information on the organisms identified, their coverage on the rock, and their reproductive state for each sample was encoded in a numerical format and punched onto cards for further analysis. Algal species were identified by the five digit code used in the British Phycological Society's Seaweed Mapping Scheme and named according to the check list of British Marine Algae (Parke and Dixon 1976). Arbitrary numbers were assigned to animal species and those plants which could not be fully identified. The fucoid germlings and *Fucus spiralis* were considered as different organisms and given different numerical identifications. *Blidingia minima* was also separated and given two numbers. The first for the crustal form of the species and the second for the tubular, erect, thallus. Although a filamentous thallus grows out of a crustal disc in *B. minima*, there were times when the crust was found to cover an extensive part of the rock without developing the erect filaments, while at other times the filaments grew

Furthermore, there was a possibility that the ...

Blidingia marginata. This species also grows from a small disc, and is separated from B.minima only on morphological differences in the erect part of the thallus (Bliding, 1963). A list of all organisms found, their nomenclatural authorities, and their code numbers are given in Appendix I. The cover values were encoded on the 1-4 scale already mentioned and a '0' was assigned for the cover of species seen only in the microscopic examination. Finally, a '1' in the position of the last encoded digit was used to indicate the presence of reproductive stages in the plants. All information collected in the preceding fashion is given in Appendix II.

B.3. Data analysis:

The analysis of similarity between samples was based on both the species identified and the estimates of their cover. A percentage value for the similarity was calculated using the coefficient, 100 x 2W/A+B, where W is the sum of the smaller cover values of those species common to both samples being compared; A is the sum of the total cover of all species in the first sample, and B is the sum for the second sample. The coefficient is after Bray and Curtis (1957), but the basic equation is that of Kulczynski (1927). Since the cover of each species was only estimated on a scale of 1-4, the mean value of the corresponding percentage range was used in the calculations. Thus, 12.5% was used for a cover value of '1', 37.5% for '2', 62.5% for '3', and 87.5% for '4'. Under field conditions it was difficult to note species which covered less than $100mm^2$, and species seen only on microscopic examination of the scrapings were assigned a cover value of 0.3% which is approximately half of the least cover visible in the sampling quadrat.

To identify the changes in species diversity, that were taking place with time, the data were tabulated with respect to presence and fertility. The programs for the data manipulations and similarity analysis were written in Fortran IV-G and are presented in Appendix III.

species inhabiting a plot were represented in ...

The precision of the method was checked by taking 10 replicate samples from one quadrat on one day. This was done four times in different parts of the undisturbed shore (2.86 m and 2.17 m levels on 6 April, and again on 7 July 1976). In the four sets of replicates, between 70 - 80% of the total species number observed were represented in the first sample. However, the species omitted from the first sampling were mostly those covering less than 100 mm^2, and as can be seen in Table 2 their contribution to the composition of the populations was minimal when the samples were compared by similarity coefficients.

By using the method of comparing a single observation with a mean (in Sokal and Rohlf, 1969; p. 169) a value was calculated for each set of replicates which could be used to statistically separate samples belonging to the same population from those belonging to different populations (Table 2). For example, a sample can be considered to come from a population different from that found at the 2.86 m level on 6 April 1976 if the mean of the similarities between it and the set of replicates is less than 79.6% (probability level of 0.05). This value of 79.6% was the lowest one calculated from the 4 sets of replicates and gives an indication of limits set by the method for the definition of separate populations on the shore.

C.2. <u>Changes in the distributions of individual algal species:</u>

Since the species is the basic unit used to describe communities, changes in community structure can be related to changes occurring in the distributions of individual species. By combining all observations from one day, the temporal changes in the distributions of individual species were monitored.

Table 2: Statistical analysis of replicate samples taken in four different quadrats. The similarity value which statistically separates populations is based on the method for comparing a single observation with a mean at a probability level of 0.05 (see Sokal and Rohlf, 1969).

Sample	Number of replicates	Mean species number in one sample as a % of total	Mean similarity between all replicates	% similarity separating populations
6 April 2.86 m	9	76	93.4% s = 8.18	79.5
5 July 2.86 m	10	80	98.8% s = 1.89	95.6
6 April 2.17 m	10	71	94.6% s = 4.95	88.1
5 July 2.17 m	10	67	97.8% s = 1.97	94.5

Notable exceptions to this were Capsosiphon fulvescens, Enteromorpha intestinalis, Ulothrix pseudoflacca, U. flacca, and Urospora penicilliformis. In this study the only species in which a seasonal pattern of reproduction could be inferred were Cladophora albida, Ralfsia verrucosa, and Prasiola stipitata.

Among the species that were present as permanent members of the populations many were found to change their vertical position on the shore with time. The data collected on the distribution of Ulothrix pseudoflacca are presented in Figure 3 as an example of this phenomenon. The histograms of the frequency with which this species was observed at the different levels show that it was virtually absent from the bottom levels during the winters, and from the top levels during the summers of 1975 and 1976. As shown in Figure 4 a similar pattern was found for the filamentous form of Blidingia minima but not for its crustal form. This provides additional evidence that these two forms are ecologically different, and is one of the reasons for separating the two growth forms in the calculations of similarity. Other species found with such temporal 'migrations' on the shore were Urospora penicilliformis, Ralfsia verrucosa, Capsosiphon fulvescens, Gigartina stellata, and the fucoid germlings. The data on the frequency of observation, with level, for all species are tabulated in Appendix IV.

The number of species found at each level varied with time, and as shown in Figure 5 two different seasonal patterns could be identified. In the top two levels sampled the number of species was found to be highest during the winter of both years, and the lowest in the late summer; whereas in the bottom three levels the number was lowest in the

U - present with [illegible]
C - present with carposporangia
T - present with tetrasporangia
Pr - present with propagulae

The occurrence of a species is summarized in the last column as an occasional (O), seasonal (S), or permanent (P) member of the population.

Species found in the control strip are marked (*).

(footnotes)

1. Samples from control and strip 2 missing on 26 September 1975.

2. Parke and Dixon (1976) have deleted Codiolum as a genus because the species have been shown to be alternate phases of members of the genera Gomontia, Ulothrix, Urospora, Monostroma, and Spongomorpha. They are kept as separate species in the present study because this life form is ecologically different from those of the alternate phases, and because the parent species were not determined.

3. Time of reproductive phases was not noted in the present study. Schonbeck (1976) found that in 1975 and 1976 Ascophyllum nodosum on Cumbrae released gametes in the spring, and Fucus spiralis, Pelvetia canaliculata in the summer.

SPECIES	DATE	1975 Feb 10	Mar 10	Apr 8	May 15	June 30	Aug 28	Sep (1) 26	N
Chlorophyceae									
* Spongomorpha arcta				+	F	+			
Blidingia marginata						+			
* Blidingia minima			+	+	F	F	F	F	
* Capsosiphon fulvescens		F	+	F	F	F	F	F	
* Chaetomorpha melagonium			+	F	+	+	+	+	
* Cladophora albida		F					+	+	
* Cladophora rupestris		+	+	F			+		
* Cladophora sericea				+	F	F			
Codiolum gregarium phase[2]				+			+		
* Codiolum petrocelidis phase[2]						F			
* Enteromorpha flexuosa									
* Enteromorpha intestinalis		F	F	F	F	F	F	F	
Enteromorpha linza					+				
* Enteromorpha prolifera				+	+	F	+	+	
Percursaria percursa									
Prasiola stipitata		F		+	+				
* Pseudendoclonium submarinum		+	+	+	F	+	F	+	
Rhizoclonium riparium									
Rosenvingiella polyrhiza				+					
* Ulothrix flacca				F	F	F			
* Ulothrix pseudoflacca		F	+	F	F	F	F	F	
* Ulva lactuca		+	+						
* Monostroma oxyspermum		+	+	+	+	F	+		
* Ulvella lens						+	+	+	
* Urospora penicilliformis		F	+	F	F	F	+	F	

Prasinophyceae													
Prasinocladus marinus									+				O
Phaeophyceae													
* Ascophyllum nodosum[3]	+	+	+	+	+	+	+	+	+	+	+	+	P
* Fucus spiralis[3]	+	+	+	+	+	+	+	+	+	+	+	+	P
Halothrix lumbricalis											+		O
* Litosiphon filiformis											+		O
* Pelvetia canaliculata[3]	+	+	+	+	+	+	+	+	+	+	+	+	P
* Ralfsia verrucosa	+	U	U	U	U	U	U	+	+	+	U	U	P
* Sphacelaria fusca												Pr	O
Stictyosiphon tortilis									+	+			O
Elachista fucicola				+							+		S
* Ectocarpus sp.	+	+	+	+					+	+	+	+	S
* Giffordia/Pilayella sp.				+	+					+	+	+	S
* Uniseriate Creeping crustose filaments			+	P	P	+	+	+	P	P	P	+	P
Rhodophyceae													
* Audouinella sp.									+		+	+	O
* Ceramium shuttleworthianum		+		+	+	+		+	+	+	+	+	O
* Gigartina stellata	+	+	+	+	+	C	+	+	+	+	+	+	P
* Hildenbrandia rubra	T	+	+	+	+	+	+	+	+	+	+	+	P
* Petrocelis cruenta	+	+	+	+	+	+	+	T	+	+	+	+	P
Porphyra linearis								+	+	+	+		O
Porphyra umbilicalis												+	O
Audouinella purpurea										+			O

Figure 3: The frequency with which Ulothrix pseudoflacca was observed in sampling quadrats at different levels between January 1975 and August 1976. The frequency is represented as a percentage of the total number of samples taken on any one level.

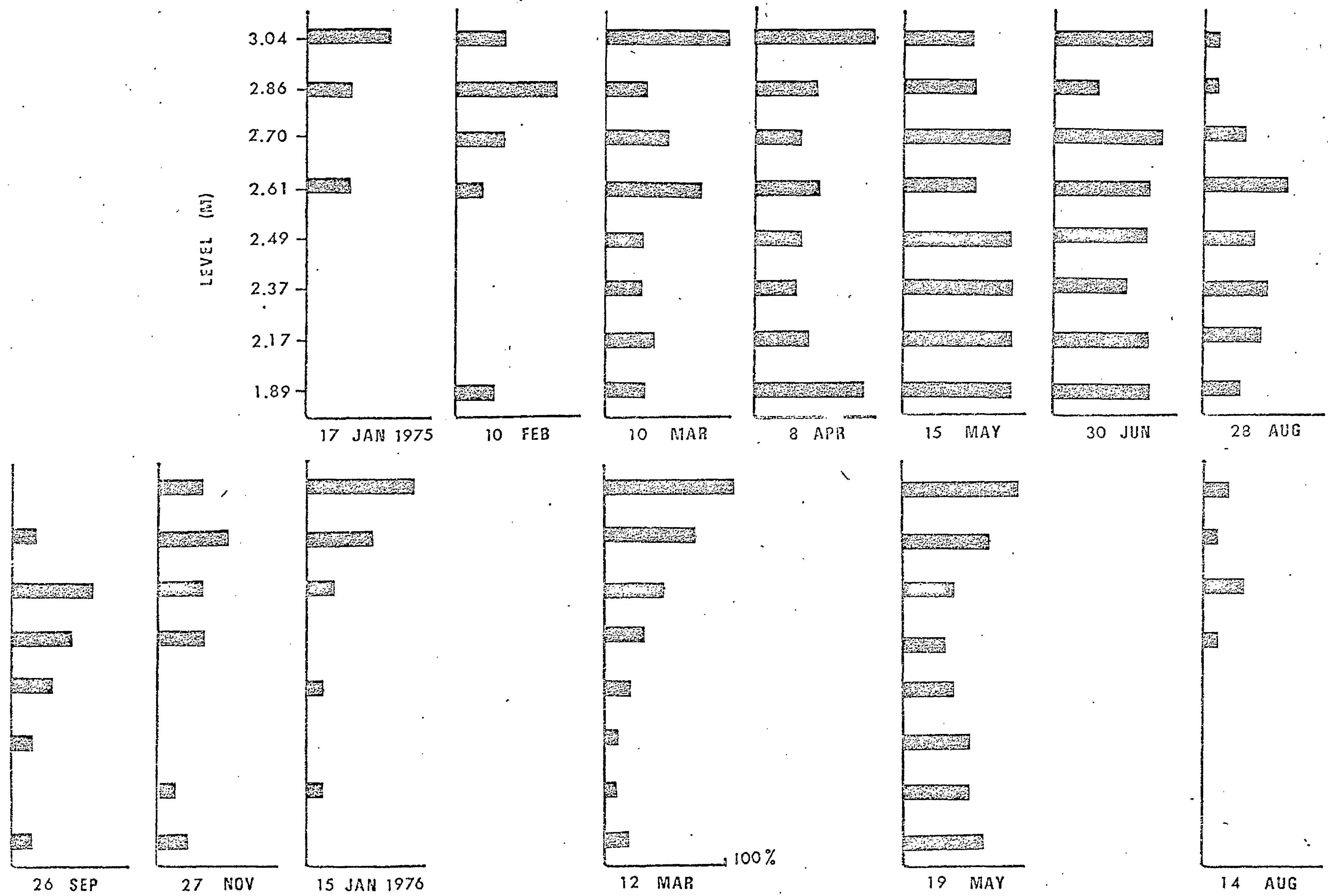
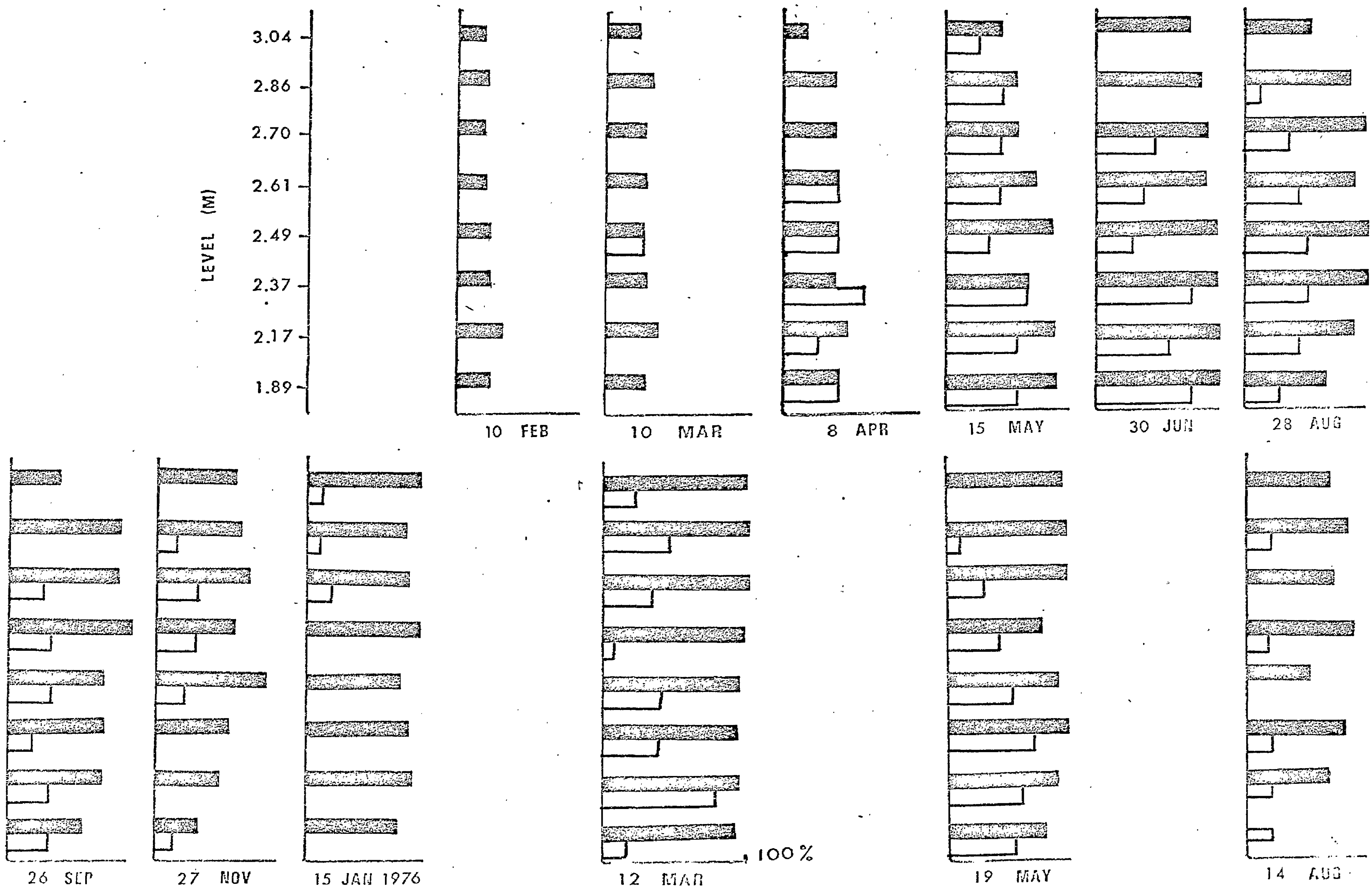

LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
17 JAN 1975
10 FEB
10 MAR
8 APR
15 MAY
30 JUN
28 AUG
26 SEP
27 NOV
15 JAN 1976
12 MAR
100%
19 MAY
14 AUG

Figure 4: The frequency with which the crustal and filamentous forms of *Blidingia* were observed in sampling quadrats between February 1975 and August 1976. The frequency is represented as a percentage of the total number of samples taken on any one level.

☐ *Blidingia minima* filaments

■ *Blidingia* crust



LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
10 FEB
10 MAR
8 APR
15 MAY
30 JUN
28 AUG
26 SEP
27 NOV
15 JAN 1976
12 MAR
100%
19 MAY
14 AUG

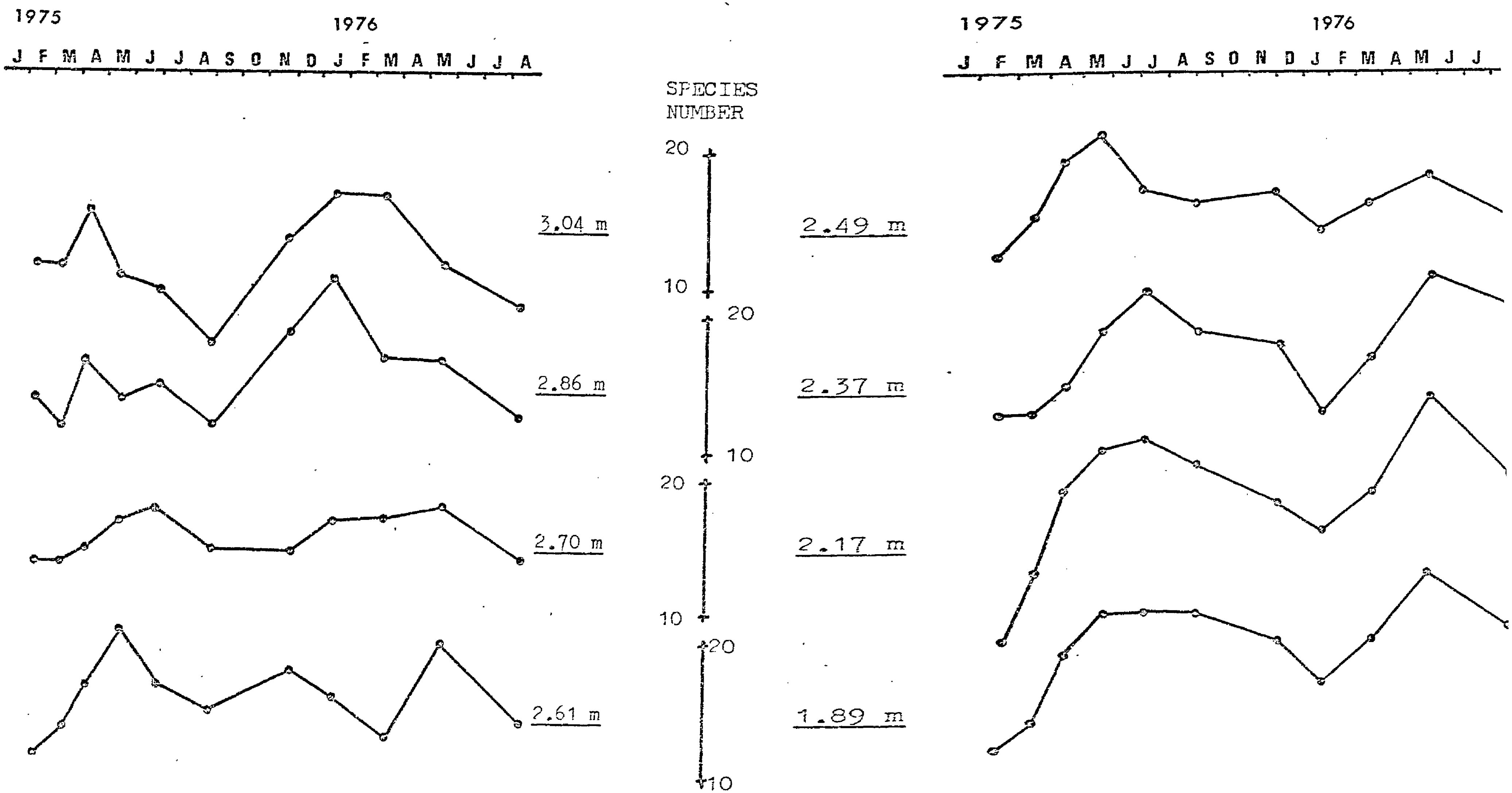


Figure 5: Temporal changes in species number between February 1975 and August 1976 at the 8 levels in the experimental site.

winter and highest in the spring. The seasonal patterns of species number in the middle levels seems to be transitional between those of the top and bottom. For example, three maxima were found at the 2.49m level - the first two at times when species numbers were increasing in the top level, and the last, in the spring of 1976, corresponding to the increase in the bottom levels.

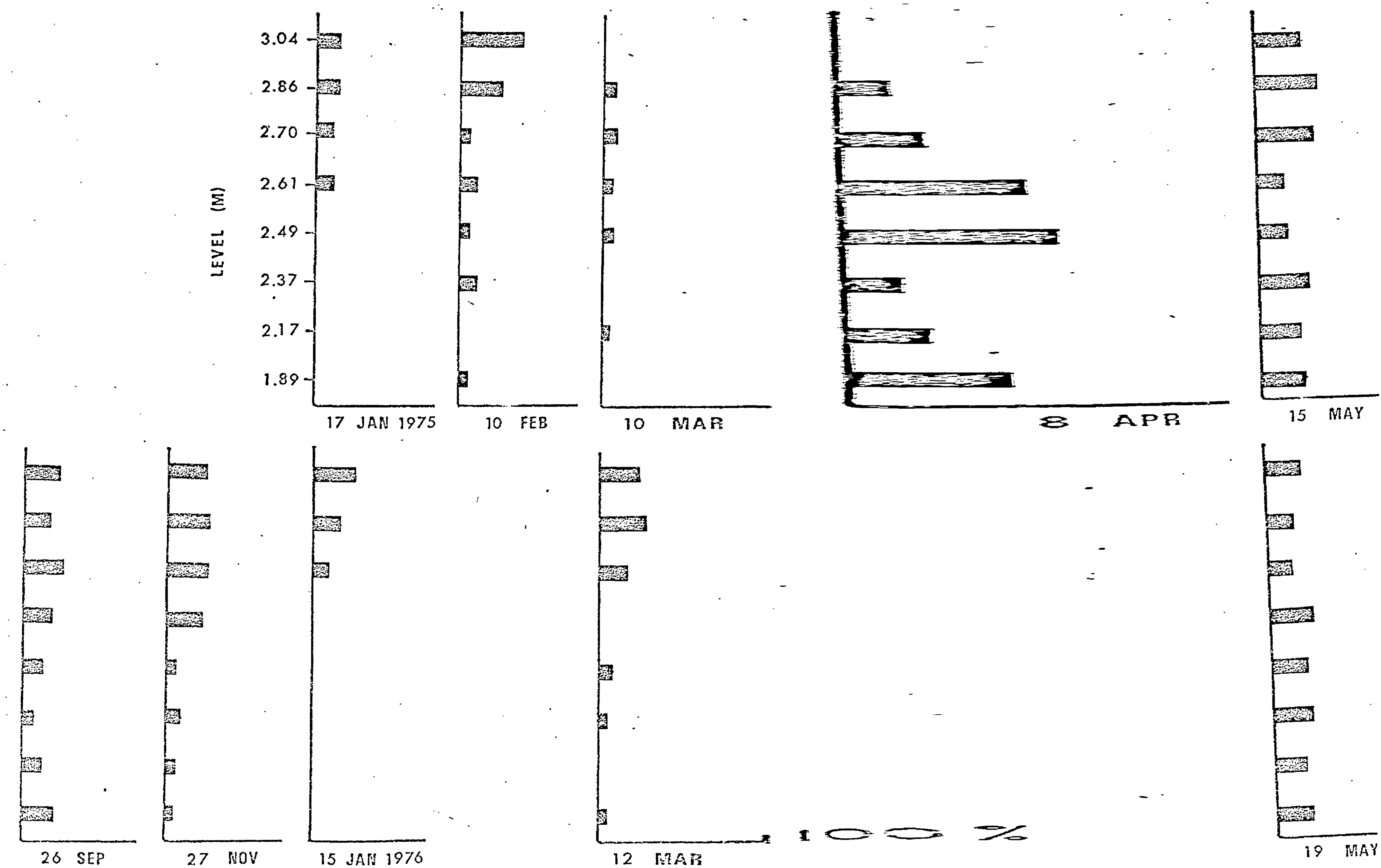
The dichotomy between the top and bottom level was also evident in the relative frequency with which species were found in their reproductive phases (Figure 6). The histograms showing the percentage of species in their reproductive phase at the different levels indicate that minima occur during the winter for the lowest levels, whereas this is the time of a maximum among the species in the top levels.

C.3. Changes in the undisturbed populations:

During the two years that the shore was observed, a crust of blue-green algae and *Pelvetia canaliculata* were generally the most conspicuous organisms in the upper levels, and *Fucus spiralis*, *Ascophyllum nodosum* in the lower ones. *Gigartina stellata* was found growing in dense stands immediately below the lowest level of sampling, and it sometimes extended into the bottom two levels in the presence of a *Fucus spiralis* canopy. An example of the species distributions found in the undisturbed strip is shown in Figure 7. A total of 32 organisms were identified in the undisturbed strip (marked with * in Table 3) but only 24 were seen at any one time. Many species were present for a short time only.

Although the probability of observing the conspicuous algal species on any one visit was high, there were times when they lost their dominant position as the species with the greatest coverage. (In this thesis 'dominant' will be used with reference to the amount of substratum covered by a plant, and not to its functional role in the community). This was especially noticeable in the early part of 1975 when most of the large *Fucus spiralis* plants were lost from the levels below 2.86m. However, by the following year the *Fucus spiralis* had

Figure 6: The percentage of species found in their reproductive phase between January 1975 and August 1976 at the different levels sampled.


LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
17 JAN 1975
10 FEB
10 MAR
8 APR
15 MAY
26 SEP
27 NOV
15 JAN 1976
12 MAR
100 %
19 MAY

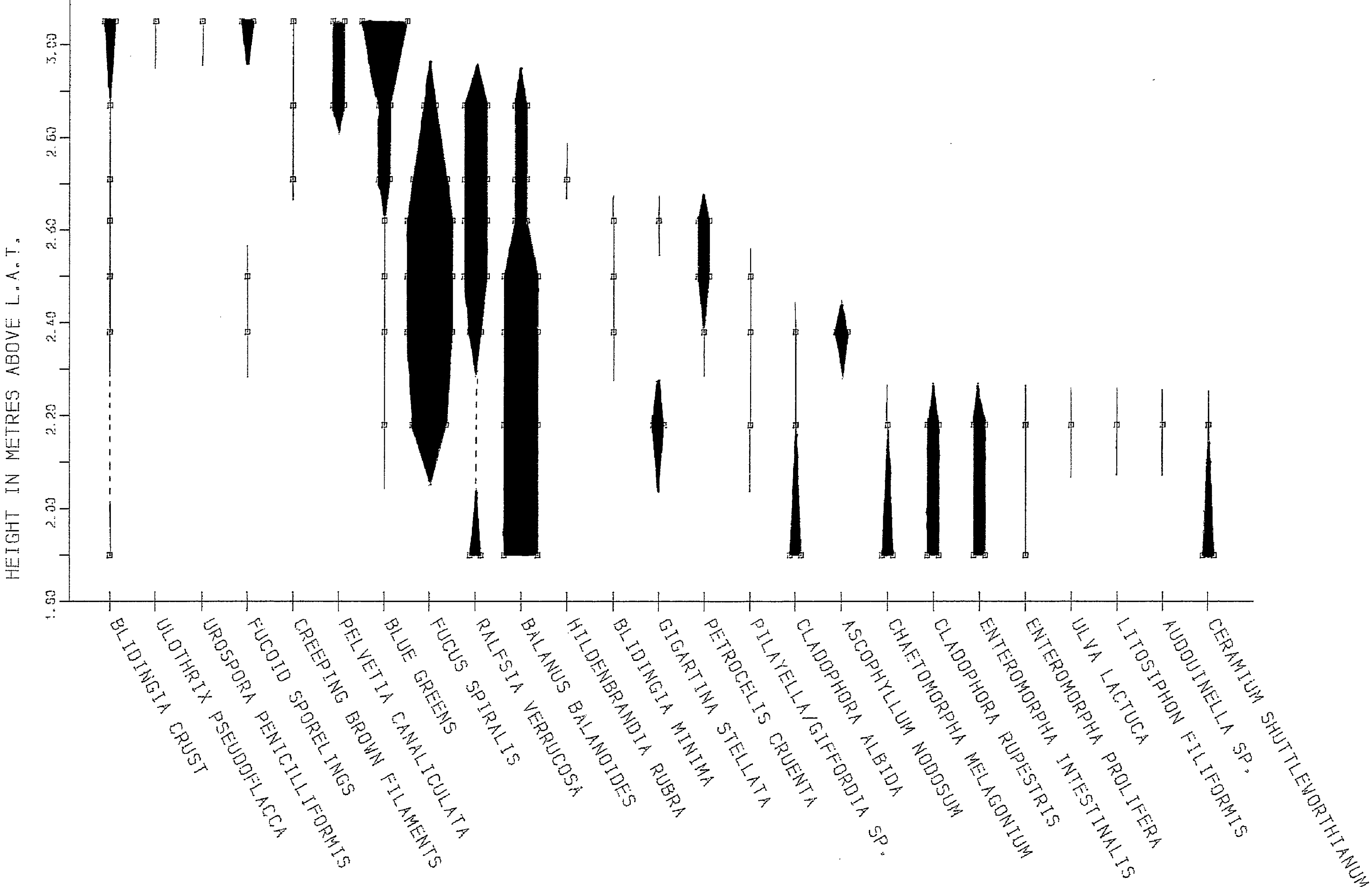


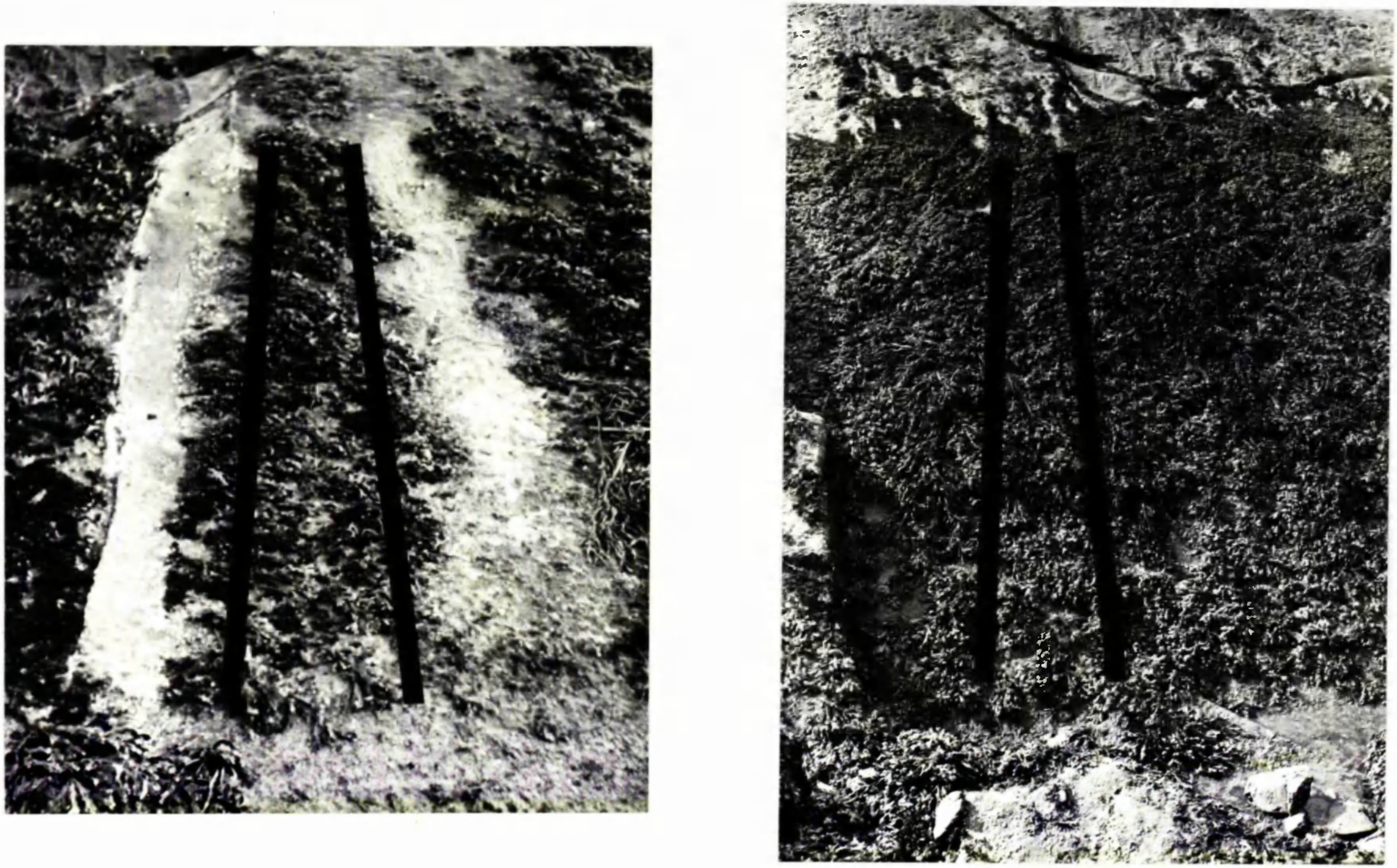
Figure 7: Species diversity in the control strip on 19 May 1976 at a time of a dense barnacle settlement. The width of the kite diagrams represent the cover of each species at the levels sampled: present microscopically, visible to 24%, 25 - 49%, 50 - 74%, 75 - 100%. A dotted line indicates the probable distribution of species at levels where they were not observed.

re-established its dominant position on the shore, and the difference between the two years can best be seen by comparing the two photographs in Plate 2.

When the large Fucus spiralis plants were lost from the shore one of two things was observed to happen: if small fucoid germlings were already present under the canopy, such as the period between 15 January and 12 March 1976, they grew quickly to fill the place left by the large plants and the dominance by the fucoids was maintained. However, in the absence of germlings, as found during the early months of 1975, other species could come to monopolize the substratum, and it took six months for the fucoids to re-establish themselves. In the absence of the fucoids, the crustose algae Ralfsia verrucosa, Petrocelis cruenta, and the crust of blue-greens became the dominants (see Figure 8). These organisms were normally present under the Fucus spiralis canopy, but individually they never occupied more than 50% of the substratum until the canopy was removed.

Above the level of Fucus spiralis a thick layer of blue-green algae was found covering the substratum throughout most of the year. However, as can be seen in Figure 8, its occurrence as the dominant life-form was seasonal. During the summer months it disappeared leaving the substratum bare. In the spring of 1975 the fucoid germlings grew higher on the shore than normally at this site (and on Cumbrae in general, see Schonbeck, 1976). The invasion of the upper shore by the germlings was so extensive that they replaced the blue-green algal crust as the dominant, even at the highest level sampled (3.04m, Figure 8). Although the crust remained dominant above this level, beneath the germlings it receded to cover only 25-50% of the rock. The germlings did not survive the summer at this high level. The following year the new growth of fucoids did not extend as high on the shore, and the crust was re-established at the 3.04m level.

Another seasonally dominant species on this shore was the barnacle, Balanus balanoides (L.). In the spring of both years dense settlements of spat were seen. These covered all available surfaces

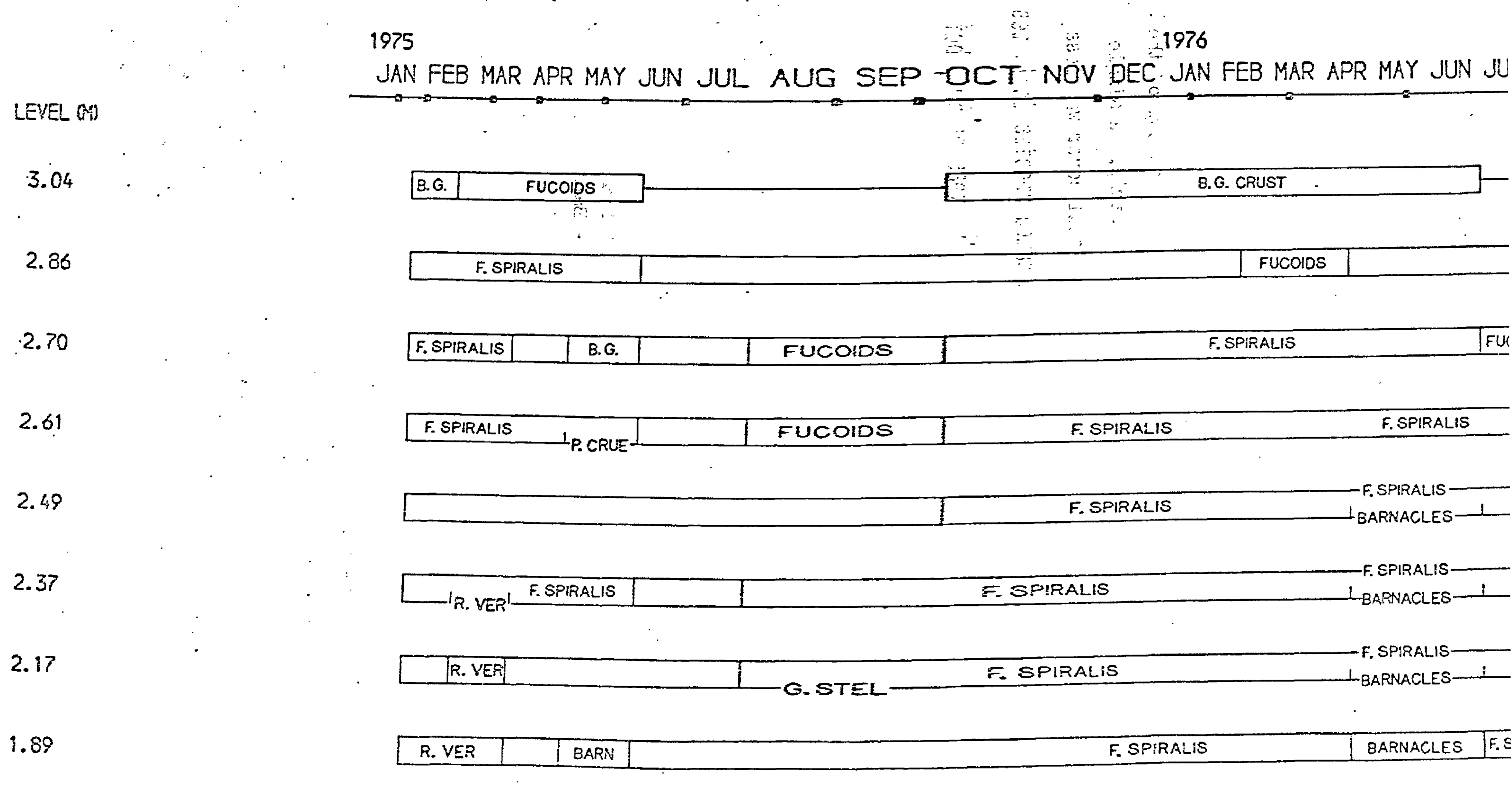


A B

Plate 2: The control strip on 10 December 1974 (A) and 24 August 1976 (B) showing the differences in the *Fucus spiralis* cover between the two years. The boundaries of the control strip are marked by heavy black lines.

Figure 8: Dominant species which covered more than 50% of the sampling quadrats in the control strip. A single line indicates times when the total cover was less than 50%. A block without a named species indicates times when the total cover was in excess of 50%, but no single species was dominant. The sampling times are marked on the horizontal axis. Abbreviations used:

B.G., B.G. CRUST	- Blue-green algal crust
FUCOIDS	- fucoid germlings
R. VER	- *Ralfsia verrucosa*
P. CRUE	- *Petrocelis cruenta*
G. STEL	- *Gigartina stellata*
BARN	- Barnacles



LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
1975
1976
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JU
B.G.
FUCOIDS
B.G. CRUST
F. SPIRALIS
FUCOIDS
F. SPIRALIS
B.G.
FUCOIDS
F. SPIRALIS
F. SPIRALIS
P. CRUE
FUCOIDS
F. SPIRALIS
F. SPIRALIS
F. SPIRALIS
F. SPIRALIS
BARNACLES
R. VER
F. SPIRALIS
F. SPIRALIS
F. SPIRALIS
BARNACLES
R. VER
G. STEL
F. SPIRALIS
F. SPIRALIS
BARNACLES
R. VER
BARN
F. SPIRALIS
BARNACLES

different in that spat settled much higher in 1976 than in 1975. In 1976 a dense settlement was found to the 2.49m level while in 1975 it did not exceed 2.1m on the shore.

The differences found in the visibly dominant species reflected changes that were occurring in entire populations. The number and abundance of species within one quadrat changed to such an extent that the similarity between consecutive samples fell at times to 8%. When the calculated coefficients are presented in the form of a matrix they can be used to show the periods when populations were changing. For example, Figure 9 represents the similarities between the different samples taken at the highest level in the undisturbed strip (matrices for all 8 levels are shown in Appendix V). The matrix shows that samples were similar in March-April 1975 and also in the winter and spring of 1976. In general, the winter and spring were periods of greater stability in the populations, but the levels on the shore which held these stable populations were slightly different between the two years. In 1975 the populations, as represented by the quadrat samples, were relatively stable between 2.86 - 3.04m (top two levels) and between 2.37 - 2.61 m (4th to 6th levels); whereas in 1976 the stable populations during the winter and spring were found between 2.17 - 2.70 m (the 3rd to 7th levels) and in the uppermost one (3.04m). In other words, two broad zones were found in which the populations remain stable during the winter and spring, but their boundaries could change from year to year.

In some cases a high similarity was found between samples taken from 6 to 12 months apart. For example, in the matrix shown in Figure 9 the samples from February 1975 were found to have a high similarity with those taken between November and March the following year.

	1975 FEB	MAR	APR	MAY	JUN	AUG	NOV	1976 JAN	MAR	MAY	AUG
FEB	100										
MAR	19	100									
APR	37	78	100								
MAY	20	87	87	100							
JUN	14	37	37	45	100						
AUG	27	37	37	45	51	100					
NOV	76	24	47	27	21	40	100				
JAN	70	21	42	24	18	34	88	100			
MAR	60	37	62	43	45	44	80	71	100		
MAY	70	32	53	35	34	34	88	90	82	100	
AUG	47	31	62	37	35	66	66	54	73	54	100

Figure 9: Matrix of the similarities calculated between the populations at the 3.04m level in the control strip. Similarities are presented as percentage values and are also grouped as follows:

0-19% , 20-39% , 40-59% , 60-79% , 80-100%

Similarity coefficients were also calculated between samples taken on the same day at the 8 levels to determine the population differences along the vertical gradient (zonation). The results obtained indicate that the differences between vertically adjacent populations changed with time to such a degree that both the number of zones and their level on the shore varied. To illustrate this point 6 of the 11 similarity matrices for the undisturbed strip are shown in Figure 10 (all are shown in Appendix VI). As shown by the matrices for 10 February and 30 June the zonation in the first 6 months of 1975 was rather indeterminate. However, by 28 August the populations could be separated into three distinct zones. By 15 January 1976 the populations had changed again, and this time only one, very strongly defined, zone could be identified from the matrix. Within two months this one zone had again disappeared to be replaced by two zones,both at different levels from the previous one.

C.4 Population changes during recolonization

C.4.1. Simultaneously cleared strips:

As shown in Table 4 the two strips cleared on the same day in September 1976 were found to be colonized by similar populations. In the first sampling after clearing, the similarities between the populations on the two strips were low because the colonizers were still microscopic and were inadequately sampled by the scrapings. However, after the initial colonizers became macroscopic the similarity between comparable levels remained above 67% for the first 9 months of recolonization. Within that time 22 out of the 32 pairs of samples compared had a similarity which was greater than 80%, the statistical limit set by the method of sampling as described previously.

However, by 14 August 1976 a marked divergence was seen in the populations near the bottom of the strips. This was observed to result from an upward migration of limpets (Patella sp.) on strip 9 relative to the other strip. The limpets were seen in the bottom level of both strips during the spring of 1976, but by August they had

Figure 10: Matrices of the similarities calculated between samples at different levels in the control strip, and showing the zonation found in vertically adjacent populations. Similarities are presented as percentage values and are also grouped as follows:

0 - 19%

20 - 39%

40 - 59%

60 - 79%

80 - 100%

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	40	100						
2.70	17	79	100					
2.61	10	40	53	100				
2.49	0	28	39	78	100			
2.37	0	59	70	50	64	100		
2.17	9	19	30	47	42	38	100	
1.89	1	11	12	54	59	32	63	100

10 FEB 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	21	100						
2.70	37	36	100					
2.61	45	54	38	100				
2.49	2	40	14	44	100			
2.37	2	47	23	39	62	100		
2.17	23	40	25	57	71	76	100	
1.89	15	10	19	22	53	39	53	100

30 JUN 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	57	100						
2.70	23	33	100					
2.61	1	15	75	100				
2.49	1	19	62	67	100			
2.37	1	1	1	1	14	100		
2.17	1	1	11	10	23	63	100	
1.89	1	0	1	0	16	47	63	100

28 AUG 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	40	100						
2.70	18	47	100					
2.61	21	40	82	100				
2.49	11	41	82	80	100			
2.37	10	26	69	77	86	100		
2.17	9	22	64	43	61	58	100	
1.89	20	27	55	60	60	57	61	100

15 JAN 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	74	100						
2.70	28	70	100					
2.61	27	70	99	100				
2.49	1	11	26	25	100			
2.37	1	9	21	21	84	100		
2.17	1	9	21	21	84	91	100	
1.89	1	1	1	1	75	74	84	100

12 MAR 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	89	100						
2.70	61	71	100					
2.61	13	12	10	100				
2.49	0	1	1	75	100			
2.37	0	1	1	84	84	100		
2.17	0	1	1	57	67	69	100	
1.89	0	0	1	52	61	56	70	100

14 AUG 1976

Table 4: The percent similarity between samples from the same level in strips 9 and 10 during the recolonization. A (-) indicates that no organisms were found in at least one of the strips on microscopic examination of the scrapings.

	1975 Sep 26	Nov 27	1976 Jan 15	Mar 12	May 19	Aug 14
LEVEL(m)						
3.04	-	71	99	82	99	99
2.86	-	84	90	91	78	67
2.70	-	78	72	67	75	89
2.61	-	80	99	77	67	82
2.49	40	86	86	89	65	76
2.37	16	99	80	80	72	19
2.17	68	99	100	100	91	13
1.89	89	100	91	100	75	79

moved much higher on strip 9. The similarities between the two strips at the 2.17 and 2.37m levels were low because only Ralfsia verrucosa was found in the presence of the limpets, whereas a population of fucoid germlings and barnacles developed on strip 10 at the same levels. The photographs in Plate 3 show the denudation caused by the limpets on strip 9 when they moved out of their usual range.

C.4.2. Initial colonizers:

The time needed for organisms to substantially cover (i.e. cover > 50%) a cleared strip was found to depend on both the level on the shore and the time of the year in which it was cleared. In general, strips cleared in the spring and summer were colonized more rapidly than those cleared in the autumn and winter, and as shown in Table 5, the higher levels on the shore took longer to develop a substantial cover than the lower ones. The largest difference between levels was found for strip 5 where it took 33 weeks for the top level to develop a cover, and only 5 weeks in the bottom levels. However, not all strips were found to follow this pattern. On strip 2 all 8 levels were colonized at the same time, and on strips 9 and 10 the middle levels took the longest to develop a substantial cover.

Six species - Enteromorpha intestinalis, Blidingia minima (both the crustal and filamentous forms), Ulothrix pseudoflacca, Urospora penicilliformis, Spongomorpha arcta, and Balanus balanoides - and the blue-green crust were the organisms that first came to dominate a strip after it was cleared (i.e. those that first covered more than 50% of the substratum). Other algal species present in the first samples after a population had developed, but never in a dominant position on the substratum, included Enteromorpha prolifera, Pseudendoclonium submarinum, Prasiola stipitata, Monostroma oxyspermum, Ulothrix flacca, Hildenbrandia rubra, Ralfsia verrucosa, Ectocarpus sp. and the creeping brown filamentous algae.

The diversity among these first colonists differed with time and

A

B

Plate 3: A: Strip 9 and 10 showing the differences in vegetation resulting from limpet grazing in the bottom levels.

B: Close-up of strip 9 showing the usual range of limpets (R) and the limpets that had migrated to the 2.37m level (L).

STRIP	1	2	4	5	6	7	8	9	10	11
Date Cleared	9 Aug 1974	25 Sep 1974	10 Dec 1974	10 Feb 1975	8 Apr 1975	4 June 1975	18 July 1975	2 Sept 1975	2 Sept 1975	15 Jan 1976
Level (M)										
3.04	14	11-16	17-22	33-42	25-34	16-25	10-19	3-12	3-12	17-30
2.86	<7	11-16	17-22	33-42	25-34	16-25	10-19	3-12	3-12	17-30
2.70	<7	11-16	17-22	4-8	21-25	16-25	6-10	3-12	3-12	8-17
2.61	<7	11-16	17-22	4-8	12-21	3-12	<6	12-19	12-19	8-17
2.49	<7	11-16	13-17	4-8	5-12	3-12	<6	19-26	19-26	8-17
2.37	<7	11-16	13-17	4-8	<5	3-12	<6	12-19	12-19	3-8
2.17	<7	11-16	13-17	4-8	<5	<3	<6	12-19	12-19	3-8
1.89	<7	11-16	13-17	4-8	<5	<3	<6	<3	<3	3-8

Table 5: The time required, in weeks, for the substratum in cleared strips to develop a substantial cover of colonizing organisms (i.e. > 50%).

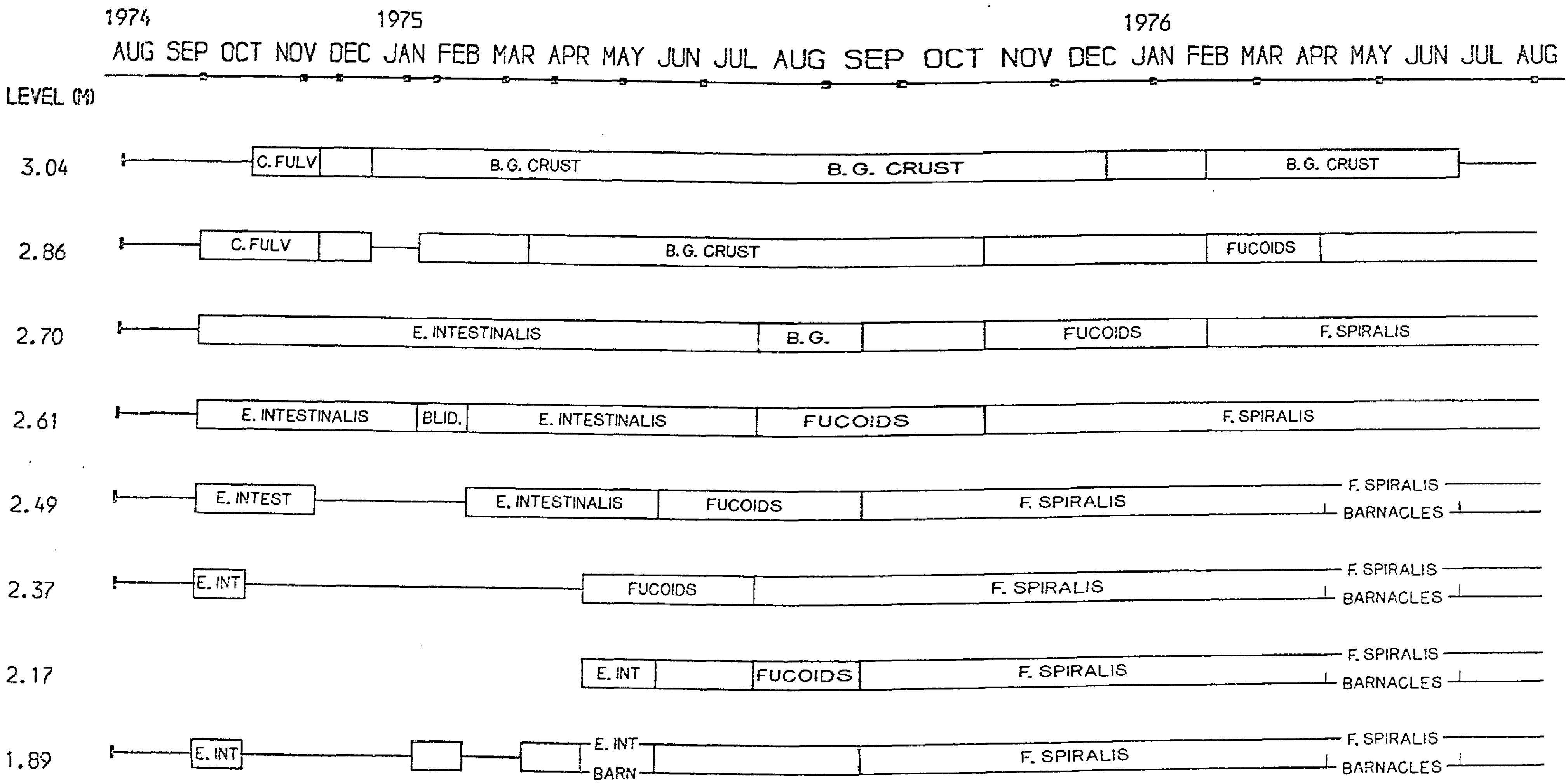
level to such a degree that no definite patterns could be distinguished for the first stages of recolonization on a cleared strip. In the first place, no pattern in the initial dominants could be distinguished as has been reported by Lee (1966) because the initial dominants as a category of species could not be established from the data. Species appearing as the first dominant on one strip could also be found as a dominant during later stages of recolonization. For example, Enteromorpha intestinalis was the first dominant species at most levels on strip 1 (Figure 11) but it appeared second in the sequences on some levels of strip 2 (Figure 12), and in strips 8,9,10,11. Moreover, Enteromorpha intestinalis appeared twice in the recolonization sequence of one quadrat. At the 2.61m level of strip 1 it was found as the first dominant, and also as the third, after a period when the substratum was dominated by the Blidingia crust (see Figure 11). The dominant species found during the recolonization on each strip are given in Appendix VII.

Secondly, although different species were found as the first dominant within one strip, no species which appeared more than once in this position could be identified with any specific zone or level. The first dominants that appeared on the 8 levels in the different strips are listed in Table 6. The Blidingia crust was the most common initial dominant, but as can be seen in the table, the levels at which the crust was found differed in each of the strips where it appeared. Its appearance as a dominant is in contrast to the fairly uniform frequency with which it was observed at the different levels (see Figure 4). In strips 4, 8 and 10 the crust even appeared in separate zones within one strip.

Finally, no definite patterns could be distinguished in the zonation that appeared with the first colonists. The similarity matrices given in Figure 13 show the zonation that first appeared after clearing in several strips, and exemplify the differences that were found. The similarity matrices for all 10 strips cleared are given in Appendix VI. It was also noted that the initial zonation in all strips was different from that in the control strip on the appropriate day.

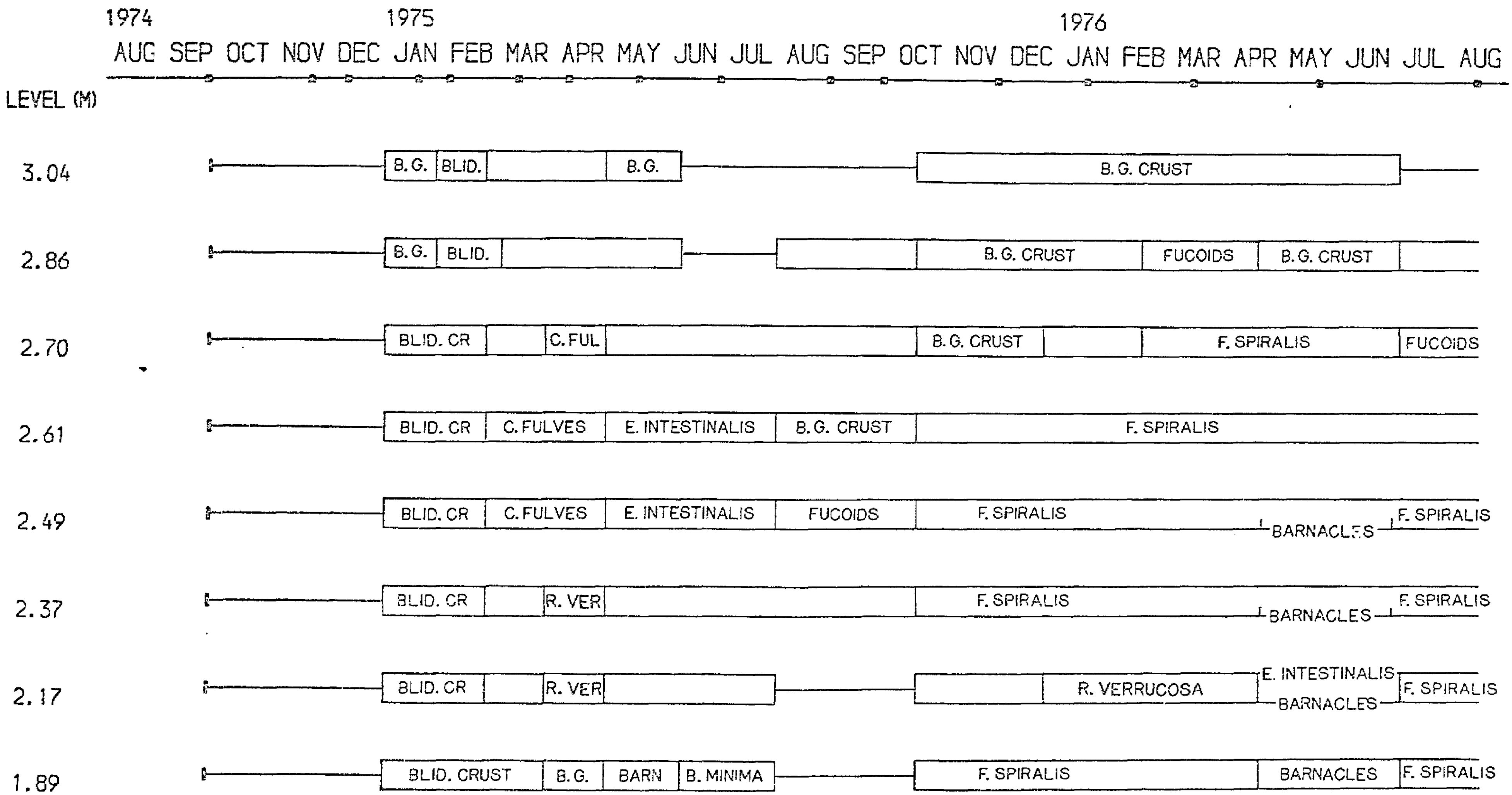
Figure 11: Dominant species which covered more than 50% of the sampling quadrats in strip 1. A single line indicates times when the total cover was less than 50%. A block without a named species indicates times when the total cover was in excess of 50%, but no single species was dominant. The sampling times are marked on the horizontal axis. Abbreviations used:

B.G., B.G.CRUST	- Blue-green algal crust
E. INT, E. INTEST	- *Enteromorpha intestinalis*
BLID, BLID.CR	- *Blidingia* crust
C.FULV, C.FULVES	- *Capsosiphon fulvescens*
FUCOIDS	- fucoid germlings
R.VER	- *Ralfsia verrucosa*
BARN	- barnacles



1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
C. FULV
B. G. CRUST
B. G. CRUST
B. G. CRUST
2.86
C. FULV
B. G. CRUST
FUCOIDS
2.70
E. INTESTINALIS
B. G.
FUCOIDS
F. SPIRALIS
2.61
E. INTESTINALIS
BLID.
E. INTESTINALIS
FUCOIDS
F. SPIRALIS
2.49
E. INTEST
E. INTESTINALIS
FUCOIDS
F. SPIRALIS
F. SPIRALIS
BARNACLES
2.37
E. INT
FUCOIDS
F. SPIRALIS
F. SPIRALIS
BARNACLES
2.17
E. INT
FUCOIDS
F. SPIRALIS
F. SPIRALIS
BARNACLES
1.89
E. INT
E. INT
BARN
F. SPIRALIS
F. SPIRALIS
BARNACLES

Figure 12: Dominant species which covered more than 50% of the sampling quadrat in strip 2. The same abbreviations are used as in Figure 11.



STRIP	1	2	4	5	6	7	8	9	10	11
Date Cleared	9 Aug 1974	25 Sep 1974	10 Dec 1974	10 Feb 1975	8 Apr 1975	4 June 1975	18 July 1975	2 Sept 1975	2 Sept 1975	15 Jan 1976
Level (M)										
3.04	C. fulvescens	Blue-green crust	Blue-green crust	Blue-green crust	Blue-green crust	Blue-green crust	Blidingia crust	Blue-green crust	Blue-green crust	Blue-green crust
2.86	C. fulvescens	Blue-green crust	Blue-green crust	Blue-green crust	Blue-green crust	Blue-green crust	Blidingia crust	Blidingia crust	Blidingia crust	Blue-green crust
2.70	E. intestinalis	Blidingia crust	Blidingia crust	fucoid germlings	Blue-green crust	fucoid germlings	Blue-green crust	Blidingia crust	Blidingia crust	Blue-green crust
2.61	E. intestinalis	Blidingia crust	Blidingia crust	U. pencilliformis	Blidingia crust	C. fulvescens	Blidingia crust	Blidingia crust	fucoid germlings	-
2.49	E. intestinalis	Blidingia crust	Blidingia crust	Blidingia crust	Barnacles	C. fulvescens	Blidingia crust	Blidingia crust	Blidingia crust	Barnacles
2.37	E. intestinalis	Blidingia crust	fucoid germlings	U. pseudoflacca	Barnacles	Blidingia crust	Blidingia crust	Blidingia crust	Blidingia crust	Barnacles
2.17	E. intestinalis	Blidingia crust	Blidingia crust	S. arcta	Barnacles	B. minima	Blue-green crust	Blidingia crust	Blidingia crust	Blidingia crust
1.89	E. intestinalis	Blidingia crust	Blidingia crust	S. arcta	Barnacles	B. minima	Blue-green crust	Blidingia crust	Blidingia crust	Blidingia crust

Table 6: The first organism whose cover was greater than 50% on the strips after they were cleared.

3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89	LEVEL (M)
100								3.04
23	100							2.86
1	0	100						2.70
23	13	93	100					2.61
23	13	93	100	100				2.49
23	13	93	100	100	100			2.37
23	13	93	100	100	100	100		2.17
23	13	93	100	100	100	100	100	1.89

STRIP 1 24 SEP 1974

100							
100	100						
100	100	100					
100	100	100	100				
100	100	100	100	100			
100	100	100	100	100	100		
100	100	100	100	100	100	100	
100	100	100	100	100	100	100	100

STRIP 2 24 OCT 1974

100							
86	100						
86	100	100					
9	8	8	100				
2	2	2	66	100			
1	1	1	23	22	100		
1	1	1	19	18	89	100	
0	0	0	14	14	64	75	100

STRIP 6 15 MAY 1975

Figure 13: Matrices of the similarities calculated between samples at different levels in strips 1,2, and 6, showing the zonation that appeared with the first colonizing populations

C.4.3. Recolonization sequences:

The crust of blue-green algae and Fucus spiralis eventually re-established their dominant position on the shore in strips 1 - 10, indicating that the recolonization sequences were terminated (field observations were stopped before these organisms appeared in strip 11). However, no pattern could be found in the sequence of dominant species that colonized the strips before this final point was reached. As shown in Table 7 the number of species that appeared as dominants in a recolonization sequence could vary between the same level on different strips and between different levels on one strip. In addition, differences were found in the sequence of dominant species appearing on strips cleared within the same season, either in the same year or in successive years. For example, strips 1 and 2 were cleared on 9 August and 25 September 1974 respectively, but as can be seen by comparing Figures 11 and 12 there was little similarity in their sequences. At the 2.61m level the sequence of dominants in strip 1 was Enteromorpha intestinalis, Blidingia crust, Enteromorpha intestinalis, and fucoid germlings, whereas in strip 2 it was Blidingia crust, Capsosiphon fulvescens, Enteromorpha intestinalis, blue-green algal crust, and finally the fucoid germlings. Strips 4, 5 and 11 were cleared during the winters of 1975 and 1976 respectively, and again their sequence of dominants was found to be quite different (see Appendix VII where the sequences of dominant species for all strips are shown). A similar sequence of dominants was observed only in the two strips cleared on the same day.

When fucoid germlings appeared as a dominant on the substratum during recolonization they grew as a very dense turf of small plants. The growth of germlings was so dense that little substratum remained available for the development of an understory or crustal layer. As a result, the populations dominated by the turf had a reduced species number when compared with that in the population that preceded or followed. For example, at the 2.49m level on strip 5 the species number decreased from 9 to 4 on the development of the turf of germlings. In contrast, the species number under the Fucus spiralis canopy in the

STRIP	1	2	4	5	6	7	8	9	10	11
Level (M)										
3.04	1	0	0	0	0	0	1	0	0	0
2.86	1	0	0	0	0	0	1	1	2	0
2.70	2	3	2	0	0	0	0	3	2	0
2.61	3	4	1	2	1	1	2	1	0	?
2.49	2	3	1	1	2	1	1	3	2	>1
2.37	1	2	0	2	1	1	2	>4	2	>1
2.17	2	5	2	1	2	2	3	>3	3	>2
1.89	3	4	3	3	2	2	5	>3	>2	>3

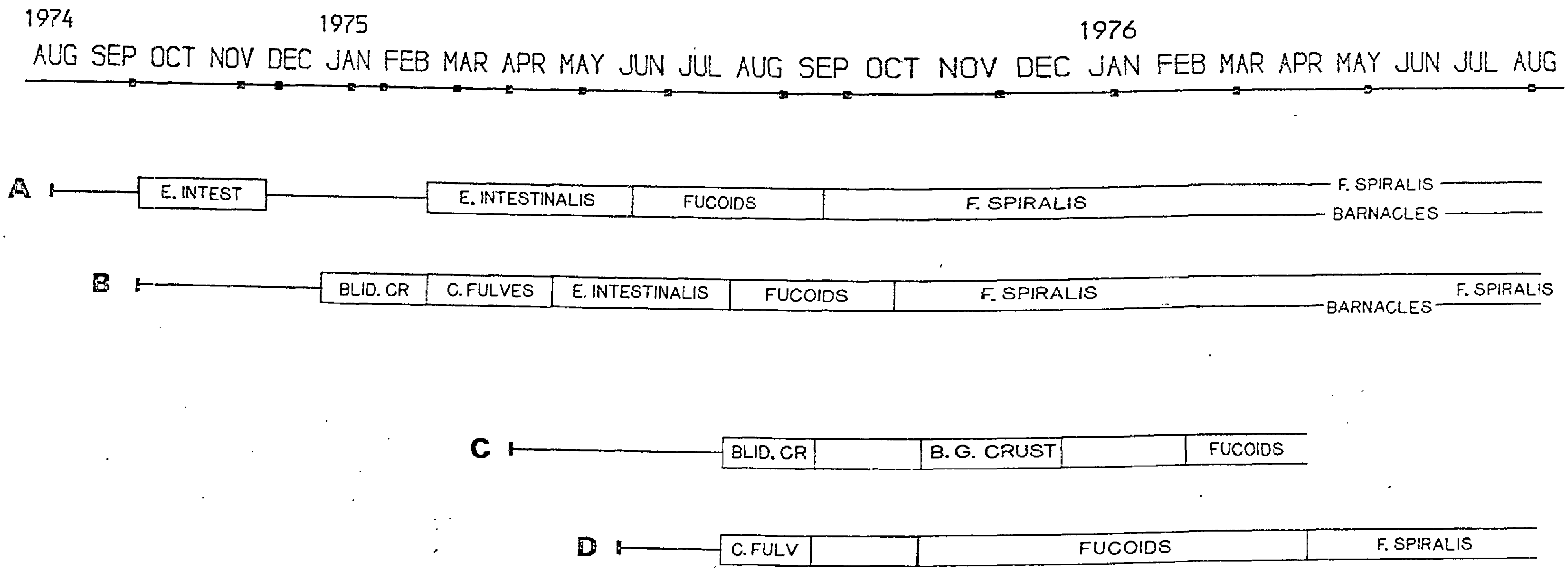
Table 7: The number of organisms whose cover was greater than 50% appearing on cleared strips during the recolonization sequences, and before the establishment of fucoid germlings or the crust of blue-green algae.

in the middle and lower levels of most strips, and this observation provides additional reason for separating the germlings from the mature plants in the calculations of similarities.

While monitoring the sequence of dominant species on the strips it was also found that an established species could effectively delay the monopolization of the substratum by the species which appeared as the next dominant in the sequence. Two examples of this phenomenon are shown in Figure 14, both involving the fucoid germlings which were the final organism in the sequence. In the first example, taken from strips 1 and 2, the dominance of the germlings in strip 2 was delayed by two months relative to that in strip 1. This was not a result of the later clearing of strip 2 because the germlings had overwintered on both strips as microscopic plants. The delay was caused by the presence on strip 2 of a dense population of Enteromorpha intestinalis at a time when it was absent from strip 1. In both strips the germlings grew into a dominant position on the substratum only after the E. intestinalis became fertile and disappeared from the rock, but in strip 2 the entire sequence was delayed for two months. The probable reason for this delay in the growth of E. intestinalis on strip 2 was the earlier presence of a dense cover of Capsosiphon fulvescens. On strip 2 the E. intestinalis became dominant only after the C. fulvescens was itself lost from the rock after it became fertile. The second example shows the sequence of dominants at the 2.61m level in strips 6 and 7. In this case the fucoid germlings became dominant on strip 6 three months later than on strip 7, even though strip 6 was cleared two months earlier. The relative delay in the establishment of the fucoid germlings as a dominant on strip 6 was 5 months. This can be attributed to the presence on the strip of crusts of blue-greens and Blidingia which effectively monopolized the substratum, probably until their growth cycle was terminated.

The differences between the colonizing populations and those normally found in undisturbed areas were large enough to permit an easy separation between them with the similarity coefficients, regardless of

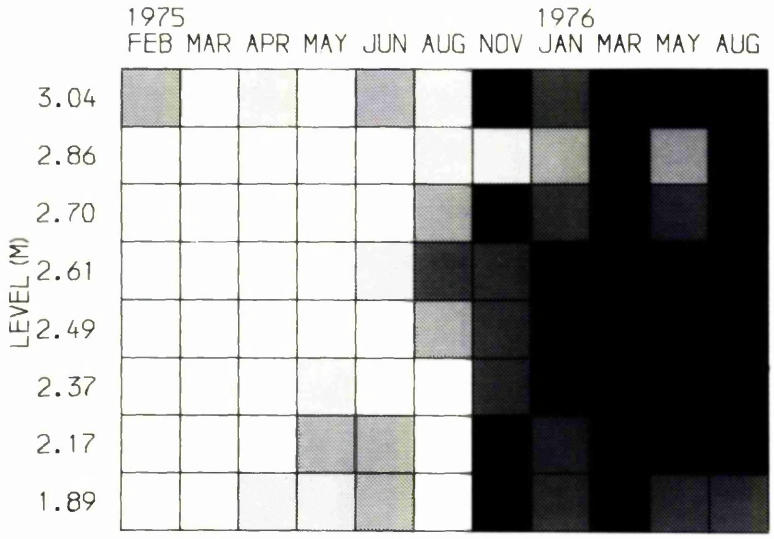
Figure 14: The sequences of dominant species which covered more than 50% of the sampling quadrat on the 2.49 m level in strips 1 (A) and 2 (B), and the 2.61 m level in strips 6 (C) and 7 (D).



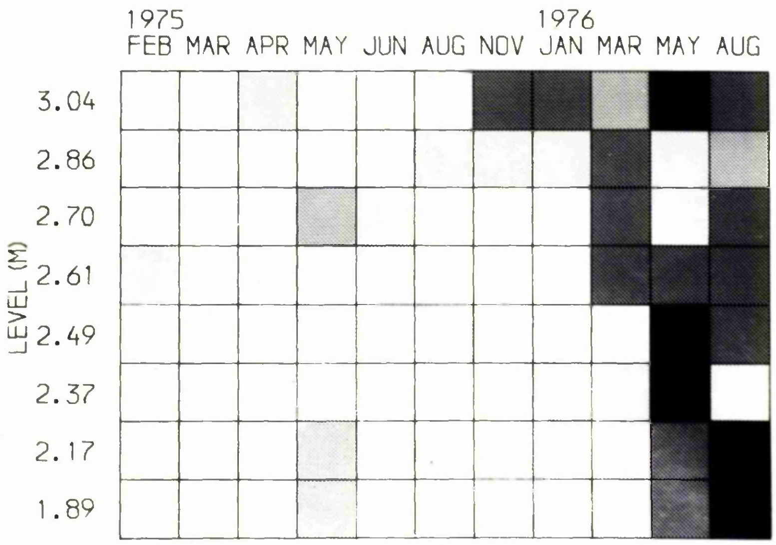
the patchiness that could be found between different quadrats at the same level. The similarity between each level on four cleared strips with the corresponding level from the control are presented graphically in Figure 15, with the actual values for all strips tabulated in Appendix VIII. The calculated coefficients show that in all strips the populations came to resemble those in the control sooner in the top levels than in the lower ones. The few anomalous values in the top levels of some strips that do not fit this pattern result from the separation of fucoid germlings and Fucus spiralis in the calculations.

Although the populations in the cleared strips eventually came to resemble those in the control, the duration of the recolonization was different for each strip. The populations in several strips returned to 'normal' (i.e. came to resemble the control) at one time rather than in the sequence of their clearing. Furthermore, major seasonal differences were found in the length of time required. In the first two strips, cleared in the autumn of 1974, more than a year elapsed before the populations returned to 'normal' (see Figure 15A). In the next 4 strips (numbers 4 - 7), cleared between December 1974 and June 1975 less time was required, and the populations on all four strips came to resemble those in the control at the same time - the top level by November 1975, the next three by March 1976, and the bottom four by May 1976 (see Figure 15B,C,D). With the exception of the uppermost levels, the three strips cleared during the autumn of 1975 (strips 9, 10) were again found to need a year to return to 'normal' since the populations in August 1976 on these strips (a year after clearing) were still different from those in the control.

Similarities calculated between the samples from the same level on each strip indicate that the populations involved in the recolonization sequence were also highly variable, and no seasonal or other patterns were evident. The number of distinct populations, and their duration was found to vary between levels on the same strip and between strips. The similarity matrices for each level of the strips that had returned to 'normal' are presented in Appendix V. The matrices showing the temporal similarities in populations from three levels in strip 5 ar-



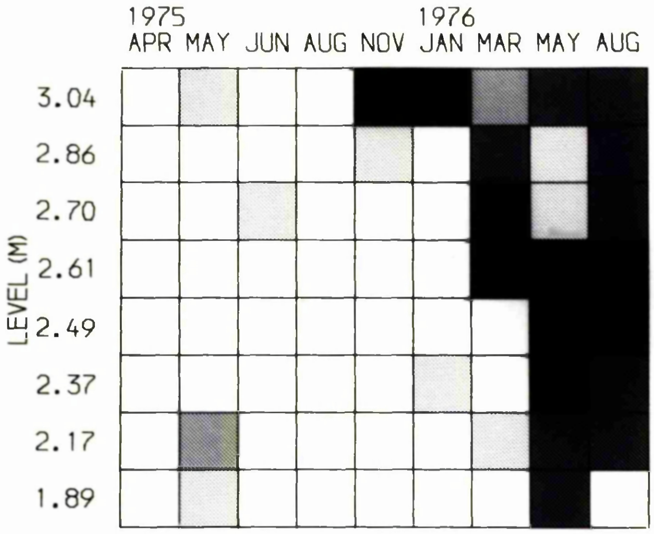
A



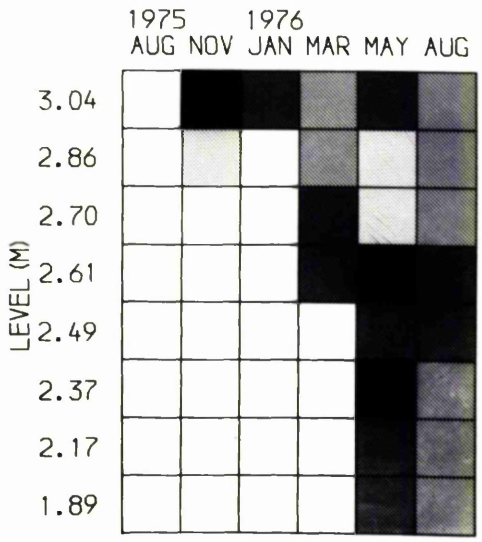
B

Figure 15: Matrices of similarities calculated between samples on the same level in cleared strips and the control. Between strip 1 and control (A); strip 4 and control (B); strip 5 and control (C); strip 7 and control (D). The percentage similarities are

0-19% , 20 - 39% , 40 - 59% , 60 - 79% , 80 - 100% .


1975
APR MAY JUN AUG NOV
1976
JAN MAR MAY AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89

C


1975
AUG NOV
1976
JAN MAR MAY AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89

D

shown in Figure 16 as an example of the variability encountered within one strip. At the 2.86m level there were two periods between the time of clearing and the return to 'normal' when the similarities between consecutive samples was fairly high. This indicates that two populations were involved in the recolonization. In this case the similarities also show that it was the same population which appeared twice in the sequence. In the level just below this one, at 2.70m, only one population could be identified from the matrix, but in the next lower level, at 2.61m, three separate populations of much shorter duration were found. In the latter case there was no repetition of populations such as that found at the 2.86m level. In addition, distinct populations were hard to identify on some levels because the species diversity between consecutive samples was not changing in a regular way (Figure 17).

The re-establishment of the usual populations at various levels was generally found to correspond to the appearance in the similarity matrices of a separate, identifiable group which bore little resemblance to those that preceded it (see Appendix V and Figure 17). In the upper levels of strips 1, 2, 4 and 5 the time at which the 'normal' population became established does not exactly match the time at which they came to resemble the control (see Figures 16A,B) because the fucoid germlings or the blue-green algal crust were absent from the control at the time they appeared on the cleared strips. The similarities between the cleared strips and the control increased only after the germlings and crust had also become established in the latter.

The zonation patterns that were established with the first colonists, described previously, never remained constant for very long. The complete set of similarity matrices showing the zonation changes in each strip are given in Appendix VI, with Figure 18 shown here to demonstrate that, as in the control strip, the number of zones could vary between one and three for the levels sampled. However, in contrast to the control, a population appearing in the recolonization sequence could appear in more than one zone on the same day (8 Apr. 1975).

	1975 APR	MAY	JUN	AUG	SEP	NOV	1976 JAN	MAR	MAY	AUG
APR	100									
MAY	96	100								
JUN	4	9	100							
AUG	49	50	3	100						
SEP	65	67	5	41	100					
NOV	2	2	1	1	20	100				
JAN	15	15	1	13	27	67	100			
MAR	1	1	1	1	17	78	87	100		
MAY	15	15	1	13	27	67	69	70	100	
AUG	1	2	1	1	20	63	76	88	57	100

A

Figure 16: Matrices of similarities calculated between populations at the same level on strip 5: 2.86m (A), 2.70m (B), 2.61m (C). Similarities are presented as percentage values and are also grouped as follows:

0 - 19% , 20 - 39% , 40 - 59% , 60 - 79% , 80 - 100%

The time populations returned to 'normal' is indicated by a black line.

	1975 APR	MAY	JUN	AUG	SEP	NOV	1976 JAN	MAR	MAY	AUG
APR	100									
MAY	71	100								
JUN	44	31	100							
AUG	21	29	67	100						
SEP	19	27	60	73	100					
NOV	1	12	1	16	15	100				
JAN	1	12	1	16	15	75	100			
MAR	1	12	1	15	14	71	94	100		
MAY	0	21	1	14	13	12	12	21	100	
AUG	0	12	0	0	0	1	1	1	89	100

C

	1975 APR	MAY	JUN	AUG	SEP	NOV	1976 JAN	MAR	MAY	AUG
APR	100									
MAY	41	100								
JUN	30	42	100							
AUG	40	25	40	100						
SEP	40	25	40	100	100					
NOV	45	30	51	57	57	100				
JAN	19	11	13	21	21	33	100			
MAR	14	1	1	16	16	34	67	100		
MAY	29	17	23	33	33	54	61	71	100	
AUG	0	1	1	0	0	20	64	88	67	100

B

	1975 FEB	MAR	APR	MAY	JUN	AUG	SEP	NOV	1976 JAN	MAR	MAY	AUG
FEB	100											
MAR	67	100										
APR	25	44	100									
MAY	12	23	44	100								
JUN	13	24	19	39	100							
AUG	34	56	50	38	31	100						
SEP	34	29	17	19	20	60	100					
NOV	18	16	12	15	16	40	53	100				
JAN	0	0	1	8	8	25	38	86	100			
MAR	1	23	57	44	19	67	51	35	34	100		
MAY	12	12	18	64	14	30	30	24	16	27	100	
AUG	1	1	1	34	9	16	17	12	11	14	61	100

Figure 17: Similarity matrix for populations at the 1.89m level on strip 4. Similarities are presented as percentage values and are also grouped as follows:

0 - 19% 20 - 39% 40 - 59% 60 - 79% 80 - 100%.

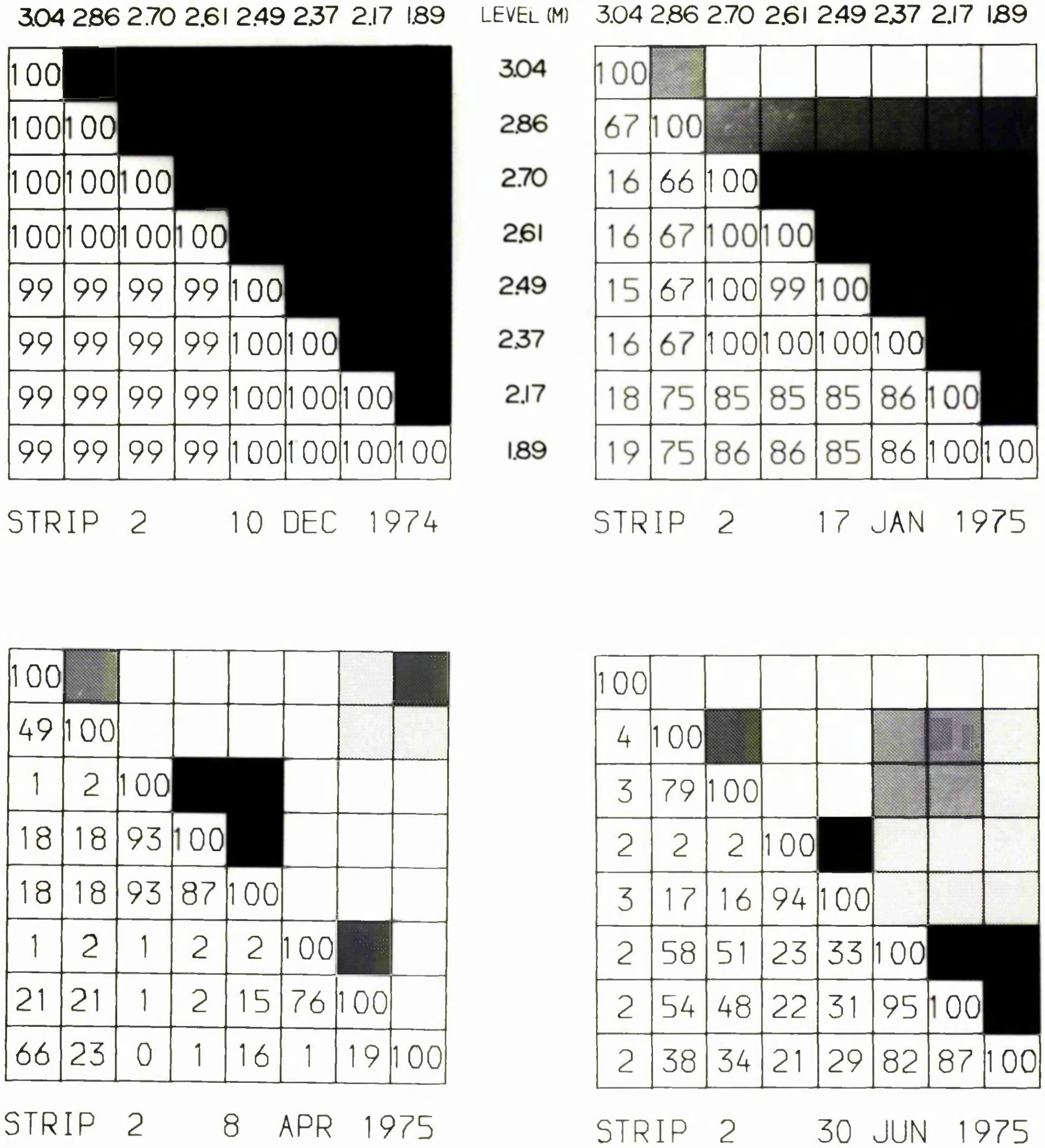


Figure 18: Similarity matrices showing zonation during the recolonization of strip 2. Similarities are presented as percentage values, and are also grouped as follows:

0 - 19%; 20 - 39%; 40 - 59%; 60 - 79%; 80 - 100%

During the recolonization of a strip very few zonation patterns were found to match those in the control for the appropriate day. Of the 47 comparisons made between the cleared strips and the control before the former had returned to normal only 9 or 19% were similar. However once the sequence was terminated the zonation in the strips that had been cleared came to generally resemble those in the control. Out of 16 possible comparisons, 12 were found to be similar (75%). Figure 19 is shown here as an example of the similarity in zonation that was found once the cleared strips came to resemble the control. On occasion the zonation patterns did not exactly match at one or two levels (last level in Figure 19D,F) because of the patchiness in species distributions which was found even on this uniform slab.

DISCUSSION

D.1. The use of similarity coefficients

The applications of similarity coefficients to ecological studies were first developed by terrestrial botanists for comparing vegetational groupings in different environments (reviewed by Goodall, 1970; Lambert, 1972). Their usefulness for such studies results from the fact that each sample, regardless of species diversity, can be treated as a single unit of a population. For similarity coefficients to have any validity it must be assumed that the samples compared are separated by some environmental dimension. In the terrestrial studies the samples have generally been separated by physical distances in three-dimensional space. In rocky shore communities this approach has been used to provide comparisons between different locations (Field and McFarlane, 1968), or between different zones (Russell, 1972; 1973).

However, time is also an environmental dimension, and similarity coefficients have been used for rocky shore communities to monitor temporal changes on one site (Boudouresque, 1973; Hruby, 1975). In the present study samples separated in both time and space have been compared by calculating the similarity between them in an attempt to

Figure 19: Similarity matrices showing zonation in the control and 5 of the cleared strips after the populations in the latter had returned to 'normal'. Similarities are presented as percentage values and are also grouped as follows:

0 - 19%
20 - 39%
40 - 59%
60 - 79%
80 - 100%

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	89	100						
2.70	61	71	100					
2.61	13	12	10	100				
2.49	0	1	1	75	100			
2.37	0	1	1	84	84	100		
2.17	0	1	1	57	67	69	100	
1.89	0	0	1	52	61	56	70	100

CONTROL 14 AUG 1976

A

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	88	100						
2.70	50	62	100					
2.61	13	12	10	100				
2.49	0	1	1	84	100			
2.37	0	1	1	84	93	100		
2.17	1	1	1	64	74	74	100	
1.89	0	1	1	67	77	77	88	100

STRIP 1 14 AUG 1976

B

100							
89	100						
29	40	100					
1	1	10	100				
0	0	10	86	100			
1	1	9	84	80	100		
12	11	18	58	69	64	100	
0	1	0	64	75	76	60	100

STRIP 2 14 AUG 1976

C

100							
71	100						
0	40	100					
0	0	1	100				
0	0	1	94	100			
1	1	1	84	90	100		
1	1	1	80	85	78	100	
20	17	1	0	16	14	38	100

STRIP 5 14 AUG 1976

D

100							
82	100						
0	32	100					
0	0	10	100				
0	0	9	92	100			
0	0	9	92	100	100		
0	0	9	92	100	100	100	
0	0	22	76	69	70	70	100

STRIP 7 14 AUG 1976

E

100							
100	100						
60	60	100					
1	1	38	100				
1	1	34	91	100			
1	1	32	87	96	100		
1	1	1	32	48	46	100	
1	1	1	1	1	1	46	100

STRIP 8 14 AUG 1976

F

understand how species distributions in three dimensional space (community structure) change with time.

Different coefficients have been developed to measure similarities between samples (Sokal and Sneath, 1963; Blanc et al., 1976). The coefficient of Bray and Curtis (1957) was used because it includes both diversity and cover in the measure of similarity. This has proved to be more suitable for comparing algal populations from one location than ones incorporating only diversity data (Hruby, 1975). The coefficient was originally chosen because it had been used in previous studies of littoral communities (Field and McFarlane, 1968; Russell, 1972; 1973; Boudouresque, 1973), but more recently a mathematical justification for its use has been made possible. The equation used, 2W/A+B, is one of a group originally developed for calculating similarities on the basis of presence/absence data which do not include the negative matches (i.e. the absence of the same species from the two samples compared is not regarded as a similarity between them). Negative matches could not be included in the calculation of similarities for the samples in the present study because the total number of units (i.e. the species and their cover) on which such matches are based was indeterminate. The sampling method did not give the total number of species within a quadrat, and the diversity was known to change with time. Of the group of coefficients which do not include negative matches the one used is the most sensitive to small changes in populations, and thus is best suited for identifying discontinuities in homogeneous assemblages (Blanc et al., 1976). On the basis of this criterion, the coefficient used is appropriate for comparing algal populations found in one habitat at one location. Algal populations within a small area such as the experimental site belong to a fairly homogeneous assemblage if they are considered in terms of the floristic differences that exist between habitats on a world-wide basis.

The data used in the calculations were the estimates of the amount of substratum covered by each species. Since the populations could be layered, with one species, such as *Ralfsia verrucosa*, growing as a crust on the rock and *Fucus spiralis* growing over this crust, the total cover for all species at times exceeded 100%. Although it has been the practice to transform such highly variable data and standardize it relative to the site (i.e. each site is allowed a maximum cover of 100% and the data is adjusted accordingly), Noy-Meir et al. (1975) have found that for studies of species distribution patterns it is best to leave the data untransformed.

Since the definition of what is an allowable variation in assigning the bounds of a population is a subjective evaluation, a controversy has existed among ecologists regarding the validity of defining identifiable population units by species diversity (Whittaker, 1967). These objections notwithstanding, the advantages of working with identifiable units remain, especially in the littoral habitat where sharp horizontal and vertical discontinuities in species distributions exist.

In this study it was found that a similarity of 80% can be used to separate populations. This however, is a statistical criterion based on the precision of the sampling method and does not take into account the variations that might be permissible within one population. To account for such variations a lower similarity value is needed to separate groups. Using the same coefficient, Russell (1972) divided littoral algal samples into different groups when similarities were less than 40%, while Field and McFarlane (1968) used a value of 60% when separating faunal samples from a rocky shore. I have found (Hruby, 1975) that a similarity of 50% will separate a subtidal algal assemblage on a seasonal basis. Furthermore, when presence/absence data was used with this equation, Sorensen (1948) identified 'first order associations' if the similarities between samples were above 50%, and when his data was subjected to a more rigorous statistical analysis Looman and Campbell (1960) found that the significant value was between 48% - 63%. In general it seems that similarity values between 40% and 60% are significant in separating faunal or floral populations on either visible or statistical criteria.

D.2. Changes in species distributions:

Time dependent changes in species diversity have been observed on most rocky shores. Among algal species changes in diversity have been found to occur in three different ways. The first, and probably most common, results from the seasonal appearance of many short-lived, or annual species (for reviews see Feldman, 1937; 1951; Fritsch, 1945; Conover, 1958). The second type of change results from seasonal differences in the abundance of some species that are permanent members of the population, and one of the earliest records of such changes are from Cumbrae (Gibb, 1939). Finally, some species have been observed to change their vertical range on the shore on a seasonal basis (a seasonal upshore 'migration', Knight and Parke, 1931; Gibb, 1939; Rees 1934, 1940; den Hartog 1959).

The temporal changes in species diversity observed during this study are in general agreement with those already reported, and all three types of seasonal changes were observed within the test site. As seen in Table 3 several species were found only during certain seasons of the year. Furthermore, many of those that were classified as 'occasional' could in fact be seasonal. The sampling method did not give the total number of species to be found at any one time, and seasonal, but rare, species could have been missed in some samples. For example, no definite seasonal pattern was found in the distribution of Monostroma oxyspermum on Cumbrae, but Kristiansen (1972) found it as an autumn-winter species in Denmark.

Seasonal differences in the abundance of some species were also noticeable on Cumbrae, especially among the Chlorophyta. Both in 1975 and 1976 the abundance of Enteromorpha intestinalis was greatest in the late winter and early spring, and on the upper levels of the shore a seasonal maximum in the spring was observed in the abundances of Prasiola stipitata, Ulothrix pseudoflacca, and Urospora penicilliformis. Seasonal maxima in these four species have been previously reported on Cumbrae by Gibb (1939).

Finally, some of the species in the experimental site were observed to 'migrate' to higher levels on the shore during the winter months, both in 1975 and 1976.

The seasonal presence of some species and the seasonal 'migration' of others resulted in very distinct patterns of species numbers at the different levels. In the top levels the maximum number of species was found during the winter, whereas in the lower ones it occurred during the spring. This aspect of species distributions was not investigated in the present study but one can speculate on the probable causes for this dichotomy. Knight and Parke (1931) suggest that the loss of species from lower levels during the winter may result from the decreased insolation associated with this period. The maximum could then occur in the spring because the amount of light available increases before the shore is severely stressed by the summer period of high temperatures. At the upper levels the number of species is maximal in the winter probably because this is the only time when many species can grow, the environmental stresses during the rest of the year being too great.

D.3. Temporal changes in the undisturbed strip:

Studies of the presence/absence in individual species are basically descriptive, and they generally only provide information on the biology of specific organisms. However, when data is available for all, or at least the dominant, species in a given assemblage the temporal changes in community structure can be monitored. Since the structure is described in terms of the spatial differences found in species distributions, any changes in the latter can be expected to change some aspects of the structure, such as zonation or stratification.

Using the usual criterion of determining zonation by the dominant species visible (see Stephenson and Stephenson, 1949; Lewis, 1964), the samples from the 8 levels can be separated into two zones, one containing the crust of blue-green algae and *Pelvetia canaliculata*, and the other Fucus spiralis, Ascophyllum nodosum, and Balanus balanoides. According to the classification scheme of Lewis (1964) this distribution identifies the two zones as the littoral fringe and the top of the eulittoral on a moderately sheltered shore. The description of zonation in these terms is very general, but even on this basis temporal changes in zonation could be observed. The visible boundary between the eulittoral and littoral fringe (i.e. between Fucus spiralis and the blue-green crust) changed by 200 vertical millimetres between 1975 and 1976.

The similarity matrices provide a more accurate picture of the vertical discontinuities in species distributions because they are constructed from data which includes information on the abundance of all species rather than just the dominant ones. On this basis the populations in the undisturbed strip show striking temporal changes in zonation. Not only was the level of separation between zones changing with time, but also the number of zones. When the similarity of 40% is used to separate populations three zones could be identified on 28 August 1975 (see Figure 10) but only one could be identified on 30 June 1975 since there was no separation between any of the 8 levels. Even in the extreme case of using 20% as the value to separate populations the 3 zones can still be identified on 28 August.

In the method used only a very narrow strip of the undisturbed shore was sampled, and therefore no claims can be made that the zonation found was representative for the entire shore. However, it does indicate that the number of vertically adjacent populations can change with time.

Thus, on a strip of shore which was originally considered to contain the top two of the three littoral zones postulated by Stephenson and Stephenson (1949); and Lewis (1964), the populations can be divided into groups representing one to three zones. These results indicate that zonation of rocky shore communities is not a fixed structural feature which can be determined for a shore by one set of observations. The fact that temporal differences in zonation do occur may help to explain why the zonation reported by Northcraft (1948), Lawson and Norton (1971), and Russell (1972) does not conform to the usual pattern of three zones.

The similarities used to determine the zonation are based on calculations in which fucoid germlings were separated from adult Fucus spiralis. There were two reasons for this. First, the species in the turf of germlings could not be identified with certainty, and second, the turf of germlings differed from the adult plants in their use of the substratum, and thus could be considered to fill a different ecological 'niche'. However, to discount the possibility that the zonation changes observed were only caused by this distinction, the similarities were re-calculated with all fucoid germlings considered as Fucus spiralis. Although this resulted in slight changes in the zonation identified from the matrices (4 matrices are shown in Appendix IX) the conclusion that zonation changes with time was still tenable.

Three vertical strata have been identified in sublittoral algal populations - a canopy, an understory, and an encrusting layer (Neushul 1965, 1967). On the basis of the different algal growth forms that were observed within the experimental site, this classification seems also to be representative of way littoral species partition the space above the substratum. Fucus spiralis and Ascophyllum nodosum were the largest species on the shore and can be considered as the canopy because they grew out over the substratum and covered it at low tide, (although present on the shore the latter species did not appear in the undisturbed strip until the spring of 1976, and thus Fucus spiralis was effectively the only canopy species sampled). The smaller tufted and filamentous species such as Enteromorpha intestinalis and Cladophora rupestris were readily classified as the understory because they never grew larger than Fucus spiralis and were often found under its canopy. Finally the lowest stratum was filled by the crustose species such as Ralfsia verrucosa, Petrocelis cruenta, Hildenbrandia rubra, and the crust of blue-green algae.

All three strata could be seen in the populations of the two bottom levels sampled. Since Fucus spiralis was the only canopy species sampled, changes in its distribution or abundance resulted in large differences in populations when these were compared by the similarity coefficients. On the other hand, several understory and crustose species were present so that changes in the distributions of individual species in these strata did not radically change the populations.

In the middle four levels only the canopy and crustal strata were readily visible. Several crustose species were again present at any one time, and the abundance of these species under the canopy was maintained in some kind of equilibrium so that no single species became dominant, even though the crustal layer usually covered more than 50% of the substratum. From the observations made during the spring of 1975 the intriguing, and as yet unexplained, inference can be made that it was the presence of Fucus spiralis which kept the crustose species in equilibrium. When the canopy disappeared either Ralfsia verrucosa, the blue-green crust or Petrocelis cruenta became dominant (see Figure 8) and greatly reduced the amount of substratum covered by the other species.

In the upper two levels the algae did manage to fill some of the available space above the substratum, but never to the same extent as further downshore. In the upper levels the crustose species formed the dominant element in the populations. A true canopy of large algae never developed even though the canopy species was present in the form of the fucoid germlings.

These observations indicate that vertical stratification in the algae becomes progressively simpler as one moves up the shore. Furthermore, the vegetation decreases in size and becomes mainly crustose. The environmental conditions are such that a canopy does not have time to develop.

Temporal changes in the amount of substratum covered by each of the three strata were observed at all levels, but they were most noticeable in the bottom ones. In the top two levels the crustal component of the populations was dominant for most of the year, with both Pelvetia canaliculata and the fucoid germlings generally in a subordinate position in terms of the amount of substratum covered. In the middle levels the basic pattern was one of an algal canopy and crust, and if the canopy was removed, as in the spring of 1975, it was quickly replaced by new plants of Fucus spiralis. However, at the bottom levels the amount of substratum covered by each stratum was found to undergo major changes in time. Table 8 gives the amount of substratum covered by each of the three strata at the 1.89m level in the undisturbed strip and shows the variability in the stratification found during the present study. In May 1975 the crustal component of the population was dominant; by the next November it was the canopy; but by the following May it was the understory. When one stratum of species dominated the other two were less developed, and on no occasion were all three strata completely filled simultaneously.

Recent studies have already indicated that temporal changes in zonation and stratification on littoral shores can result from trophic interactions between species in the community. Paine (1974) has found that the zonation of mussels and barnacles can change slightly from year to year as a result of predatory pressures by starfish, and Dayton (1975) has suggested that the removal of canopy species by grazing can result in the subsequent destruction of some of its understory. However, in the present study zonation and stratification were found to change with time in an assemblage of species which are basically all at one trophic level. Highly variable patterns in the presence and abundance of algal species occurred in the absence of any evidence of major grazing pressure.

Although the distribution of individual species can be determined by seasonal factors, no seasonal patterns were found in community structure when the populations were compared by the similarity coefficient. The calculated similarities showed no seasonal trends because the importance of a species in a population was found to change from year to year. For example, Hildenbrandia rubra was found in the spring of both 1975 and 1976, but in 1975 it covered much more of the substratum than in 1976. The diversity of species on the experimental

	1975 Feb	Mar	Apr	May	Jun	Aug	Nov	1976 Jan	Mar	May	Aug
Canopy	<25	<25	<25	<25	<25	25-50	75-100	50-75	50-75	0	50-75
Understory	<25	<25	25-50	25-50	25-50	50-75	25-50	25-50	25-50	75-100	25-50
Crust	50-75	50-75	<25	75-100	50-75	0	<25	<25	0	<25	<25

Table 8: The percent of the substratum covered by each of the three strata at the 1.89 m level in the control strip.

site was high enough so that the composition of a population at any one time seemed to be quite unpredictable.

The magnitude of the changes observed in the undisturbed populations indicate that a definite partitioning of the substratum in time was taking place. If all three vertical strata are filled then the maximum amount of space available for growth is 300% of the original surface. However, the estimated cover of the different species appearing during a year was much greater than this value. At the 1.89m level between March 1975 and March 1976 the equivalent of 500% of the original quadrat was covered by different species. Parts of the substratum must have been continually available for colonization by new species and the diversity of the community was significantly increased in this manner. A maximum of 24 different species were found on the strip at any one time but in the 18 months of this study, 38 species were identified within the same area.

Since the changes in populations were frequent, and occurred within the life-span of the canopy of Fucus spiralis (3-5 years according to Rees, 1932), the ecological concept of a 'climax' population does not seem to be applicable to this rocky shore. The term is usually used to describe a fairly stable population where fluctuations if they exist, center around a stable, relatively constant, mean condition (Whittaker, 1970).

D.4 Changes during recolonization of cleared strips:

The changes in the undisturbed populations described in the previous section can be considered as a process of continuous colonization of the substratum by new species, and the process was investigated by observing the recolonization of strips cleared at different times during the year.

One feature of the results from the clearing experiments is the large variations found in the sequence of colonizing species. Since the two strips cleared on the same day had similar sequences, the causes for such variations must be sought among the environmental or biotic factors that were changing with time.

The large diversity among the first species to colonize a cleared strip was expected since differences in the initial colonization of sequentially exposed substrata is a common phenomenon in both littoral and sublittoral habitats (Wilson, 1925; Hatton, 1932; Bokenham and Stephenson, 1938; Rees, 1940; Lodge, 1948; Northcraft, 1948; Lee, 1966; Boudouresque, 1973; Kain, 1975) and on introduced substrata such as plates (Pyefinch, 1943; Fry, 1975; Harlin and Lindbergh, 1977). Seasonal factors have often been considered to cause these differences. Many species are known to have seasonally determined reproduction; therefore they can appear as colonists only when viable settling cells (spores, gametes, propagules) are available. However, this does not seem adequate to explain all the differences observed during the recolonization of t of the strips cleared in the present study. Fertile plants of Enteromorpha Fertile plants of Enteromorpha intestinalis and Capsosiphon fulvescens were found on the shore at all times strips were cleared, but these species appeared among the first colonists only occasionally. This was especially noticeable with Capsosiphon fulvescens which did not colonize strip 6 even though a dense fertile population inhabited strip 2 nearby.

It is also believed that the species which become the first visible dominants, among those that are seasonally available, are those with relatively faster growth rates (Bokenham and Stephenson, 1938; Northcraft, 1948; Lee, 1966). Lee (1966) argues that the species with simpler growth forms are generally faster growing than those with more complex ones, and thus the species with filamentous and thin thalli will appear first in a sequence, even when spores from all types of plants are available from the beginning. However, once these rapid growing species die off, they cannot re-establish themselves because of a lack of space.

Such a phase of rapid growing plants, predominantly of Chlorophyta, has been commonly noticed in recolonization studies on littoral shores (Wilson, 1925; Hatton, 1932; Moore, 1939; Bokenham and Stephenson, 1938; Lodge, 1948; Northcraft, 1948; Fahey, 1953; Lee, 1966).

However, the results obtained in the present study indicate that the appearance of the filamentous phase in the sequence of colonizing species was unpredictable, and some of the observed sequences cannot be explained on the basis on faster growth rates in certain species. In some sequences of recolonization the filamentous phase never appeared, in some it appeared at the beginning, in some strips it appeared in the middle of a sequence, and finally in some it was found both at the beginning and in the middle of the sequence. The position in the recolonizing sequence of a filamentous or thin bladed type was different from strip to strip and between the different levels on the same strip. Fahey (1953) has already noted that Enteromorpha intestinalis, which is a species commonly found in the initial 'green' phase of recolonization, could appear at different stages in the sequence. In the present study this species appeared as the first dominant at some levels of strip 1; the second dominant species on strips 9, 10, 11; and third in some levels on strip 2.

In the present study zonation appeared as a structural element with the first colonizing species. Although mentioned by Rees (1940), Lodge (1948) and den Hartog (1968), this aspect of recolonization has been given little attention. Some of the initial zonation which was indicated on the similarity matrices resulted from the much slower growth rates of plants in the higher levels. A low similarity would be calculated between upper and lower levels colonized by the same species if the amount of substratum covered in each was substantially different. However, in the two cases (strips 1 and 2), where all levels developed substantial populations at the same time, differences were still apparent between the different levels. In these cases the zonation was a result of real differences in the species colonizing the different levels.

The patterns of zonation found during the recolonizing sequences were so variable that it becomes difficult to reconcile all the observations with the theories developed to explain zonation in mature communities. On rocky shores not undergoing recolonization the zonation between species on the same trophic level is seen as an interaction between physical and biological factors; where the lower of two species is competitively superior to the one higher on the shore (either by better utilization of resources or by avoiding predation), - but it is kept from the upper zone by the increased physical stresses which inhibit its growth (Connell, 1972; Chapman, 1973; Menge and Sutherland, 1976; Schonbeck 1976). Such mechanisms obviously cannot explain the zonation observed between the Blidingia crust and Enteromorpha intestinalis. On strip 8 (27 November 1975) a dominant cover of Enteromorpha intestinalis was found below one of the Blidingia crust, whereas on strip 1, (10 February 1975), E. intestinalis was dominant in a zone above the crust. Furthermore the zonation patterns that were found during the recolonization were quite different from those in the undisturbed strip on the same day, indicating that the mechanisms controlling the zonation in the undisturbed strip were probably different from those in the cleared ones.

When the populations in the cleared strips came to resemble those in the undisturbed one, the zonation patterns were generally comparable on any one day. The differences that did occur can be attributed to the patchiness in species distributions which was found at all times, even on this fairly uniform substratum. Patches in the distributions of species ranged in size from 50 μ, in the crust of blue-green algae, to 1-2 m for patches of Ascophyllum nodosum. The size of the patches fell within the size of the sampling quadrats, and thus could not be avoided. The similarity between individual samples from the populations that had returned to 'normal' could be low if two distinct patches of different species were samples. Some differences in the patterns of zonation at different locations on the slab also occurred because the level on the shore which separated dominant species was never absolutely straight across the slab. For example, slight differences were present in the easily discernible boundary between the fucoids and crust of blue-green algae, as shown in Plate 4, with the result that the separation of zones in the similarity matrices constructed for different strips could vary by one sampling level. This difference in the level of zonal boundaries probably accounts for the slightly different patterns found in Figure 15D,F.

A

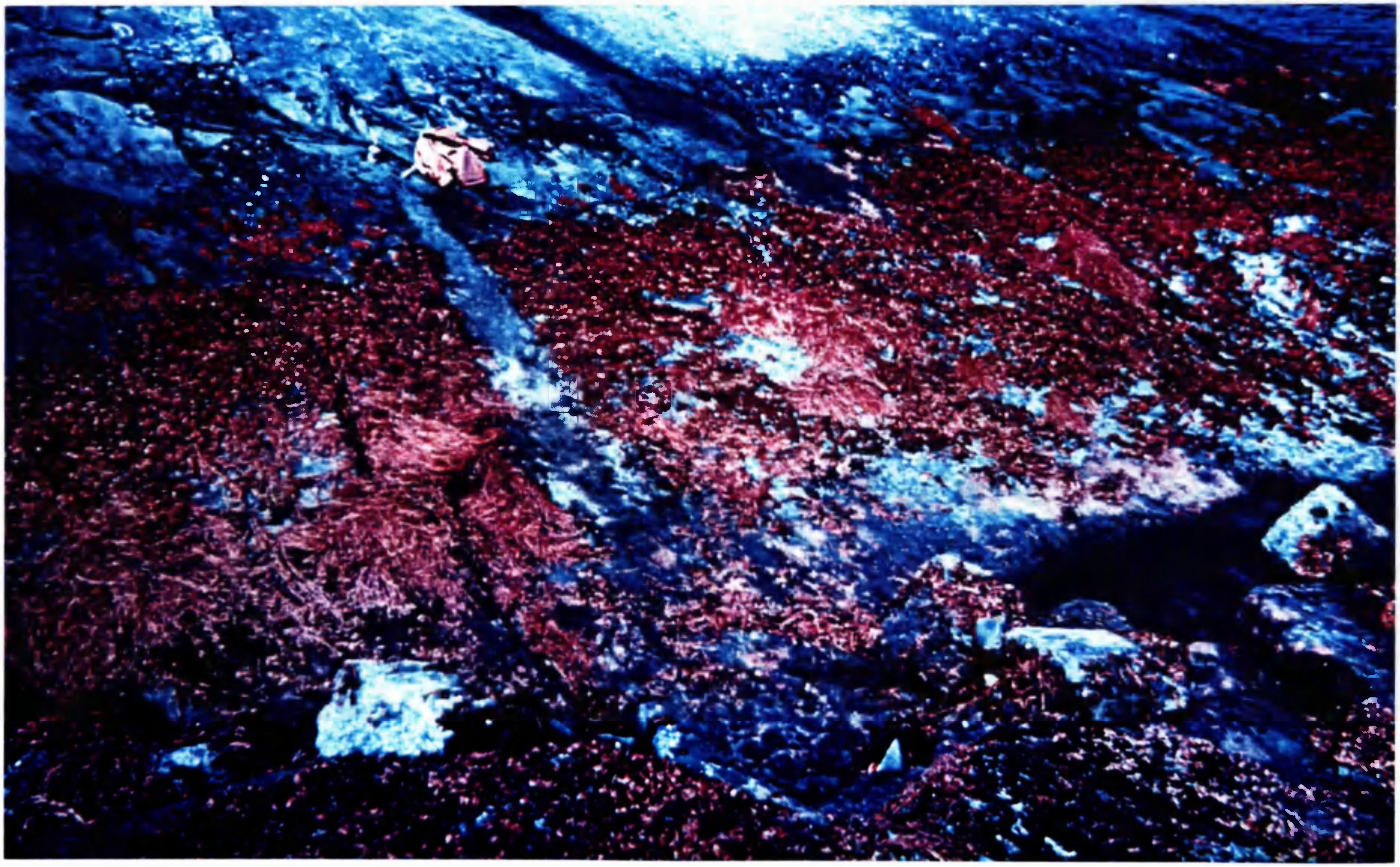


Plate 4: Photograph of shore taken with Infra-red sensitive Kodak Ektachrome film showing the uneven separation (A) between the fucoids (bright red) and the crust of blue-green algae (dark purple). Strip 1 is in the process of being cleared and shows little vegetation.

Unlike zonation, vertical stratification of species was not established immediately after clearing. Fucus spiralis and Ascophyllum nodosum were the only large canopy species in this community, and the full extent of stratification was not established until the fucoid germlings had grown large enough for the plants to lie flat rather than erect. Since Ascophyllum nodosum grew slowly it never achieved the role of canopy in the cleared strips during the period the shore was under observation. From the time of clearing to the development of the canopy, species with a crustose or filamentous growth form covered the greater part of the substratum. This was the only time that species with a filamentous growth form appeared in a dominant position on the substratum above the encrusting layer. In undisturbed areas they were observed sporadically beneath the canopy of Fucus spiralis, but more often their presence was noticed only on the microscopic examination of the scrapings.

The presence of an algal crust throughout most of the recolonizing sequence seems to be unique to this location, for it has not been generally noticed in other recolonization studies. The crustal component was an important part of the population from the beginning of the sequences since the crustal form of Blidingia and the crust of blue-green algae were found as the first dominant colonizers in 58 out of the 80 possible quadrats (8 levels on 10 strips). Even though the Blidingia crust fills a different 'niche' on the substratum, and has a different seasonal distribution than its filamentous counterpart, its position in the recolonization sequences is similar. Both growth forms appeared regularly in the early parts of the sequence and their presence in undisturbed populations was greatly reduced. The Blidingia crust was replaced as the encrusting layer by Ralfsia verrucosa, Petrocelis cruenta, and Hildenbrandia rubra. A sequence of species could also have been present in the crust of blue-green algae, but this was not determined because of the problems involved in identifying species.

Blidingia minima, Capsosiphon fulvescens, Urospora penicilliformis, and the two Ulothrix species are generally found dominant in the littoral fringe and in the boundary zone between the fringe and the eulittoral

(Knight and Parke, 1931; Gibb, 1938; 1939; den Hartog, 1968). Although they were not found as dominants in the top levels at Tomont Point on Cumbrae, they do appear regularly in the littoral fringe at other locations in the Firth of Clyde. In undisturbed areas these species were found only rarely below the top of the *Fucus spiralis* zone, and then only as very minor components of the population. However, the littoral fringe species were also found as members of the green algal phase which appeared during recolonization. They are fairly simple plants with rapid growth rates and high reproductive capacities and after a strip was cleared they covered large areas of substratum well below their normal levels of distribution. In one case (strip 7) *Blidingia* crust actually formed a zone below that of fucoid germlings. Furthermore, *Enteromorpha intestinalis*, which den Hartog (1968) normally finds in zones below *Blidingia minima*, was on several occasions found as a dominant above both forms of *Blidingia* (strips 1, 2, 9, 10).

For marine organisms the littoral fringe is generally considered to be a habitat of higher environmental stress than the eulittoral (Lewis, 1964; den Hartog, 1968; Russell, 1973). In theory, the populations of stressed habitats in a community are characterized by their high tolerances to environmental variations (generalistic species) and their rapid and proliferous reproduction (opportunistic species) (Wilson, 1965; Slobodkin and Sanders, 1969). However, they are considered to be competitively inferior to species dominant in less stressed habitats of the same community. The generalistic and opportunistic species dominate in the stressed habitats because the competitively superior ones do not survive. Under optimal habitat conditions the former group is usually found as the 'weedy' or 'fugitive' component of a population (reviewed by Southwood, 1977). However, after a period of disturbance, these species can appear as dominants in the early stages of succession because of their rapid growth rates and high reproductive capacity (reviewed by Colinvaux, 1973).

The species distribution observed in the undisturbed and cleared strips suggest that the species which dominate in the littoral fringe are indeed the opportunistic and generalistic species of a eulittoral community. Based on theoretical considerations the observed distributions could be explained as follows: the littoral fringe species maintain their dominance in the top levels because the environmental conditions do not permit the growth of the species normally found further downshore, but they are excluded from the more favourable habitat by competition. In general, these are some of the same conclusions which have been independently derived from the experimental studies on zonation (Connell, 1972; Chapman, 1973; Menge and Sutherland, 1976).

The striking feature of the rocky shore community observed in the two years of the present study was the high variability in algal populations. The changes were so unpredictable that they cannot be completely explained in terms of seasonal reproduction. Furthermore, in disturbed areas the initial populations were not always controlled by competition (the factor considered by Menge and Sutherland (1976) to control species distributions in populations at one trophic level). Since the usual generalizations about community structure on rocky shores cannot account for all the variations found, other factors must be involved. The field observations gave some indication of possible factors, but because the data is basically descriptive hypotheses could not be tested. The observation that many species did not settle on cleared strips even though fertile plants were present on the shore indicated that factors involved in the settlement and survival of propagules might account for some observed variations. The involvement of such factors was also indicated by the observations that zonation appeared simultaneously with the first populations, and that the same population could appear in two separate zones. The experimental investigations of factors affecting settlement and survival are described in the following chapter, and the significance of the results for the observed differences in algal distributions are discussed in the final chapter.

CHAPTER II

ALGAL SETTLEMENT AND SURVIVAL

The observations on algal recolonization on cleared strips indicated that some of the differences found in species distributions might be attributed to factors influencing the early stages of colonization. To determine if species colonized the shore when their propagules were present, the algal diversity in the surface waters was compared with that settling on glass microscope slides attached to the rock. The slides were placed at different levels, locations, and under an algal canopy to determine if these factors can influence colonization. To further isolate the mechanisms involved in colonization, the survival and growth of several littoral species were investigated in a simulated tidal regime.

A. METHODS

A.1 Algal cultures:

All algae were cultured in an enriched seawater medium recommended by A.D. Boney, (personal communication). Seawater collected in the Irish Sea was aged for at least two weeks, filtered, and then pasteurized by heating it twice to 75°C from room temperature. Nutrient enrichments were kept in 4 different sterile stock solutions and added to the pasteurized seawater. The concentrations of nutrients used are shown in Appendix X. The addition of the nutrient solutions lowered the salinity of the original seawater by 2% so that the final salinities in the medium ranged between 30.5-33%.

Algae were grown in a large culture cabinet on a 16 hour light - 8 hour dark cycle, at a temperature of 12°C ± 1°C. The light was provided by three, Phillips 'Daylight' fluorescent tubes placed 280mm above the shelves on which cultures were kept. The lamps in this system provided an irradiance of 11.5 - 16.5 watts/m^2, depending on the age of the tubes (Schonbeck, 1976).

A.2 Viable spores in the surface waters:

To determine the number and species of the algal propagules in the surface waters near the shore, 500 ml aliquots of seawater were collected in polyethylene bottles. Within two hours of collection, two, 200 ml samples from each bottle were filtered separately through 45mm glass fibre filters (Whatman GF/C) using a water powered aspirator. The two filters from each sample were placed in a single culture dish with 100 ml of enriched seawater. At 5-7 day intervals the filters were removed from the growth cabinet and examined under a dissecting microscope. The individual plants growing on the filters were identified and counted. In some cases identifications were limited to the genus. In Ectocarpus, Pilayella, Giffordia, Ralfsia, and Sphacelaria the identification of species depends closely on differences in their reproductive bodies, but it was not practical to culture the plants to this stage. In order to obtain accurate counts of the number of propagules in the surface water the plants growing on the filters had to be removed from culture before reproducing. The sporelings of Enteromorpha intestinalis and E. prolifera were indistinguishable in cultures for the first 8 to 10 weeks, and they also had to be counted together. The counts of Ulothrix pseudoflacca, Ulothrix flacca, and Urospora penicilliformis were also combined because it was not always possible to separate them. In culture, the cell sizes of the three species were often comparable and the pyrenoids were not readily visible.

In these experiments, the medium was changed at two to three week intervals. The cultures were kept for a total of 6 - 8 weeks until they were so contaminated with diatoms and filamentous green algae that further observations became impossible. The number of Ralfsia sp. on filters could not be counted because this organism grew as a small hemispherical clump which could not be distinguished from the gametophytic stages of other browns, or from the clumps of diatoms and Chrysophytes which came to cover the surface of the filters.

A.3 Algal colonization in the field:

The algal species colonizing the substratum in the littoral zone were monitored by placing microscope slides on the shore for one week. These were ground on one side to better simulate the texture of the rock surface. The slides were brought back to the laboratory in plastic petri dishes containing moist filter paper; rinsed by agitating them in pasteurized seawater; and then placed in culture dishes with 50 ml of enriched seawater. The species growing on the slides were counted as soon as they became identifiable. The small encrusting discs of Blidingia minima and the filaments of Ulothrix/Urospora sp. could be identified within a week, but for other species 3-4 weeks in culture were needed. The medium was again changed at two to three week intervals and the cultures had to be terminated after 6 weeks because further observations were made too difficult by the dense algal growth. As previously described, the identification of some plants was limited to the genus, but in this series of experiments it was possible to count the number of Ralfsia sp. because the microscope slides could be observed with a transmission microscope which gave a greater resolution than the dissecting microscope.

The microscope slides were prepared and attached to the shore as follows: ordinary microscope slides (25mm x 76mm) were ground on one face using a coarse grinding disc, and then acid washed. Slide holders, described in figure 20, were prepared in the laboratory and attached to cleared (by burning), dry rock with a quick setting epoxy resin (Araldite Rapid). The slides were fixed in the holders with a drop of Dow Corning Silicone Aquarium Sealer. To remove the slides after their week on the shore, the drop of rubber was easily cut with a razor blade. Three to four holders were placed together in one area, and these were re-used for as long as they remained attached. During the summer tourist season the loss of holders from the shore was high, but in winter some holders remained attached for 8 months. A photograph of a holder in place on the shore is shown in Plate 5 and the locations where slides were placed at Tomont Point are shown in Figure 21. The

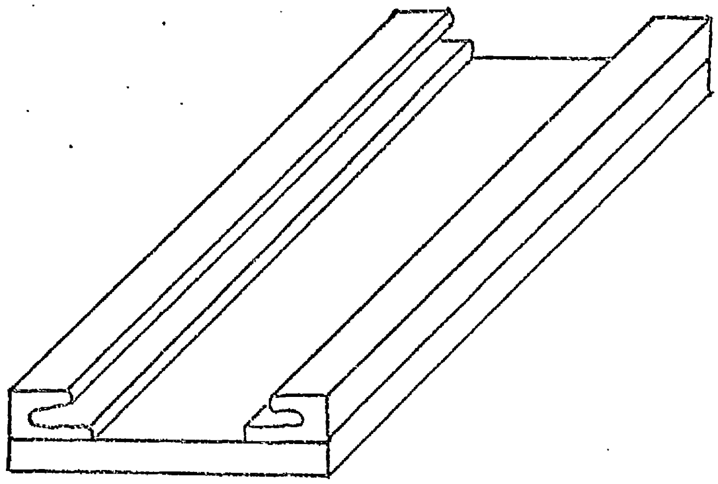


Figure 20: Diagram of the plastic frame used for holding microscope slides to the shore. The base is a piece of PERSPEX, 33mm x 77mm x 2.5mm. The slides are held in place with two strips of curtain railing. The railing was melted down at one end to hold the slide in place on a sloping shore.

Plate 5: A slide holder attached to the substratum. The photograph was taken 8 weeks after placement of holder and also shows the algae recolonizing the adjacent rock.

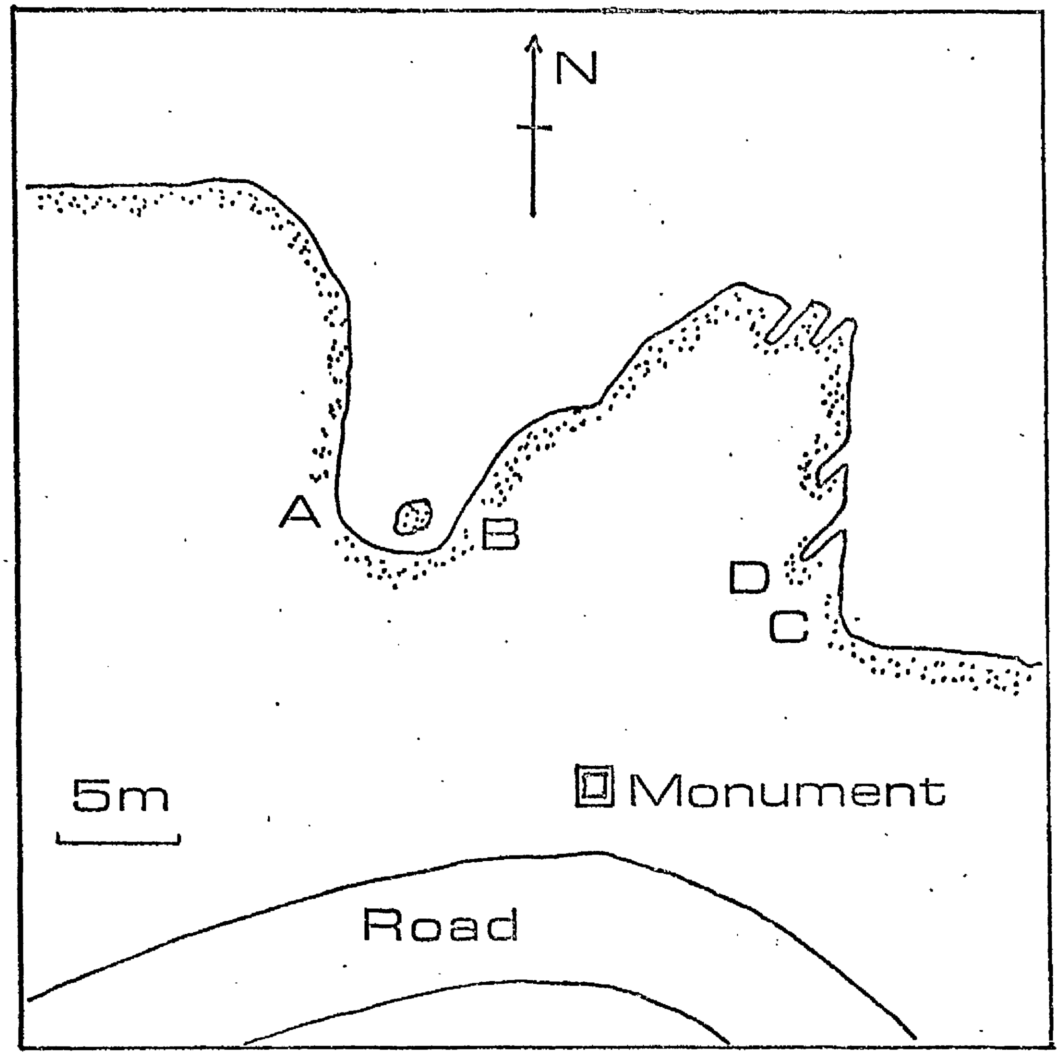


Figure 21: The four locations (A,B,C,D) at which slides were placed in the vicinity of the experimental site. The sandstone slab on which strips were cleared extends on either side of location A.

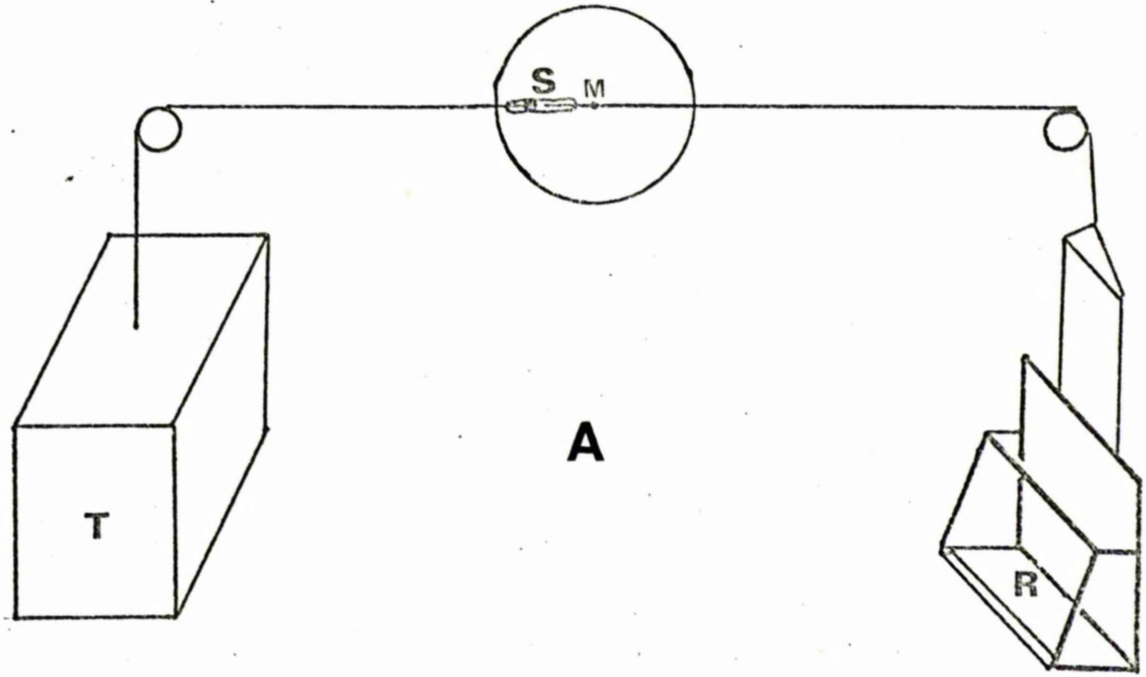
slides were all placed facing East at the 2.49m and the 2.89m levels. At the 2.49m level some slide holders were placed so that Ascophyllum nodosum fronds covered them on a low tide.

After retrieval and return to the laboratory, the plants growing on the slides were counted using microscope fields at 100x or 400x as the sampling units. To avoid possible 'edge' effects due to the contact between the slide and the holder, counts were limited to the central area of the slide at least 5mm from each edge. The fields used in counting were located by randomly moving the stage in both the 'x' and 'y' directions, and then by selecting only those fields within the centre of the slide. Positions were not assigned by using random numbers because this procedure was lengthy, and it was feared that the exposure of the growing plants to the combined effects of room temperature, desiccation, and the bright microscope light might damage them. However, it was assumed that the two methods were comparable because no statistical difference was found in the mean densities of young plants ($p > 0.10$ using Student's 't' test) on the four occasions when both methods were used to count one slide.

A.4 Algal growth in the tidal simulator:

The apparatus employed in this study to simulate a tidal cycle is shown in Figure 22, and is based on the system described by Townsend and Lawson (1972). Four large glass plates, each 39 mm x 157 mm and ground on one side, were placed on a rack which could be lowered and raised on a 12 hour sinusoidal cycle within a glass tank containing 5 litres of enriched seawater.

The water was aerated and filtered in one step using a filter constructed with the bottom half of a 125ml polyethylene bottle and a 100 ml glass beaker (see Figure 22). Glass wool was used in the filter to trap unicellular contaminants and other debri which accumulated in the medium. The small size of the tanks precluded the use of commercially available filters, but the design is the same as that of filters commonly used in small aquaria. One driving motor was used



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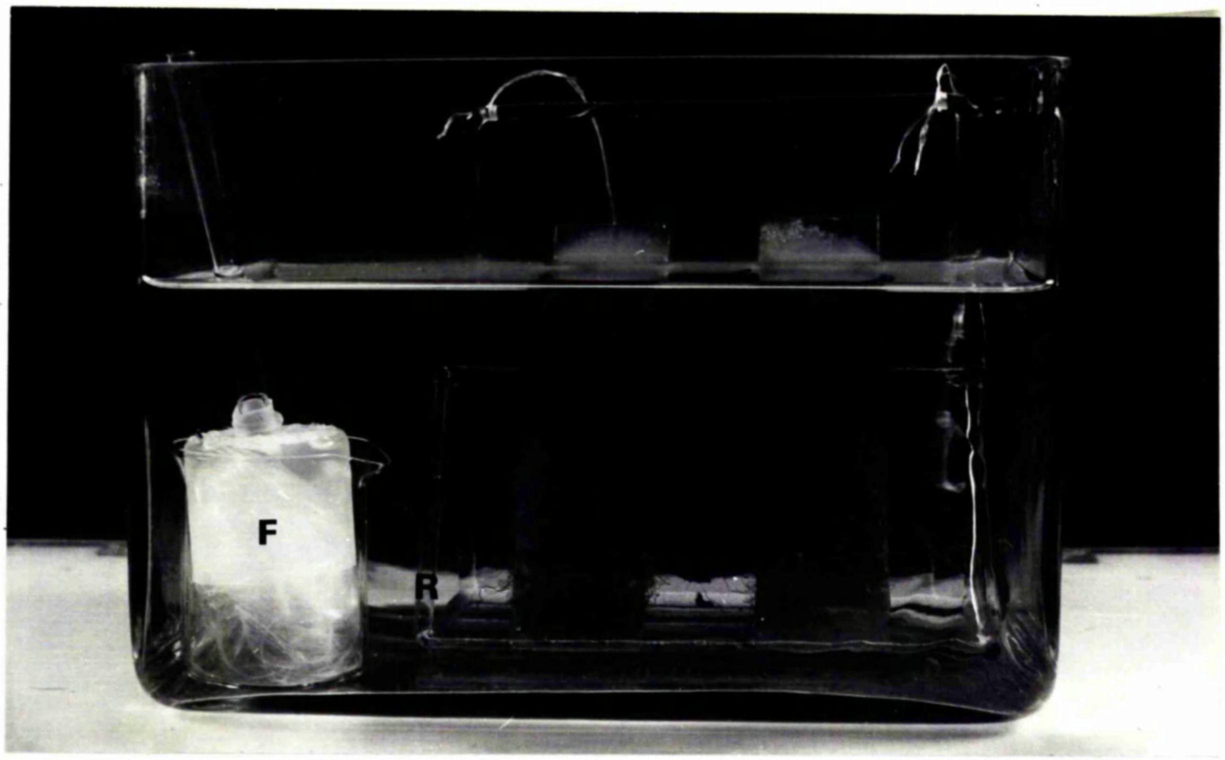


B

Figure 22: A. Diagram of tidal simulator showing placement of tank (T) and motor (M), a CROUZET type 82-344 (1 rev/12 hrs.). The distance between the maximum and minimum elevation on a cycle was adjusted by a movable bolt held in slot (S).
B. Photograph showing tank, the glass rack (R) to hold 4 plates, and filter (F). A piece of black canvas is attached to the rack for the grazing experiment described in section B.3.6.

to power two racks, each one acting as the counterweight to the other. The experiments were started in the mornings so that each rack would have one full tidal cycle in the 16 hour photoperiod.

Using the apparatus described in Figure 23, which is based on the system of Charters, et al. (1973), algal propagules were allowed to settle on the glass plates in one of two ways:

(1) the plates were placed in a tank of pasteurized seawater directly under the rotating container holding the fertile plants, or
(2) the apparatus was placed near the side of the tank in the tidal simulator as the glass plates were being moved.

The first method resulted in a statistically random distribution of propagules over the entire slide, while the second (which could be used only when propagules were motile) resulted in relatively denser settlements on levels that were submerged the longest. Glass plates were left in the presence of fertile parent plants for 24-48 hours depending on the rate at which propagules were settling. It was found that settlement densities of $10/mm^2$ to $100/mm^2$ were best suited for the experiments carried out in the simulated tidal regime. Zygotes of *Fucus spiralis* were released into pasteurized seawater by treating fertile receptacles to a 15 second osmotic shock in distilled water, as described by Schonbeck (1976). In this case the rotating apparatus was not used to disperse the zygotes because the plants were too large, and zygotes were settled by dispersing them in seawater above the plates for 24 hours.

The apparatus for simulating the tides was kept in the growth cabinet under the conditions described previously, and the enriched seawater was changed at two week intervals.

Measurements of plant densities and growth were made at different levels on each plate during the course of an experiment. Ten microscope fields at each level were chosen for the measurements, again by randomly moving the microscope stage. The time during which each level was

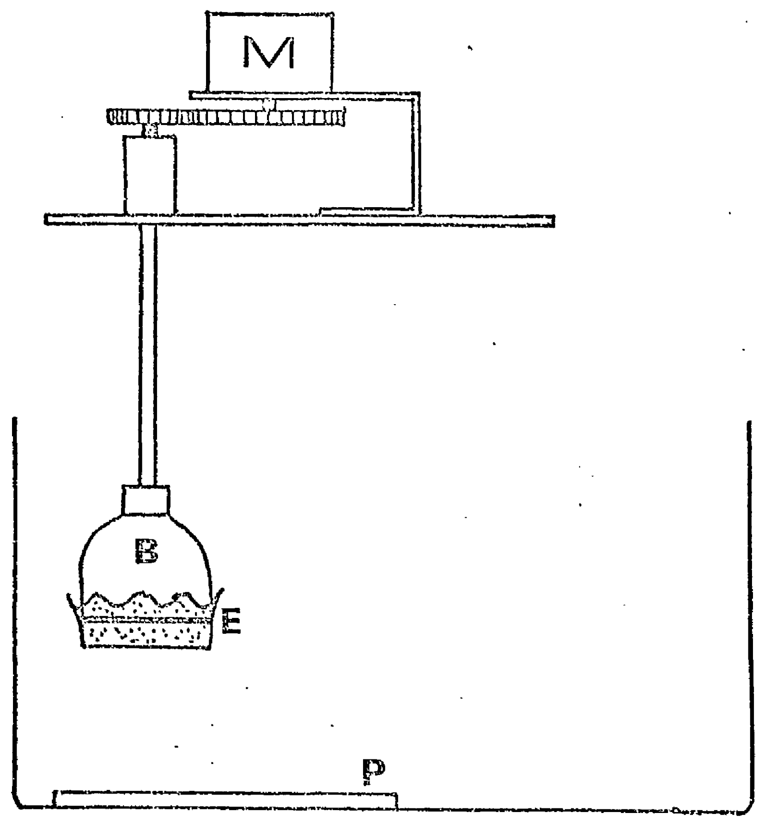


Figure 23: Diagram of apparatus used for releasing propagules. Fertile plants were placed into the top half of a 250 ml polyethylene bottle (B) which was attached to a rotating shaft (12 rpm) powered by a CROUZET motor (M) type 392. The open end of the bottle was covered with a nylon net (mesh size 70 - 85u) which was attached with an elastic band (E). Glass plates were placed under the apparatus (P) in a tank of pasteurized seawater. If more than one plate were in the tank the apparatus was moved to another position over the plates at 4 - 6 hour intervals.

submerged per cycle was calculated using the following algorithm:

$$T = 12 \times \frac{\cos^{-1}(2(D/M)-1)}{\pi}$$

where T is the time submerged, M is the maximum distance on the slide between the lowest level which was out of the water and the highest level which was submerged, and D is the distance between the lowest level of emersion and the level on which the plants were measured.

B. RESULTS

B.1 Algal species in the surface water:

There was no way to determine if the filtration method used gave a totally accurate picture of all viable propagules in the surface water. The method, or any other used to test its effectiveness, involved non-natural manipulations which could be fatal to some species.

However, 24 different algae were observed growing on the filters, and these are listed in Table 9 with an indication of their abundance at different sampling times. Many species occurred only rarely on the filters. Little can therefore be said about their numerical distributions, but their presence is an important indication of the species available for colonization at the time of sampling. In only two organisms, *Blidingia minima* and *Enteromorpha* sp., were the counts high enough to determine the variation in spore densities between samples, and results obtained (see Table 9) indicate that densities could differ by two orders of magnitude between samples. Some of the changes in spore densities occurred rapidly, as is demonstrated by the 20-fold decrease in the number of *Enteromorpha* sp. spores between the 6th and 11th November. Furthermore, large differences were also found between successive samples taken on the same day. The number of *Enteromorpha* sp. spores in the first sample on 30 July was 38, but it was 240 in the second, a six-fold difference.

Table 9: Algae from the surface waters of Tomont Point appearing on filters cultured in enriched seawater. The values given represent the range of counts in two or three 400 ml samples. Blanks indicate the alga was absent in all samples on a given day.

Date of Sample	1976 Apr 6	May 5	July 30	Nov 6	Nov 11	1977 Feb 26
CHLOROPHYCEAE						
Blidingia minima	37-84	2-16	2-10	8-13	4-14	2-10
Cladophora albida	2				0-1	0-3
Cladophora rupestris	0-1	11-18	0-2		0-1	10-23
Enteromorpha intestinalis } Enteromorpha prolifera }	2-9	236-917	38-240	102-151	2-4	107-194
Rhizoclonium riparium			0-2	0-1		0-1
Ulothrix sp. } Urospora penicilliformis }	114-119	13-112	3-63	0-4	5-8	62-83
Ulva lactuca				0-1	0-1	
Spongomorpha arcta		1-8			1-2	
Monostroma oxyspermum		0-1				
PHAEOPHYCEAE						
Ectocarpus sp.	11-20	3-92	4-12	0-3	0-1	0-2
Fucoid germlings			0-1		0-12	
Giffordia sp.	2-3					
Leptonematella fasciculata	0-1					
Litosiphon filiformis	0-3			0-2		0-1
Pilayella sp.	1			0-3		
Ralfsia sp.	present			present	present	
Sphacelaria sp.				0-1	0-2	
RHODOPHYCEAE						
Audouinella sp.		0-15		0-1		
Audouinella daviesii			5			
Bangia atropurpurea		2-7	5-13	0-1	1-3	
Ceramium sp.			0-5		0-1	
Gelidium sp.					0-1	
Petrocelis cruenta					0-1	
Porphyra sp.				0-1		

To determine if these large differences between successive samples were not just an artefact of the method, larger volumes of water were collected on two occasions and several 400 ml aliquots filtered from one sample. The counts for Enteromorpha sp. from the first sample on 30 July 1976 were 109, 125, 101, and for the second, on 26 February 1977, they were 107 and 121. The coefficient of variation for the number of Enteromorpha spores in one sample estimated from this data is 13%. This is a relatively low value which strongly suggests that the 6-fold (600%) difference observed in the two consecutive samples results from some natural phenomena and not the method.

B.2 Colonization of slides:

By placing slides on the shore for a week it was not possible to discriminate between species that were not settling, and those that were settling and immediately dying. However, this is not an important consideration for the purposes of the present study since the final effect of these two factors was the same: the propagules were either able to colonize the glass side, or they were not.

Only 15 algae out of the 24 found in the surface waters colonized the slides during this study, and these are listed in Table 10 with an indication of their abundance at different times. Fourteen algae were found at the lower level (2.49m) and only 6 at the higher one (2.89m). Prasiola stipitata was the only species not found at the lower level, and those common to both levels were the blue-green algae, Ulothrix/ Urospora sp., Enteromorpha sp., Blidingia minima, and Capsosiphon fulvescens. Species of Phaeophyta and Rhodophyta were found only at the lower level, and there they were more common under the Ascophyllum nodosum cover than out in the open (the complete data on algal distributions and abundances on the slides are given in Appendix XI).

Blidingia minima, Enteromorpha sp., Ralfsia sp., and Ulothrix/ Urospora sp. were found with high colonization densities throughout most of the experiment, and the data were statistically analyzed to test the possible influence of the different treatments on the observed distribution of settled plants. Each different treatment

	1976 Apr 6	May 5	Jun 2	Jul 5	Nov 6	1977 Mar 4
Blidingia minima	+++	+++	+++	+++	+++	+++
Capsosiphon fulvescens			++	+		
Cladophora rupestris *		++	+	+		
Enteromorpha intestinalis) Enteromorpha prolifera)	+++	+++	+++	+++	++	+
Monostroma oxyspermum		++				
Prasiola stipitata		+		+		
Ulothrix pseudoflacca) Ulothrix flacca) Urospora penicilliformis)	+++	+++	+++	++	++	++
Ectocarpus sp. *	++		++		+	
Fucoid germlings				+		
Litosiphon filiformis *	+					
Ralfsia verrucosa) Ralfsia clavata)	+	+	++	++	+++	
Gigartina stellata crust) Petrocelis cruenta)					+	
Porphyra sp. *					+	
Blue-green algae		++	+			++
creeping crustose brown filaments *	+	+	++	++	++	++

Table 10: Algae colonizing glass slides placed on the shore in week following the dates given. Algae marked with an * were found only under the Ascophyllum nodosum canopy. The maximum density of plants found on any one slide is shown as follows:

+ – present to < $0.04/mm^2$; ++ – 0.04 to $10/mm^2$;

+++ – > $10/mm^2$.

(i.e. slides placed at different levels, locations, under cover or in the open, and on different days) can be considered as a separate factor, and the experimental design should, in theory, lend itself to a factorial analysis of variance. However, such an analysis was not feasible because the data collected was not balanced; replicate slides were lost from some treatments, and zeros had to be registered in some data sets because species failed to colonize the slides. For data sets with large numbers of '0' counts the non-parametric Kruskal-Wallis test was used. In this case the counts for all replicate slides at one site were combined, and each treatment of the slides was considered in turn as a separate factor. For data sets which were considered to be normally distributed a nested analysis of variance was used. Each treatment was in turn considered at the lowest possible level of nesting to maintain the basic assumptions in this kind of statistical analysis (see Sokal and Rohlf, 1969 p.300). The analysis of variance was calculated using the FORTRAN program in Sokal and Rohlf (1969) which produced a value for the F-statistic at each level of nesting, and the one appropriate to the hypothesis being tested was used.

In general, the hypothesis tested by the non-parametric statistic was that the distribution of counts in different treatments was the same, and the one tested by the parametric statistic was that the mean density of propagules settling under the different treatments were the same. As shown in Table 11 the probabilities that the hypotheses are correct for the different treatments tested are almost all less than 5%, and indicate that each treatment does influence algal colonization. In the case of Blidingia minima the density of colonization was even significantly different within the same slides at one site, and the high variation at this level of nesting may be the reason why no significance could be found in the colonization density on different days.

To determine if the colonization of the slides was comparable to that of the rock, the cleared substratum on which slides were attached was observed at intervals. The first species seen on the rock were the same as those colonizing the slides. For example, the green algae adjacent tothe slide holder in Plate 5 is a mixture of

Table 11: The statistical probabilities (P) that the variations in the density of colonization on glass slides in different environments result from chance. Calculations were done using a non-parametric test (N), and a nested analysis of variance (AV). Probabilities below 0.05 are considered significant (*). Some factors could not be tested because slides in the appropriate categories were not colonized by the species (-).
The mean density of plants mm^2 found under each treatment are given on the infold. The standard deviation is given in brackets on the data sets that were normally distributed.

Probability for the number colonizing:		Blidingia minima	Enteromorpha sp.	Ulothrix/ Urospora	Ralfsia sp.
different slides at one site in any one week	in the Open	p <.01 (AV)*	p >.05 (AV)	p >.05 (AV)	-
	under Canopy	p >.05 (AV)	p <.01 (AV)*	p >.05 (AV)	p >.05 (AV)
slides under the A. nodosum canopy and in the open in any one week		p < .01 (AV)*	p <.005 (N)*	p <.005 (N)*	p <.005 (N)*
slides at different locations in any one week	2.89m	p <.01 (AV)*	-	p <.01 (N)*	-
	2.49m in the Open	p <.01 (AV)*	p <.005 (N)*	p <.005 (N)*	-
	2.49m under canopy	p <.05 (AV)*	.025<p<.05 (AV)*	p <.05 (AV)*	p <.01 (AV)*
slides at different levels in any one week		p <.005 (N)*	p <.005 (N)*	p <.005 (N)*	
slides during the different weeks	2.86m	p <.005 (N)*	p <.01 (N)*	p <.005 (N)*	-
	2.49m in the Open	p >.01 (AV)A	p <.005 (N)*	p <.005 (N)*	-
	2.49 m under Canopy	p >.10 (AV)	p <.005 (N)*	p <.005 (N)*	.05<p<.10 (AV)

Blidingia minima and **Enteromorpha sp.**

SITE	LEVEL	B. minima 1976 Apr	May	Jun	Jul	Nov	1977 Mar	Enteromorpha 1976 Apr	May	Jun	Jul	Nov	1977 Mar
A	2.86m open		-	3.5 (1.4)	26 (13)				-	0.6	-		
	2.49m open	21 (9.2)						26 (25)					
	covered	11 (7.7)						1.9					
B	2.86m open		0.15	0.22					-	-			
	2.49m open		33 (21)	78 (19)					25 (19)	0.7			
	covered				.69 (13)						40 (11)		
C	2.49m open		9.0 (6.1)	17 (9.3)		7.6	10 (9.3)		0.9	.04		0.1	.04
	covered		27 (14)	71 (14)	33 (16)	32 (13)			7.0 (8.6)	2.2 (1.0)	171 (29)	1.2 0.75)	
D	2.49m covered			27 (12)						19 (11)			

Ulothrix Urospora sp. and **Ralfsia sp.**

SITE	LEVEL	Ulothrix 1976 Apr	May	Jun	Jul	Nov	1977 Mar	Ralfsia 1976 Apr	May	Jun	Jul	Nov	1977 Mar
A	2.86m open		.04	0.5	2.1 (.53)				-	-	-		
	2.49m open	47 (16)						-					
	covered	25 (12)						2.2					
B	2.86m open		.04	0.19					-	-			
	2.49m open		26 (19)	22 (12)					-	-			
	covered				3.5 (1.4)						present		
C	2.49m open		3.1	2.6		0.11	.04		-	-		-	-
	covered		2.1	25 (14)	2.9 (1.2)	0.4			0.7	0.7	pre- sent	7.6	
D	2.49m covered			16 (7.2)						1.6 (1.0)			

Blidingia minima, Blidingia marginata, Enteromorpha intestinalis, Urospora penicilliformis and Ulothrix pseudoflacca. These were the same species that colonized two slides placed on the shore during the week immediately after the rock was cleared on 5 May 1976. Furthermore, the relative densities of the different species were approximately the same on the slides and on the rock. On the rock, the two Blidingia species and their crustal form covered about half of the cleared space, and the others each covered between 10 - 25%. Out of the 85 plants/mm^2 that settled on the slide 40% were Blidingia sp., 31% were Ulothrix/Urospora sp., and 29% were Enteromorpha sp.

B.3 Algal growth in the tidal simulator :

B.3.1 The growth and survival of individual species:

Propagules of several littoral species were settled individually on the glass plates and cultured in the tidal simulator to investigate the effect exposure in a controlled environment has on the growth of newly settled propagules. As shown in Figure 24, Prasiola stipitata, Ulothrix pseudoflacca and Fucus spiralis all had maximum growth at levels which were completely submerged throughout the entire cycle. Blidingia minima was the only species tested which did not, but the apparent decrease in size that appears on the histogram is not significantly different ($p > 0.05$) when the sizes of the plants from the bottom level are compared with those in the two levels immediately above it. Furthermore, at the time plant sizes were measured, the bottom levels on plates containing Blidingia minima were covered with a thick mat of diatoms and unicellular Chlorophyta which could have adversely affected the growth.

The individual species represented in Figure 24 were grown as controls in different experiments and the procedures varied slightly between them. As indicated in the figure caption, the measurements of size were made after different periods in culture. Furthermore, Fucus spiralis was cultured in a medium in which the original nutrient concentrations were diluted to 1/10th, as Schonbeck (1976) found that

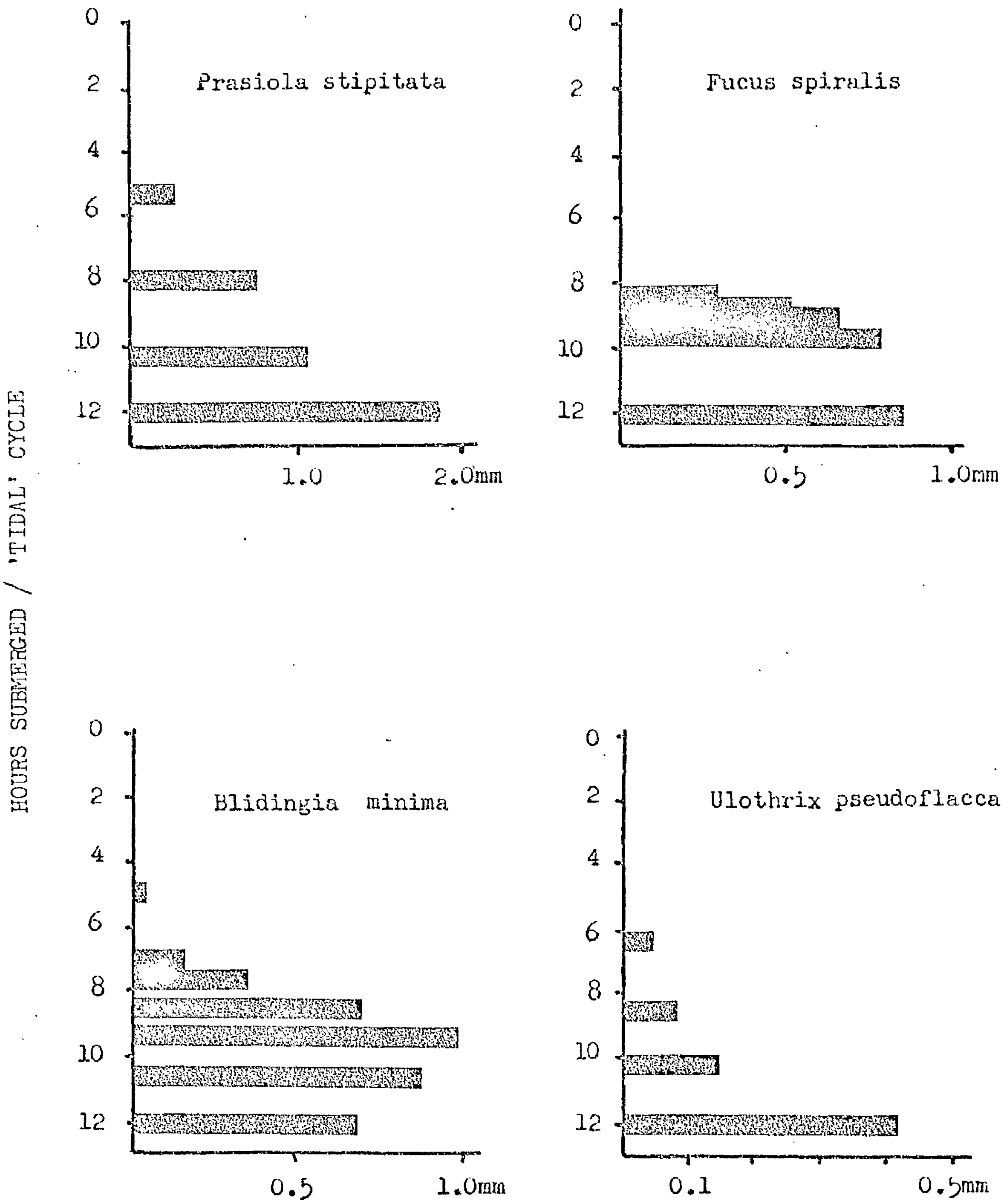


Figure 24: The growth of 4 algal species in the simulated tidal regime. For *Prasiola stipitata* the lengths were measured after 9 weeks on the simulator; *Fucus spiralis*, 7 weeks; *Blidingia minima*, 10 weeks; and *Ulothrix pseudoflacca*, 9 days.

this slowed the growth of contaminants without imparing the growth of Fucus species. For Prasiola stipitata, Ulothrix pseudoflacca, and Fucus spiralis the histograms represent the mean length of at least 20 randomly selected plants at each level (10 from each of 2 plates), but for Blidingia minima the histograms represent the mean length of the 40 longest plants at each level (10 plants from each of 4 plates). The plants were selected from a 2mm wide scraping made across the slide at each level.

No histograms representing plant sizes are shown for the top levels because few, if any, surviving plants could be found. The relative survival of the different species was determined by comparing the initial density of propagules settled on the plates with the number remaining after 1 to 3 weeks in the simulated tidal regime (again the time varied with the experiment). A propagule was considered to have survived if the cells retained their pigmentation, or if there was evidence of cell division. For Fucus spiralis only the latter criterion could be used, for the zygotes retained their pigmentation even after death (i.e. no cell division was observed after zygotes were placed fully submerged in enriched sea water).

The survival rates for the four species cultured are summarized in Figure 25. No statistically significant loss of propagules could be measured in the lowest level for any of the species, but marked differences were found in their survival higher on the plates. Prasiola stipitata was the least susceptible to the effects of emmersion as its spores were found to survive and grow at the highest levels. Fucus spiralis was the most sensitive, surviving only at levels which were submerged for more than 8.7 hours out of every 12.

B.3.2 Factors affecting the growth and survival of individual species:

The survival and growth of young plants in the simulated tidal regime was found to be greatly increased by an initial period of favourable conditions, and by the density of spores settled on the plates. The phenomenon was first observed by accident in an experiment with

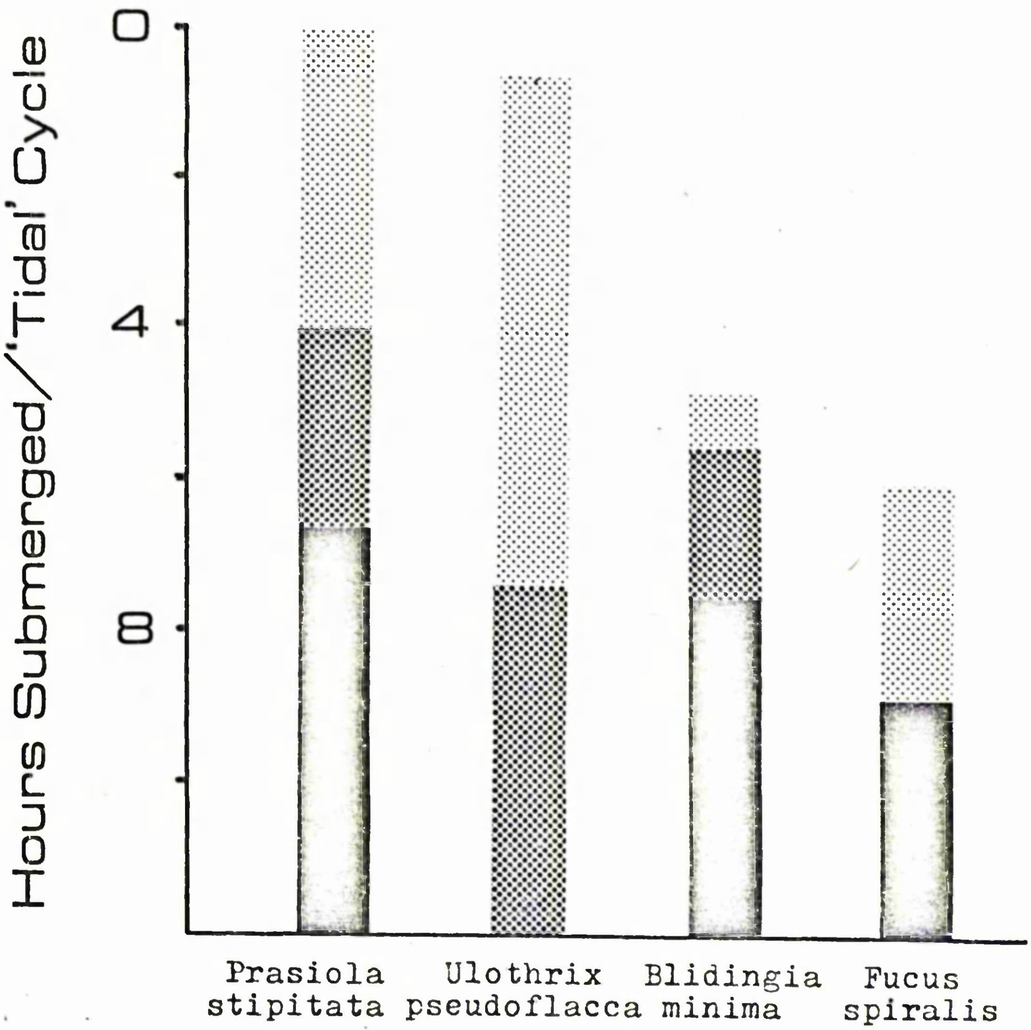


Figure 25: Relative survival of propagules in the simulated tidal regime. Propagules were settled on ground glass slides and placed immediately in the apparatus.


60 - 100%: not significantly different ($p > 0.05$) from the number settled


20 - 59%


0 - 19%

Enteromorpha linza. No measurements of size or survival were made, but the photograph shown in Plate 6 indicates sufficiently the effect of these factors. On glass slides placed immediately in the simulator, E. linza sporelings extended only 35mm up the slide which corresponds to a minimum submersion time of 8.9 hours/cycle. However, on the two slides submerged first in enriched seawater for 7 days the sporelings were found up to levels corresponding to a submersion time of 0 hours/cycle and 3.8 hours/cycle.

The difference in the level of survival on the two plates first cultured fully submerged (C and D in Plate 6) was caused by a difference in the density of spores settled on the two plates. The plate on which E. linza survived the highest had 360 spores/mm^2 while the second only had 65/mm^2 . However, this effect of spore density was found to be limited only to those plates first treated with a period of submerged growth. The two plates placed in the apparatus immediately after the spores had been settled (A and B in Plate 6) had densities of 760/mm^2 and 72/mm^2 respectively, but no difference could be seen in the levels to which sporelings survived. On both plates sporelings did not survive above the level corresponding to a minimum of 8.9 hours submerged/cycle.

Quantitative observations of these two phenomena were made using Blidingia minima as the test species. Spores were first settled on 8 plates at different densities which ranged from 36-120/mm^2 . Four plates were placed directly in the simulated tidal regime, but the other four were first cultured fully submerged for two weeks. Since two tanks had to be used to accommodate the 8 plates, the ones from the submerged treatment were alternately placed between the others in the apparatus. However, in the final four weeks the treated and untreated plates had to be separated because the growth on the treated plates was beginning to cover the adjacent plates.

After two weeks of submerged culture and 1 week in the simulated tidal regime the B. minima sporelings were found to be surviving 10mm higher on plates with high densities than on those with lower densities.

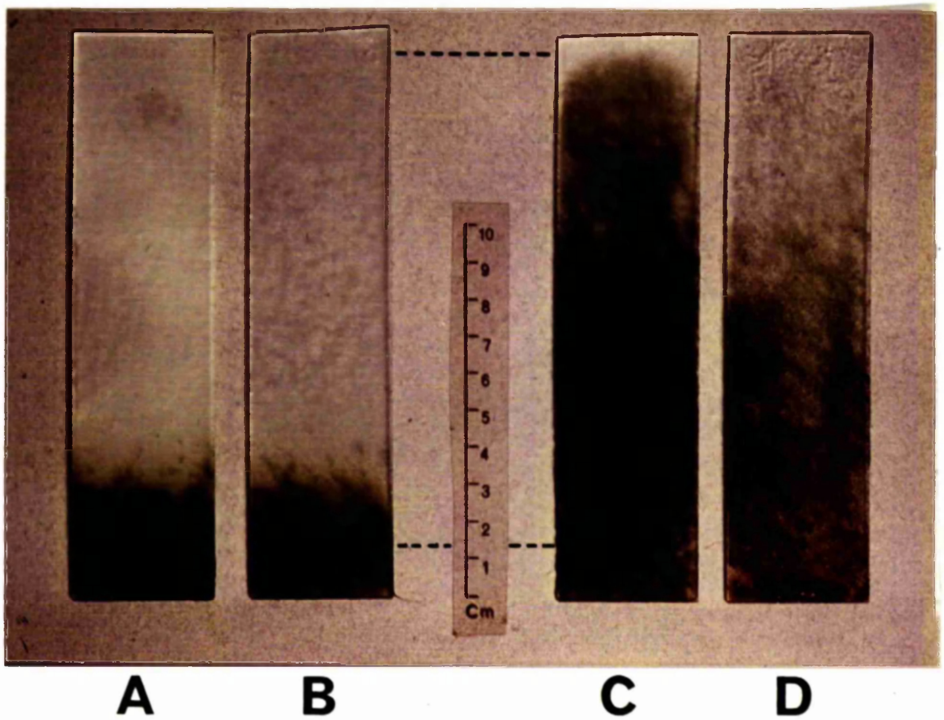


Plate 6: *Enteromorpha linza* after 5 weeks in the tidal simulator. Plates (A), (B) were placed directly in the simulator and (C), (D) were first cultured submerged for one week. Spore densities were: (A) - 760/mm^2, (B) - 72/mm^2, (C) - 360/mm^2, (D) - 65/mm^2 . Dotted lines mark the limits of the 'tidal' range.

However, no such density effect was found on the plates placed directly in the simulated tidal regime. The counts of sporelings at the critical levels on the plates are shown in Table 12. On the treated plates the difference in the level of survival was maintained throughout the experiment, as can be seen in the photographs taken at the end of 10 weeks (Plate 7).

After 10 weeks in the simulated tidal regime, B. minima had disappeared from levels submerged for less than 4.7 hours/cycle on plates placed directly in the apparatus. However, on plates first cultured submerged some sporelings were even found to be growing higher than the level of total emmersion, as shown in the photographs in Plate 7. The 10 longest filaments from a 2mm wide scraping were measured at certain levels, and as can be seen in Figure 26 marked differences were found in the growth of B. minima in the two treatments. The measurements were made on all 4 untreated plates, but only on 3 of those treated with a period of submerged culture. The fourth was retained for a grazing experiment to be described in a following section. The growth of the 10 longest plants at the fully submerged level was not statistically different between treated and untreated plants (using a nested analysis of variance $p > 0.05$), but there was a five-fold increase in the size of the plants in the middle levels. Unfortunately, any biological significance ascribed to these results must be suspect because the bottom 20-30mm on each slide was heavily overgrown with a thick mat of diatoms and unicellular Chlorophyta, which could have influenced the observed patterns of growth. However, the histograms do show that B. minima survived and grew successfully at higher levels when it had been treated to an initial period of less severe conditions.

Although the level at which B. minima survived on treated plates was raised by a higher spore density, the density had no effect on the growth when measured by the 10 longest plants at each level. No statistical difference ($p > 0.05$ using Student's 't' test) was found in the lengths of sporelings on the four plates placed directly on the apparatus, and none was found below the 130mm level on the plates treated with a period of submerged culture.

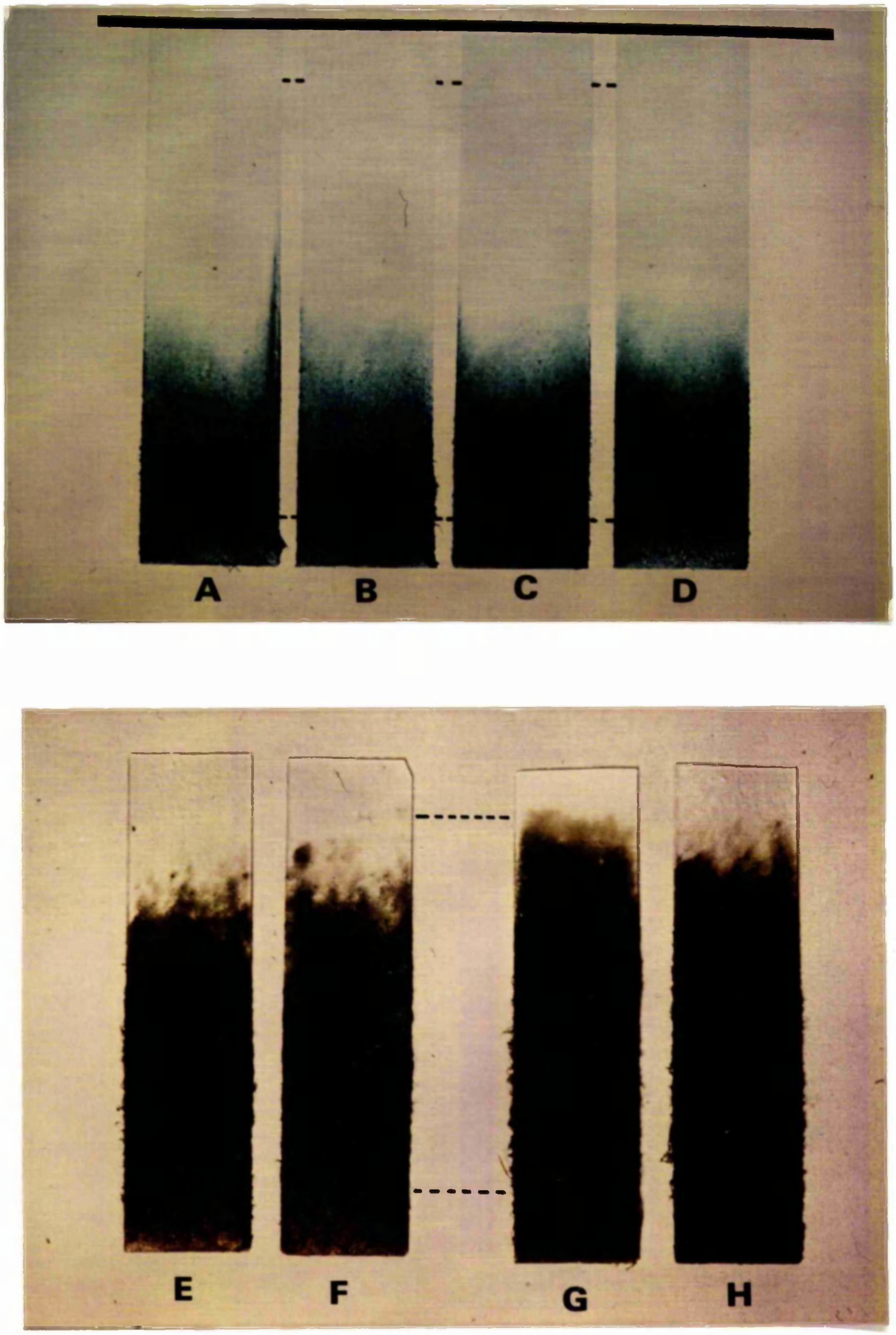
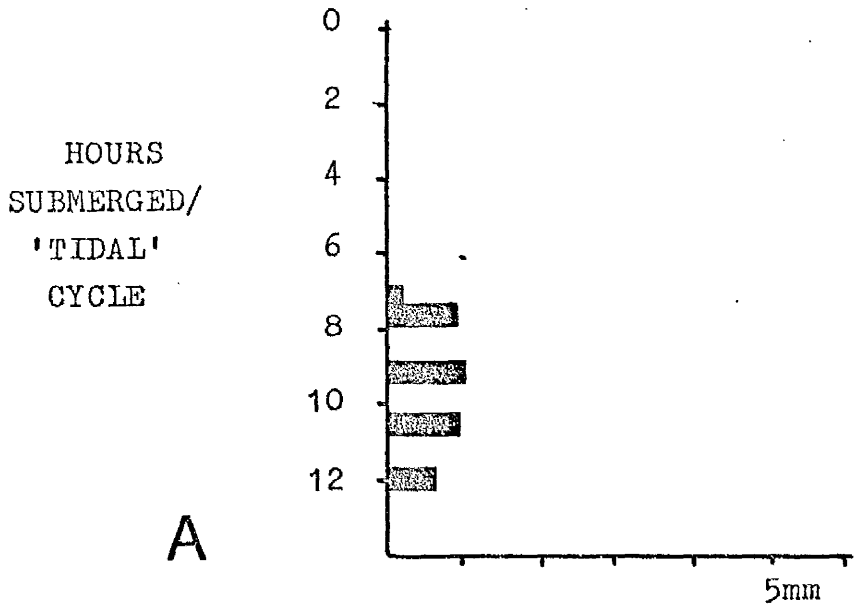


Plate 7: Blidingia minima after 10 weeks in the tidal simulator. Plates A,B,C,D were placed directly in the simulator with spore densities of 101, 42, 100, 35/mm^2 respectively. Plates E,F,G,H were first cultured for two weeks submerged, and had spore densities of 39,36,120,125/mm^2 respectively. Dotted lines mark the limits of the 'tidal' range.



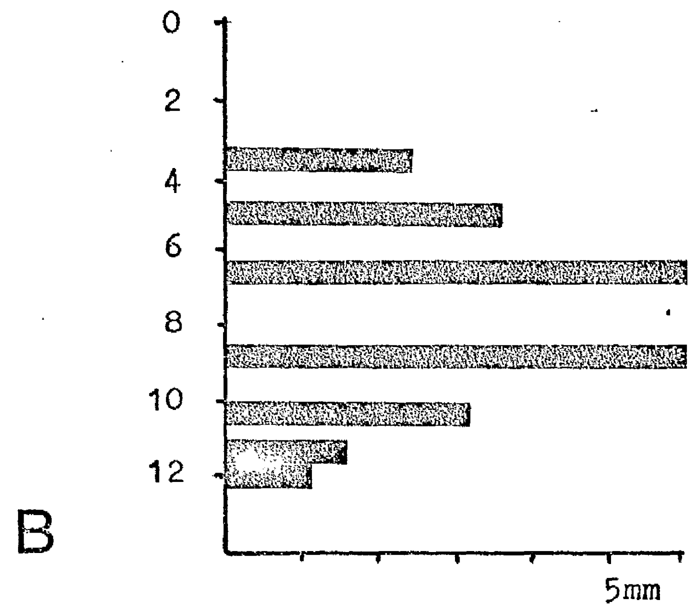


Figure 26: The mean lengths of the longest <u>Blidingia minima</u> in a 2 mm strip on the glass plates after 10 weeks in culture on plates put directly in the simulator (A), and on plates cultured submerged for 2 weeks (B). In (A) the values represented are the means of 10 plants/level on each of 4 plates, and in (B) the same from 3 plates.

Table 12: The percentage of *Blidingia minima* plants surviving after 3 weeks in culture at different levels on the glass plates settled with different densities of spores.

Slides cultured submerged for 2 weeks

Plate		I	II	III	IV	
Spore Density		39/mm^2	36/mm^2	120/mm^2	125/mm^2	
Distance on plate from bottom (mm)	130	91	100	not measurable because crustal discs coalesced		
	135	61	93			
	140	<5	16	100%	95%	Level of total emersion ↓
	145	0	0	57%	<5%	
	147	0	0	0	0	

Slides placed directly on simulator

Plate		I	II	III	IV
Spore density		42/mm^2	35/mm^2	101/mm^2	100/mm^2
Distance on plate from bottom (mm)	40			not measurable because crustal discs coalesced	
	50	21	43	58	33
	60	<1	2	10	9
	70	0	0	0	0

B.3.3 The effects of a canopy on settlement and growth:

Observations on recolonization in the field suggested that an established species could successfully prevent the utilization of the substratum by other species. The mechanisms of such interactions were investigated using Enteromorpha intestinalis and Ulothrix pseudoflacca. To provide a canopy on the plates used in the apparatus, adult plants of E. intestinalis were threaded together on a cotton thread, and the string of plants was wound on a slide in a spiral going from top to bottom. The algal blades were all placed on one face of the plate to produce a thick cover similar to that found in field populations. A photograph of the covered glass plate is shown in Plate 8.

The settlement of U. pseudoflacca in the presence of E. intestinalis was measured by comparing the number of spores settling under the canopy with the number settling on uncovered plates. Spores were released into the simulator for 36 hours while 4 plates (2 with a canopy and 2 without) were being raised and lowered on the 12 hour cycle. The plates were then placed fully submerged in enriched seawater for one week before the sporelings were counted. After a week of growth the U. pseudoflacca which had settled could be distinguished from the E. intestinalis spores also present on the plates. The results, shown in Figure 27, clearly indicate that the presence of the canopy impairs the settlement of U. pseudoflacca spores, and this was found to be significant ($p < 0.01$ using the Kruskal-Wallis non-parametric test) at all levels in the simulated tidal regime.

To measure the growth of U. pseudoflacca under the canopy the procedure was reversed. First, spores were settled on four slides at a density of $37/mm^2$. The canopy of E. intestinalis was then placed on two of the slides, and all four were cultured in the simulated tidal regime. After nine days the canopy was removed and the lengths of the U. pseudoflacca filaments were measured at several levels. In this case the five filaments closest to the centre of a microscope field (x100) were measured at three randomly selected locations on each level. The results, summarized in Figure 28, indicate that the E. intestinalis

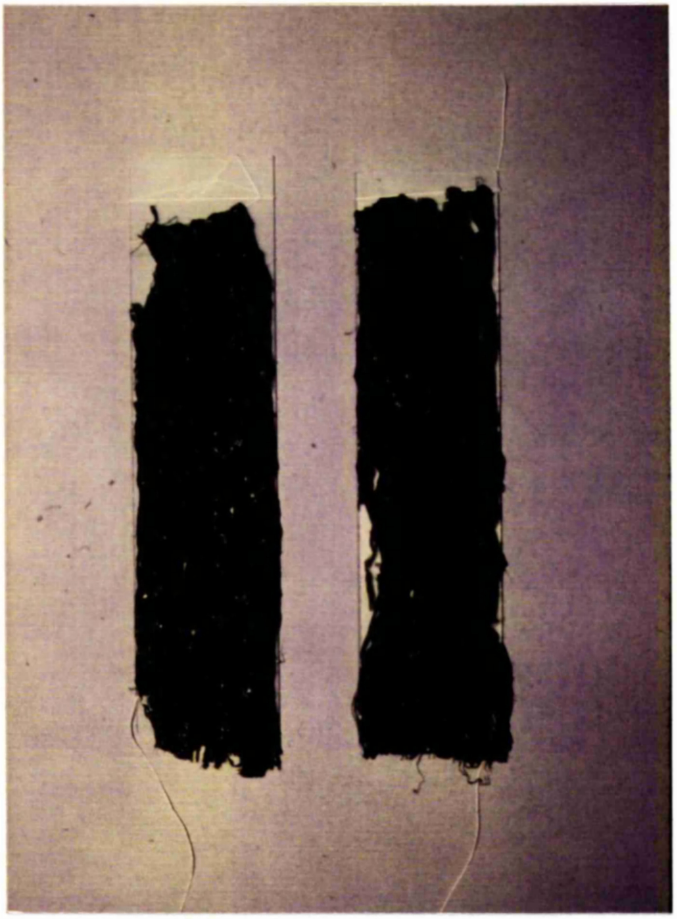


Plate 8: A cover of Enteromorpha intestinalis on glass plates produced by threading plants together and attaching them to the plate.

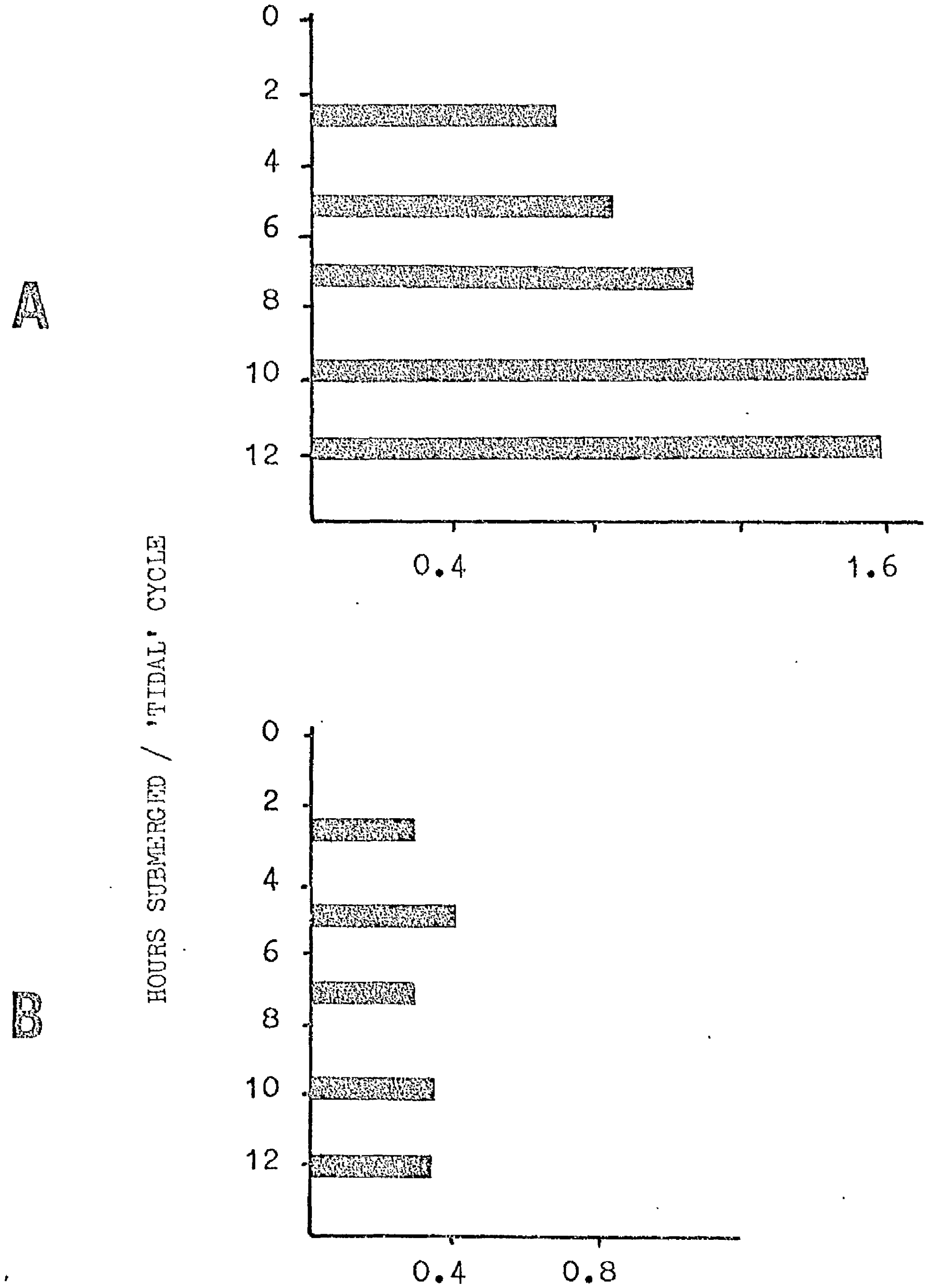


Figure 27: The density/mm^2 of Ulothrix pseudoflacca settling on glass plates in the tidal simulator, uncovered (A) and under a cover of Enteromorpha intestinalis (B).

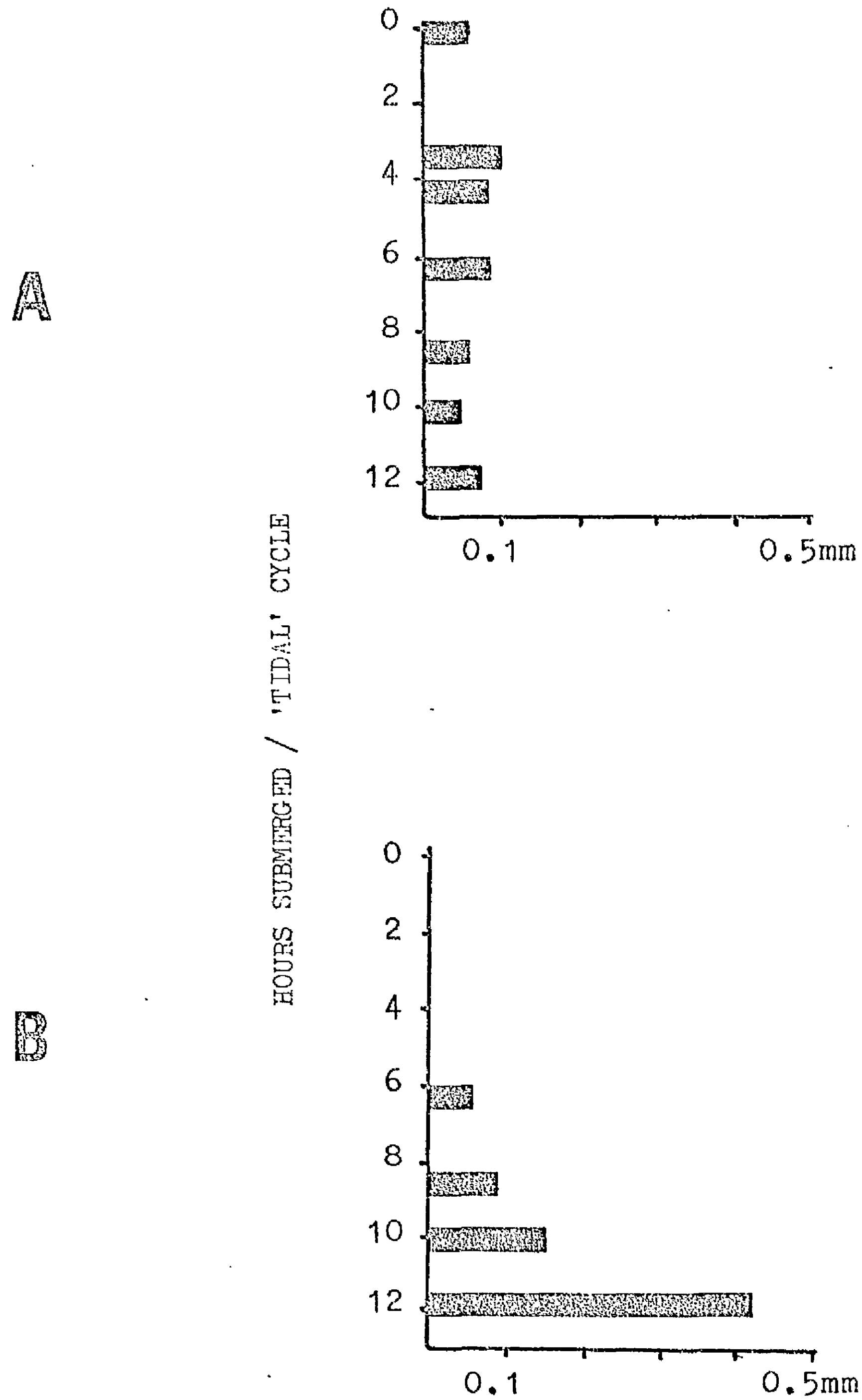


Figure 28: The length of <u>Ulothrix pseudoflacca</u> after 9 days under a cover of <u>Enteromorpha intestinalis</u> (A), and uncovered (B).

cover significantly reduced ($p < 0.01$ using Student's 't' test) the growth of U. pseudoflacca at the lower levels, but it significantly increased the growth ($p < 0.01$) at the higher levels. Moreover, the cover of E. intestinalis allows the spores to survive much higher on the glass plate. On uncovered plates no plants, or even spores were found above 65mm (6.2 hours submerged/cycle), whereas under the canopy they not only survived but also grew at the highest level submerged on a cycle (124 mm).

B.3.4 The effect of different species settled simultaneously:

To determine if newly settled species interact on the tidal gradient the spores of several different species were settled on glass plates simultaneously, and then cultured in the simulated tidal regime. In this case Prasiola stipitata was used as the test species because it very rarely appeared in the lower levels on the shore, even during recolonization of cleared strips, when plants were still small and no canopy was present to retard settlement. Following the usual procedure, 4 glass plates were settled with Prasiola stipitata and on 2 of these spores of Ulothrix pseudoflacca were settled. The Ulothrix pseudoflacca was contaminated with Enteromorpha intestinalis, Urospora penicilliformis, Monostroma grevillei, and Capsosiphon fulvescens, and these species also appeared on the plates when cultured in the simulator. The density of P. stipitata was $3/mm^2$ and that of the other species combined was $6/mm^2$. After 9 weeks in the simulator the length of 10 plants at specified levels were measured. In contrast to the experiment with Blidingia minima, the Prasiola stipitata plants were small enough to be measured directly on the plate, and in this case the plant closest to the centre of a randomly selected microscope field were used. As shown in Figure 29 there was no difference in the lengths of plants on plates containing only P. stipitata and those which also had the other species. No statistical difference was found at any level ($p > 0.05$).

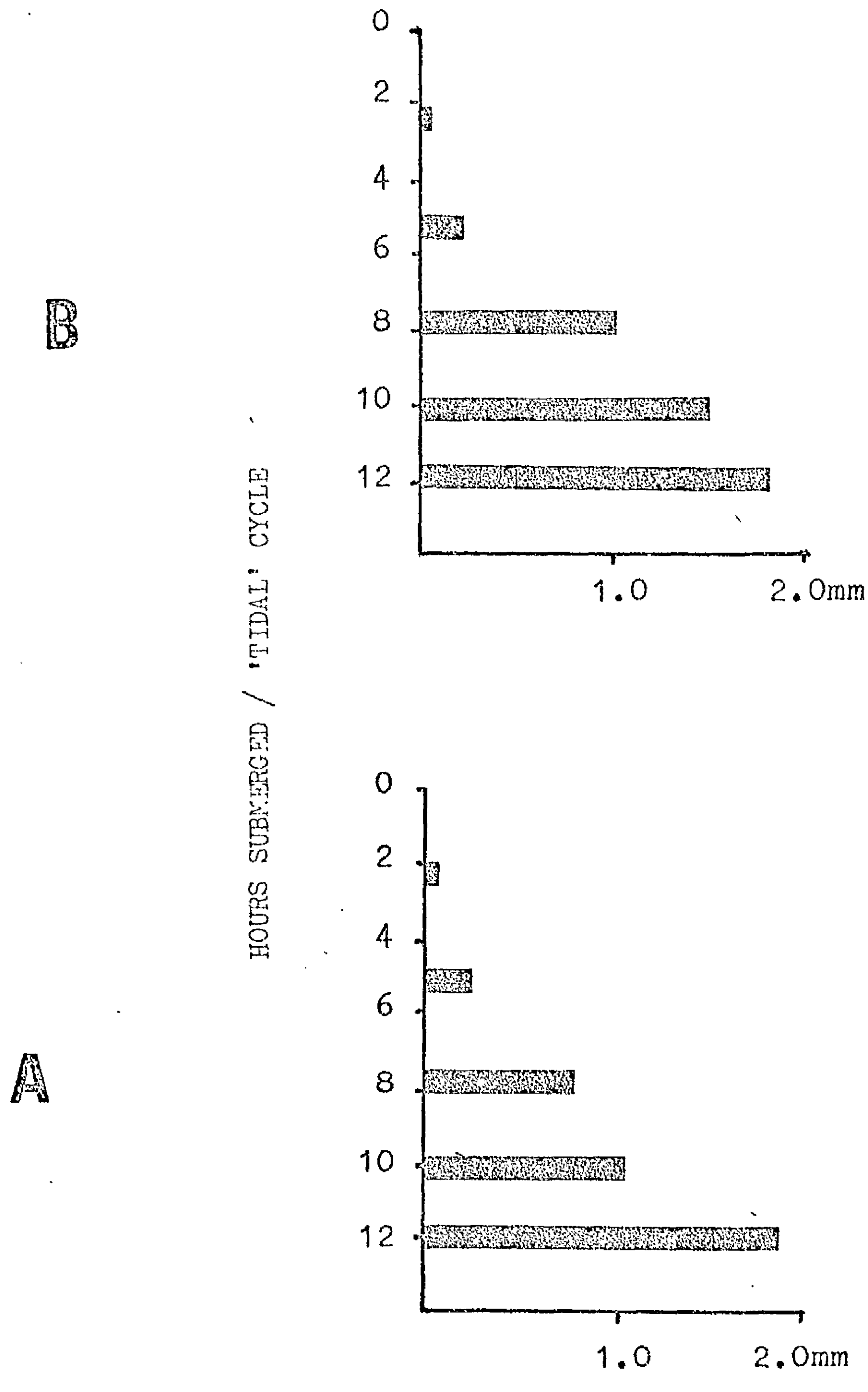


Figure 29: The length of <u>Prasiola stipitata</u> after 9 weeks in the simulated tidal regime when cultured alone (A), and in the presence of <u>Ulothrix pseudoflacca</u> and other species (B).

B.3.5 Growth of Fucus spiralis under Enteromorpha intestinalis:

Observations on the cleared strips indicated that Enteromorpha intestinalis could slow the growth of fucoid germlings. This interaction was investigated in the simulated tidal regime by growing F. spiralis and E. intestinalis together on one plate. Zygotes of F. spiralis were settled on 4 plates at a density of $0.3/mm^2$, and on two of these E. intestinalis was settled at a density of $86/mm^2$. Different densities were used because the F. spiralis zygotes were much larger than E. intestinalis spores. Furthermore, the densities used probably fall within the range found in natural populations. Enteromorpha sp. spores were found to colonize glass slides in densities up to $189/mm^2$ (see Appendix XI), and Schonbeck (1976) reports that Fucus spiralis germlings can be found on the shore in densities up to $1/mm^2$. Before placing the plates in the apparatus all were cultured fully submerged in 1/10th concentration seawater. After 4 weeks the E. intestinalis sporelings were the same size as the F. spiralis germlings and the plates were placed in the simulated tidal regime.

As can be seen in the photograph shown in Plate 9 the growth of E. intestinalis followed the pattern found in both Blidingia minima and Enteromorpha linza. After 5 weeks in the simulated tidal regime the sporelings grew at all levels, but the growth was noticeably greater near the bottom of the plates. Within the first week on the simulator, E. intestinalis had grown large enough to cover F. spiralis germlings, and the presence of the germlings did not have any visible effect on the growth of the sporelings. Five large plants of E. intestinalis were individually measured at each of 4 levels, and the results are shown in Figure 30b. Scrapings were not taken because these would have dislodged the germlings underneath. Although these measurements provide only an indication of the E. intestinalis sizes, the results are consistent with the observations of growth in other species where the largest plants were found at the lowest levels.

However, after 5 weeks in the simulator marked differences were found in the size and distribution of surviving germlings. Under the

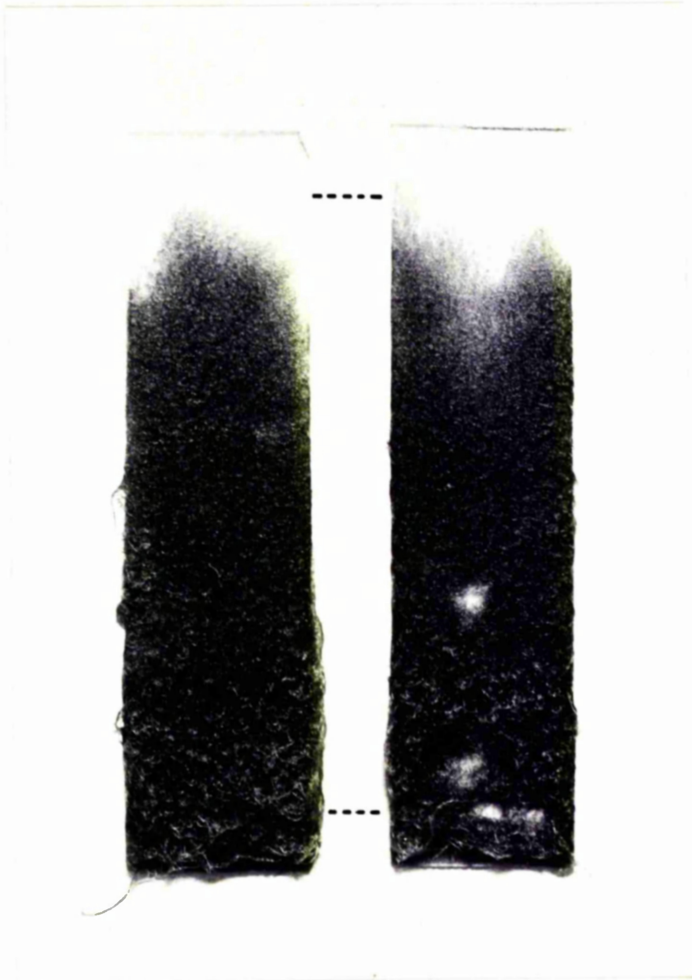


Plate 9: *Enteromorpha intestinalis* and *Fucus spiralis* cultured together in the tidal simulator for 5 weeks after growing 4 weeks submerged. *F. spiralis* germlings are not visible because of the *E. intestinalis* cover. The holes appearing in the algal cover were made by scraping, and do not represent abberrations in growth. Dotted lines mark the boundaries of the 'tidal' range.

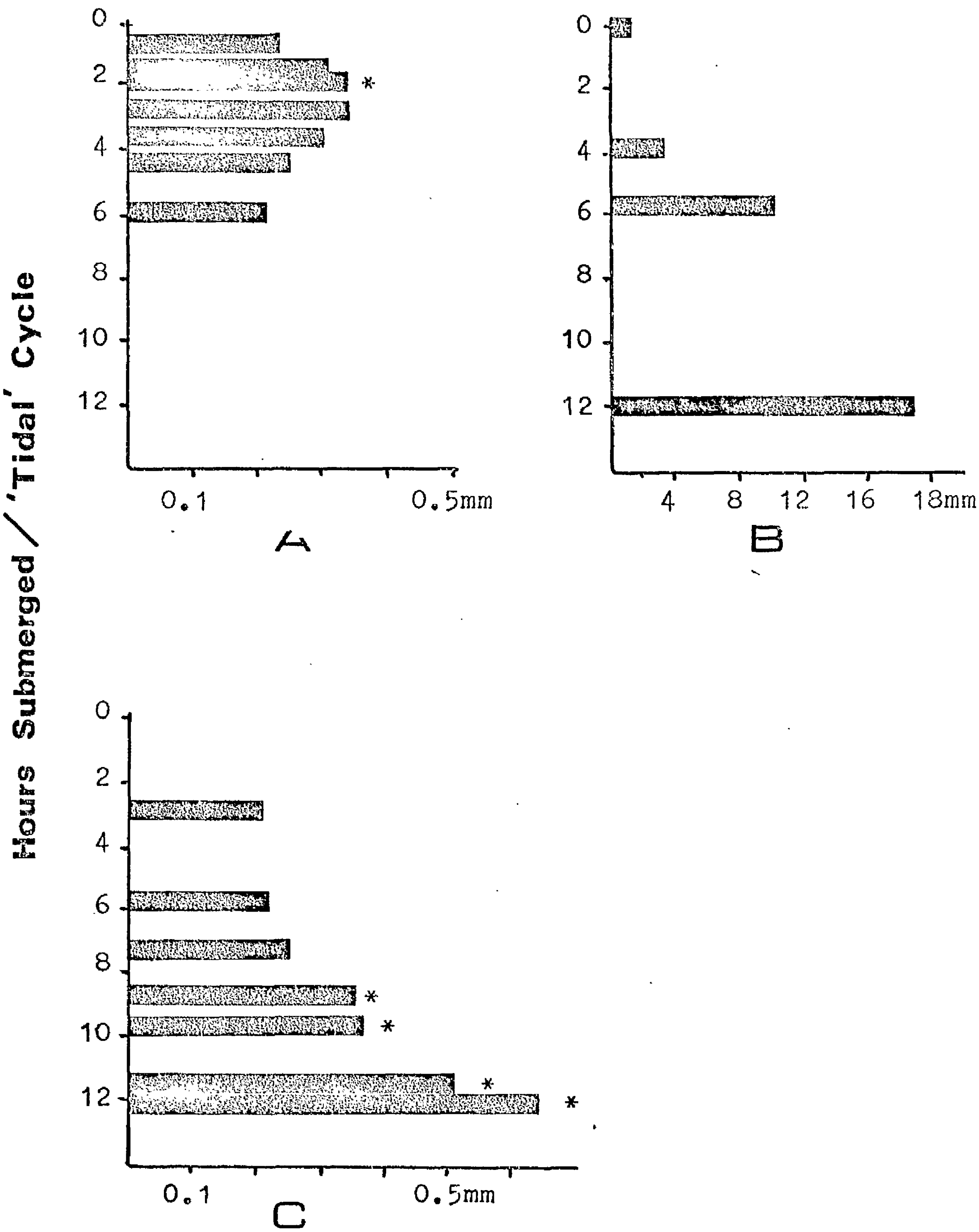


Figure 30: The growth of _Fucus spiralis_ in the simulated tidal regime under a cover of _Enteromorpha intestinalis_ (A), and uncovered (C). The sizes of the _E. intestinalis_ plants covering the germlings are shown in (B). An (*) indicates that the mean length of the germlings was significantly different ($p < 0.05$) from their length before they were placed in the simulator.

cover of sporelings, *F. spiralis* had completely disappeared from levels submerged for more than 6 hours per cycle (Figure 30), whereas on the control plates no significant amount of growth was measured at levels submerged for less than 8.9 hours/cycle. Under the *E. intestinalis* a significant growth in germlings was found only at the level corresponding to a 1.9 hour submersion/cycle, but the zygotes had undergone cell division up to the level corresponding to a submersion time of 0.5 hours/cycle. In summary, the results from this experiment show that an *E. intestinalis* cover adversely affects *F. spiralis* germlings at the lower levels in the tidal simulator, but it increases both growth and survival at the higher levels.

B.3.6 Effects of amphipod grazing:

The amphipod, *Hyale nilssoni*, was the only herbivore commonly occurring on the shore where strips were cleared. Since it could not be readily observed or controlled in the field, its effects on populations of some recolonizing species were investigated in the tidal simulator.

As described previously, it was possible to culture both *Blidingia minima* and *Enteromorpha intestinalis* at all levels in the simulated tidal regime. After completion of the original experiments one plate with the dense growth of each species was re-introduced in the apparatus together with approximately 100 amphipods and 5 l of pasteurized seawater. The density of amphipods used is roughly twice that found in a dense stand of *Pelvetia canaliculata* of the same area as the glass plate (P.G. Moore, personal communication). A higher density was used than found in the field to balance the loss of animals which occurred in the first few days of each experiment. A piece of black canvas was placed behind the plates to provide some shade for the animals (see Figure 22).

The effects of two weeks of grazing were the same in both algal species used, as shown in Plate 10. The amphipods grazed in small but distinct patches. Furthermore, the grazing was found to be more intense at the lower levels as shown by the thinner algal cover.

No adequate way was found to quantify these

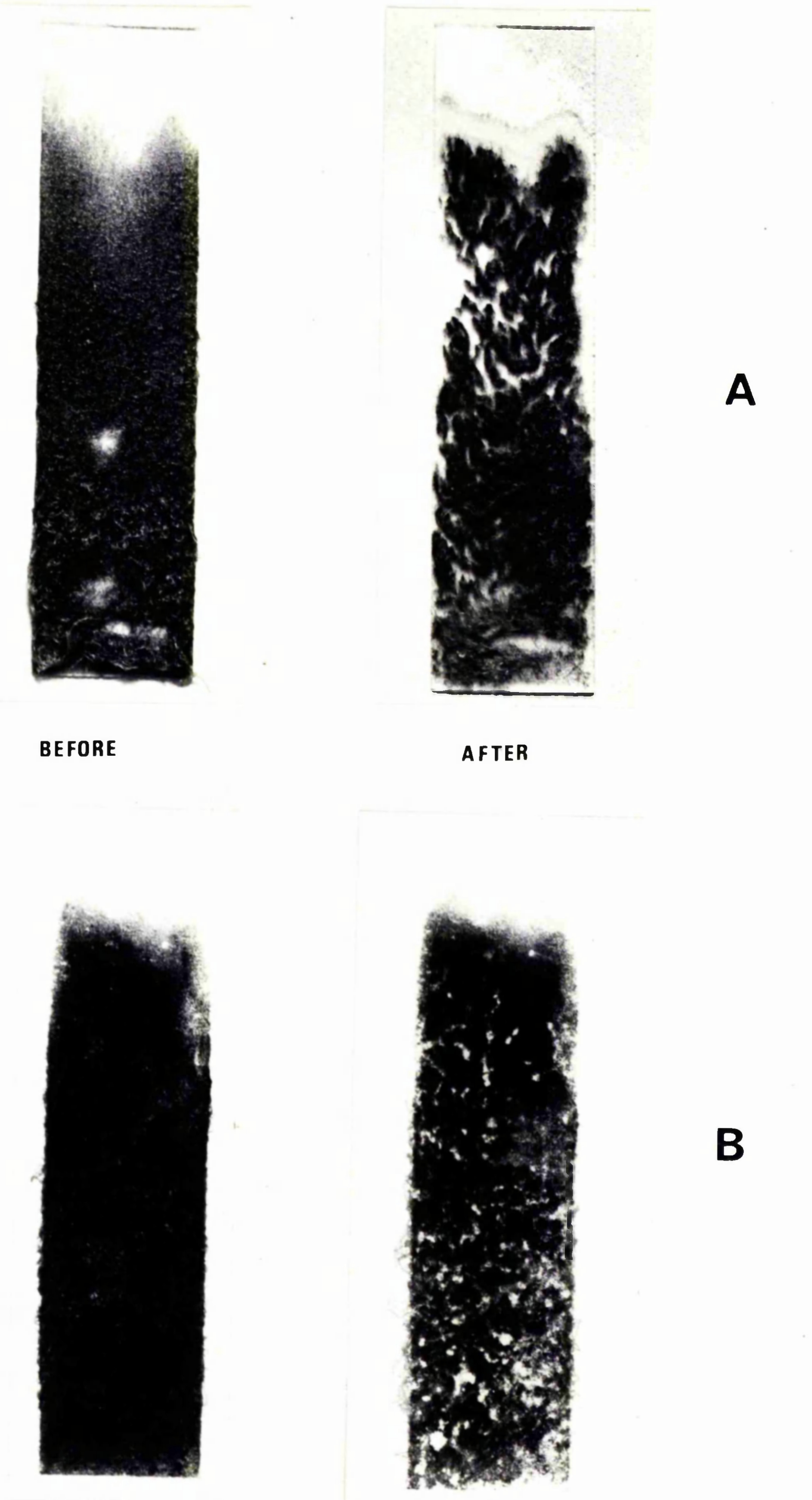


Plate 10: The effect of 2 weeks of grazing by Hyale nilssoni on Enteromorpha intestinalis (A) and Blidingia minima (B) in the tidal simulator.

observations, but the difference in the amount of cover between the middle and bottom levels is readily visible from the photographs, especially in the case of Blidingia minima.

C. DISCUSSION

The primary factor which determines whether a species appears on the shore has to be the availability of propagules from parent plants. However, the results obtained during this study indicate that the appearance of a species on the shore can be influenced by several additional factors operating in the earliest stages of colonization.

Only those species normally found in the littoral fringe and the top of the eulittoral colonized the slides placed at these levels, regardless of the inoculum available. For example, Spongomorpha arcta, Bangia atropurpurea, Audouinella sp., Ceramium sp., Gelidium sp., and Sphacelaria sp. were not found in the field samples above the 2.37 m level. Propagules of these species were commonly found in the surface waters but they never colonized the slides placed at the 2.49m or 2.89m levels. On the other hand, adult plants of Cladophora rupestris, Capsosiphon fulvescens, Monostroma oxyspermum, Porphyra sp. and Litosiphon filiformis were found on the shore above 2.37m and they also colonized the slides, even in the case of the latter three species which appeared only in the surface water at the time they colonized the slides.

These observations suggest that the upper limits of some species distributions can be determined at the time of settlement rather than later, and this is supported by the results obtained in the tidal simulator. Spores of plants were found to be much more sensitive to the environmental stresses of the littoral zone than young plants. In both Blidingia minima and Enteromorpha linza the sporelings were much more tolerant to longer periods of emersion than were the spores. Examples of plants dying on the shore (such as the kill of fucoid germlings observed at the 3m level in 1975) will therefore occur only if conditions for young plants are much worse than at the time of settlement. Since environmental conditions on the shore undergo major changes on a seasonal basis the fast growing seasonal species are more likely to have their upper limits of distribution determined at the time of settlement, while the slower growing and perennial ones will be limited more often by the survival of young plants after they have become established.

However, the results have also shown that propagules of a species do not always colonize all levels within its normal zone of distribution. Cladophora albida, Ulva lactuca and Rhizoclonium riparium were found in the surface water samples but not on the slides; even though they appeared in the field surveys within the 2.49 and 2.89m levels. These species occurred rarely in the surface samples, and the failure to settle can be attributed to chance. However, this phenomenon was also observed on several occasions in Enteromorpha sp. which settled in high densities on the slides. Normally spores were found on slides at both levels, but in the week of 5 May 1976 they were found only at the lower level. Even though the higher level was submerged on high tides that week, colonization did not take place within the full range of the usual Enteromorpha distribution.

Furthermore, differences in the density of colonization at the two levels were much greater than could have been expected on the basis of the time each level was submerged. For the week of 5 May the 2.49m level was submerged for a total of approximately 31 hours while the 2.89 m level was submerged for 13 hours (estimated from the standard tide plots in the Admiralty Tide Tables). If all other factors were equal the colonization densities should not have differed by more than 2.4 times. However, the densities of Blidingia minima differed by two orders of magnitude on slides placed directly above each other, indicating that additional factors must be involved in colonization. Either there is a difference in settling behaviour at the two levels, or there is an increase in mortality of newly settled spores due to the higher environmental stresses associated with the upper level.

The latter explanation is favoured on the basis of the results obtained in the tidal simulator. Although direct comparisons between the shore and the simulator are not possible since conditions in the two systems were not identical, it can be expected that the same factors operate in both. In the tidal simulator the successful colonization of both Blidingia minima and Enteromorpha linza on the upper half of the plates (at levels comparable with most of the eulittoral and the littoral fringe) was dependent on a period of favourable environmental conditions immediately after settlement (i.e. submerged culture). Assuming a similar situation exists on the shore, the small differences in temperature, rainfall, or insolation that occur from day to day may determine whether a propagule survives after settling. Since the higher levels on the shore can be expected to have fewer and shorter periods suitable for the survival of a propagule the large differences found in colonization densities between the 2.49m and 2.89m levels can be attributed to this rather than to differences in settling behaviour.

At the 2.49m level the algal diversity was found to be higher under the Ascophyllum nodosum canopy than out in the open. If the establishment of a propagule on the shore is only a question of survival after settlement then this observation can easily be explained by the fact that on low tides the conditions under the canopy remain moist, and therefore more favourable. However, the method used did not separate settlement from survival and there exists a possibility that other factors caused the difference in diversity. These might include:

(1) the moist environment enhances the adhesion of propagules,

(2) the A. nodosum secretes an attractant toward which motile cells can swim, or

(3) the fronds of A. nodosum act like a trap for propagules, which then settle down to the substratum.

Unfortunately it was not possible to test these hypotheses in the present study.

Some of the temporal differences in diversity found on slides and filters can be assumed to result from the seasonal nature of much algal reproduction. However, this explanation is insufficient since variations were found in spore densities of species fertile at all times of the year (Blidingia minima, Capsosiphon fulvescens, Enteromorpha intestinalis, Ulothrix pseudoflacca, Urospora penicilliformis). Although these species do show seasonal differences in abundance (Gibb, 1939, and present study), the spore densities changed within a much shorter scale. In consecutive samples taken from the surface the density of Enteromorpha sp. spores could change by a factor of 6, and within 5 days in November it changed by a factor of 20. In the surface waters off Tighnabruich (also in the Firth of Clyde) G. Smith (1977) found that counts of Blidingia minima spores could vary by a factor of 3 in one day (her counts, obtained by using the same procedures, were 136 and 423 in 400ml samples). Samples taken 7 days apart differed by a factor of 5, and she also found that counts of B. minima spores differed by a factor of 10 on the same day between locations 4 km apart. These results indicate that the observed differences in spore densities arise more from a patchiness in spore distributions than from temporal changes in abundance. The patchiness was so extensive that it masked any obvious seasonal differences.

Because propagule densities of other species in the Cumbrae samples were too low, patchiness was not very evident. However, I believe that the propagule distributions of most littoral species are patchy in the same way as those of Blidingia minima and the Enteromorpha species. The phenomenon is most likely to result from the characteristics of the environment, and these are independent of the individual species involved. Species living on rocky shores were found in patches ranging from 50 µ to several metres or more, and it is likely that their propagules will be released in patches roughly corresponding in size to that of the parent stand. Even if a littoral species is releasing propagules continually during its fertile period they will be dispersed into the water only during the time the plant is submerged. This factor will further increase the patchiness in locations such as the Clyde because the tidal currents bring a different body of water onto the shore in each tidal cycle. Although one can expect good mixing of tidal waters in mid-channel, inshore the shallow bottom and coastal topo..aphy do not permit a complete mixing (personal observations made du... the use of the Puget Sound Tidal Model at the University of Washington). This will keep patches from coalescing into a uniform distribution.

The small scale patchiness found in distributions of algal propagules in the surface water is probably a cause of the differences in colonization densities found between different locations. The four most numerous algae all showed significant differences (see Table 11) between locations within 50m of each other, and even to some degree on the slides at one location (significantly so in Blidingia minima). Glass slides placed on the shore at Tighnabruich by G. Smith (1977) were also colonized by Blidingia minima, and when her data was statistically analysed using the nested analysis of variance, significant differences ($p < 0.01$) were also found in the densities of settlement on single slides separated by only 300-500mm.

The experiments in the simulated tidal regime have indicated that a high initial density of settlement may, under certain conditions, raise the level at which propagules survive. The 'density' effect was observed when spore densities differed by factors ranging from 2-10, and this is well within the range of variation found at different locations on the shore. Since the densities of Blidingia minima used in the simulator were also similar to those found on the glass slides, and these were sufficient to establish an adult population, it is probable that differences in the density of settlement on the shore are important for the survival of a species.

Individually, all species grown in the simulated tidal regime survived and grew better when submerged longer. It has become increasingly evident that this seems to be a general characteristic of littoral algae grown in simulated tidal regimes (Townsend and Lawson, 1972; Edwards, 1977; Schonbeck, 1976). The levels of optimal growth in such cultures does not match the levels on the shore where these species are normally distributed, and this evidence strongly supports the hypothesis that the lower limit of a species distribution is set by biological rather than physical factors (Connell, 1972; Chapman, 1973; Edwards, 1977). This discrepancy between the levels of optimal growth and distributions on the shore is most noticeable in the species of the littoral fringe (Monostroma oxyspermum, Edwards, 1977; Blidingia minima, Prasiola stipitata, and Ulothrix pseudoflacca in the present study). The observations made during recolonization also indicated that these species do grow well at the lower levels if none of the longer-lived dominant species are present.

To survive in the littoral fringe, species must be more tolerant of environmental stresses, and the experiments in the simulated tidal regime indicate that this manifests itself in the earliest stages of colonization. The propagules of the 3 littoral fringe species grown in the simulator all survived to higher levels than those of either Enteromorpha linza or Fucus spiralis. Furthermore, within the group of littoral fringe species, Prasiola stipitata survived to higher levels than either of the other two, and Ulothrix pseudoflacca survived at higher levels than Blidingia minima. This pattern matches their normal distributions in the Firth of Clyde. Prasiola stipitata reaches the highest level of any marine alga, Ulothrix pseudoflacca is found lower, and Blidingia minima is found only at the lowest levels of the zone, at the edge of the boundary between the fringe and the eulittoral.

In culture, the patterns of survival and growth were radically changed by the presence of an established species. In both Ulothrix pseudoflacca and Fucus spiralis the growth of plants under a dense cover of Enteromorpha intestinalis was decreased at the lower levels relative to the growth on exposed slides. In the case of Fucus germlings the effect at the lower levels was so marked that death occurred. No plants remained in the lower levels so the cause of death could not be determined. On the other hand, the cover protected the propagules at higher levels where they died if left exposed. Since these experiments measured survival after settlement the results suggest that the increased species diversity settling under the Ascophyllum nodosum cover on the shore is a result of the more favourable conditions. The inhibitory effect shown by a cover to plants beneath it is probably not significant at the levels sampled in the field survey because these included only the highest levels on the shore.

When spores of different species were settled at the same time no interactions were observed between the plants as they grew. *Prasiola stipitata* was not affected by the presence of other Chlorophyta species in the tidal simulator, and all species that colonized the slides placed on the shore also grew to visible size on the adjacent rock. The absence of interactions seems to be limited to the species which form the 'green' phase in recolonization, for Schonbeck (1976) found that competition does occur between the longer lived dominants, *Fucus spiralis* and *Pelvetia canaliculata*. The absence of interactions may also help to explain the varied patterns found in the early recolonizing sequences, since any species that colonizes the shore successfully in the higher levels can be expected to grow to a visible size.

In summary, the factors found during this study which can influence the colonization and survival of algal propagules are

(1) the patchiness in propagule distributions in the surface water and the differences in colonization densities that can result from this,

(2) the level on the shore at which substratum is made available,

(3) the environmental conditions following settlement,

(4) the presence of an overlying canopy of *Ascophyllum nodosum*, and

(5) the presence of an established turf on the substratum.

GENERAL DISCUSSION

The changes in species distributions observed on the shore of Cumbrae indicate that the factors causing community structure must in themselves by dynamic. Menge and Sutherland (1976) have suggested that the major factors which control community structure in simple communities, where trophic complexity is limited, are competitive exclusion and the tolerances of individual species to environmental stresses. Both of these factors change with time, and therefore could account for some of the variations found in community structure. However, in the present study not all structural differences could be explained in terms of these factors, or in terms of others that have been suggested such as the tidal gradient (Lewis, 1964) or grazing (Dayton, 1975). The same piece of substratum could be occupied by several species within the course of a year, but the effects of seasonal or cyclic fluctuations in individual species on the zonation and stratification of the entire population were unpredictable, and could not always be correlated with known factors.

Even though the magnitude of diversity changes in the undisturbed strip indicated that substratum was continually being colonized by new species, the populations that appeared on this strip were different from those colonizing cleared strips at the same time. This difference can to some degree be attributed to the presence of an algal canopy in the control. The results from the experiments in the tidal simulator, and the glass slides placed in the field, indicate that many littoral species found on the upper levels of the shore need protection at the time of settlement to successfully colonize the substratum. Even the dominant canopy species survive higher on the shore if protected when small. Hatton (1932) found that the level of Fucus vesiculosus on the shore was raised when germlings were first covered by Enteromorpha intestinalis, and a similar result was obtained with Fucus spiralis in the tidal simulator. The populations in the lower levels of the cleared strips came to resemble those in the control only after the Fucus spiralis canopy was restored. Since the same species could then colonize the cleared strips and the control, the populations changed in phase with each other, as shown by the high similarities calculated between populations at the same level.

Since an algal canopy was not well developed in the top levels of the control this factor should be less important there in determining the diversity of colonizing species. In the absence of a canopy the same species can be expected to colonize the control and cleared strips from the beginning. This would account for the observation that on cleared strips populations at the top levels came to resemble those in the control sooner than the populations at the bottom levels.

Although these conclusions adequately explain the species distribution observed on the strips, the experimental results indicate that the interactions between colonizing species and the presence of an algal cover are more complex. It was found that different kinds of algal cover will result in different colonization patterns. Ascophyllum nodosum provides a cover over a large surface without monopolizing much of the actual substratum. In this case the diversity of colonizing species under the canopy was increased. Since Fucus spiralis provides a similar kind of cover, the same conditions will probably apply under its canopy. On the other hand, an algal cover in the form of a dense turf monopolizes the substratum underneath in such a way that the diversity of colonizing species is decreased. The number of species found under the turf of fucoid germlings was half that under adult Fucus spiralis plants, and the abundance of Ulothrix pseudoflacca colonizing under a cover of Enteromorpha intestinalis was greatly reduced. The field observations of Seshappa (1956) also suggest that a dense turf of Blidingia minima (as Enteromorpha minima) can prevent the settlement of Fucus spiralis zygotes.

The differences in colonization under a turf and a canopy are probably the result of conditions when submerged. Under water the blades of both Ascophyllum nodosum and Fucus spiralis float vertically, thus freeing the substratum they covered on the low tide. However, fucoid germlings and Enteromorpha intestinalis do not free the substratum when submerged, and propagules are kept from colonizing the substratum by the thick layer of fronds.

Since an algal cover in the form of a crust also monopolizes the substratum, it can be expected to exclude newly settling species. Although not experimentally demonstrated in the present study, the delay in the development of fucoid germlings on strip 6 was probably caused by the presence of the Blidingia and blue-green algal crusts. The Fucus zygotes could not colonize the substratum because it was completely covered by the crustose species. If they did manage to attach themselves to the top of the crust they would have been lost when the crust disappeared. Furthermore, certain crusts such as Ralfsia have been shown to have an antibiotic effect (Fletcher, 1975) and this might actively exclude settling species.

The zonation found among the initial colonizers on cleared strips could not be attributed wholly to seasonal factors, growth rates, or competition, and the probable cause of many of the vertical discontinuities found in populations lie with some of the factors influencing colonization. For example, zonation could appear as the tidal currents bring patches of different species into contact with different levels of the shore as the tide rises and falls. This might explain the observation that patches of the same species appeared in two separate zones within one strip (see Figure 18). Furthermore, the establishment of a species within a zone can depend on the actual number of propagules settling and on the environmental conditions following the settlement. As shown in the tidal simulator, severe conditions are more critical to species immediately after settlement than the same conditions are later in life, even a week later, and patches of propagules which settle at high densities have a better chance of survival than those with lower densities.

Zonation could also result from the increased environmental stresses associated with the higher levels. At lower levels a successful colonization might occur as soon as the substratum became available, but some time might elapse before conditions are favourable for colonization in the top levels. In 8 of the 10 cleared strips colonization took longer in the top levels than in the bottom ones, and in strip 4 the top levels remained unfavourable to algae for 6 months after clearing. By the time conditions were favourable in the upper levels, the species diversity in the surface water could have changed as a result of patchiness or the seasonal reproduction in some algae. The many different ways in which variations in enviromental conditions can be combined with spatial and temporal differences in propagule distributions would account for the apparently random patterns of zonation that were found in the cleared strips.

Patchiness, as a structural feature of the community, was not experimentally investigated in the present study because no way was found to measure or quantify the patches. Generally, communities on a shore are considered to be patchy if obvious discontinuities in species distributions are visible (Levin and Paine, 1974). However, any discussion on such a basis may misrepresent the real patterns to be found, because the patch sizes are not always limited to our scale of vision. Patchiness must be defined in terms of the size of the organisms involved, and this was not feasible within the experimental site because the size range of the organisms was too large. Patches of 50 μ were observed in the distributions of the blue-green algae, but for Ascophyllum nodosum the scale was in metres.

Although patchiness was not directly investigated in the present study, some of the results obtained do have a bearing on this aspect of community structure. In the first place, the observations of grazing in the tidal simulator and on strips 9 and 10 provide additional evidence that some of the patchiness found on uniform substrata can be attributed to trophic interactions as also indicated by Connell (1972). The concept of grazing induced patchiness in the littoral has developed from observing large grazing animals such as limpets. Most algae are absent in the areas where the herbivores are located, and the discontinuities between grazed and ungrazed areas are easily identified (Lodge, 1948; Southward, 1964; Cubit, 1974). This was the case when limpets moved into the middle levels of strip 9 and left only Ralfsia verrucosa. A similar phenomenon was also observed by J. Menge, (1975).

However, the grazing experiments in the tidal simulator have also shown that the relationship between patchiness and grazing is more complex than has been previously anticipated. In the first place, grazing by smaller herbivores can cause a patchiness which cannot be normally seen or measured in field studies. The amphipods were found to graze both Enteromorpha intestinalis and Blidingia minima in patches whose size was in millimetres. Such patchiness could readily be observed on the uniform glass plates, but because the natural substratum is rough and opaque it would not be visible in the field. Since the herbivore densities used in the experiment were similar to those found on Cumbrae, the patches resulting from amphipod grazing are probably present in the natural populations of these two green algae.

Furthermore, not all amphipod grazing occurred in patches. At the lower levels on the glass plates they not only grazed patches in the turf, but they also shortened the length of many blades by cutting through them above the substratum (see Plate 10). Thus, the effect of this herbivore species on algal distributions will depend on the feeding method used.

Patchiness caused by local disturbances could also be increased by the effect settlement densities have on survival during colonization. The differences found in the density of colonization between proximate locations could result in small areas where plants survive and others where they do not. A possible example of this phenomenon is the patchiness found in the top levels of growth in the tidal simulator (see Plates 6,7,9). Since the environment in the simulator was uniform and without disturbances, the patchiness can only be attributed to the differences in local spore densities which arose from the random dispersal of spores (a random distribution does not imply an even one). The plants survived higher on the plates in patches where random dispersal resulted in locally higher densities. This factor might also account for the uneven boundary between the fucoids and the crust of blue-green algae shown in Plate 4. These observations provide an example of the situation hypothesized by Levin (1974) where spatial heterogeneities result from 'essentially random variations with respect to colonization'.

Since the organisms which inhabit rocky shores grow relatively quickly the normal populations can be expected to re-establish themselves rapidly. Dayton (1971) therefore believes that disturbances need to occur on a fairly regular basis if patchiness is to be maintained as a structural feature of the community. However, Levin (1974) has recently hypothesized, using a mathematical model, that continuous disturbances are not necessary to maintain patchiness if the initial colonizers of a patch can resist the invasion of its habitat by other species, especially the ones following it in the recolonizing sequence. Such behaviour will prolong the life of a patch as a separate and visible unit in the community.

In view of the results obtained in the present study this hypothesis seems to be applicable to some rocky shore communities. As mentioned previously, the invasion of the substratum by new species was found to be reduced by a dense growth of an established species. On several occasions even the turf of fucoid germlings (the local dominant) was delayed by the presence of species already established on the substratum. The dominance of established algal species over colonizing ones seems to be a common phenomenon on rocky shores for it has also been observed in the sublittoral zone (Kain, 1975; Foster, 1975a). In general, the established species seems always to be competitively superior to one just settling, or growing beneath its cover, and this would explain the observation that species colonizing a newly cleared strip rarely appeared in strips already covered by other species.

Most species appearing early in the colonizing sequences were ephemeral and did not remain long on the shore. Thus Fucus spiralis has a chance to become the dominant by settling and growing during the periods when the ephemerals disappeared, even though it has a relatively slower growth rate. When the fucoid germlings are small, ephemeral species such as Enteromorpha intestinalis may cover them and slow their growth even further, but the species seems to have adapted to its role as an understory. There was no evidence of unhealthy germlings under the E. intestinalis in the field, and Schonbeck (1976) found that germlings will survive a period of total darkness for 90 days. Once established, the relative longevity of Fucus spiralis in the top of the eulittoral zone will make it the dominant, since it can keep newly arrived species from monopolizing the substratum for longer than other species.

Since established algal species which monopolize the substratum can prevent other species from taking over their habitat, the sequence of colonizing species in the cleared strips was probably determined at the time each established species finished its life-cycle. The species to appear next in the sequence was dependent on the propagules available in the surface water and in the environmental conditions at that time. If the environmental or biotic conditions were unfavourable at the time an established species in the sequence was lost from the shore, the substratum remained bare, as was observed in strip 1 (see Figure 11).

These observations suggest that dominance within a zone is more likely to be a result of longevity rather than direct competition. In locations where species change rapidly the alga which can monopolize the substratum for the longest period will be seen as the dominant. In addition to the example of Fucus spiralis from the present study, a dominance based on longevity has been reported in algal populations of other zones. The dominance of Ascophyllum nodosum over Fucus vesiculosus and Fucus serratus on sheltered shores can only be attributed to its longevity. Normally A. nodosum grows much slower than the two Fucus species and thus seems to be competitively inferior (Schonbeck, 1976). However, its advantage lies in the longevity of its fronds, which can last up to 13 years (Baardseth, 1968) against 1-3 years for the Fucus species (Rees, 1932). It may take 30 years for A. nodosum to establish itself (Baardseth, 1968) for it remains under a canopy of Fucus species for many years (Knight and Parke, 1950), but once established it will be the dominant because it monopolizes the substratum for longer than the other species.

The dominance of Laminaria hyperborea over Saccheriza polyschides in the sublittoral can also be related to its longevity, since the former is a perennial plant and the latter only an annual. Both species will colonize open substrata. In the first year the faster growing S. polyschides can keep L. hyperborea from becomining the dominant by being the first to form a canopy. However, after the first year the annual species is lost from the shore giving the L. hyperborea a chance to grow. By the second year the L. hyperborea canopy is extensive enough to prevent the development of new S. polyschides (Norton and Burrows, 1968; Kain, 1975). Since L. hyperborea is a perrenial, it will monopolize the substratum for a number of years. Thus in many areas S. polyschides can appear only in a year which follows the loss of L. hyperborea plants from the substratum.

Once long-lived algal species have colonized disturbed patches on the shore, they will partition the substratum according to their individual tolerances and by direct competition. These factors then determine the normal zonation patterns that one finds on the shore among the dominant species, as has been indicated in numerous studies (reviewed in Connell, 1972; Chapman, 1973; Menge and Sutherland, 1976). The three long-lived species found within the cleared strips were Pelvetia canaliculata, Fucus spiralis, and Gigartina stellata. Schonbeck (1976) found that Pelvetia canaliculata is limited to the littoral fringe by competition with Fucus spiralis, and the latter species is probably kept from the lower eulittoral through competition with Gigartina stellata (K. Khfagi, personal communication).

The term succession has been avoided in this discussion and as suggested by Kain (1975) 'sequence' has been used in preference to describe recolonization. Although it was found that a canopy was necessary for the development of the terminal populations in a sequence, there was no order in the appearance of species before the development of a canopy. Furthermore, species which appeared first in a sequence could prevent or inhibit the growth of species following it; an observation which is contrary to the usual concept of succession, where each species appearing in a sequence is competitively superior to the one preceding it (Colinvaux, 1973).

The present study of temporal changes in a rocky shore algal community has shown that community structure is highly variable, and that the factors involved in determining species distributions are more complex than has previously been anticipated. In considering only those factors that influence colonization it was found that the presence of a species on the shore may depend on:

(1) the patchiness of propagule densities in the water,

(2) the density of settlement,

(3) the level on the shore, and

(4) the presence of an established algal cover on the substratum.

In a study of this kind it is impossible to consider all possible factors, and further investigations may indicate additional ones that cause discontinuities in species distributions. However, the results have provided sufficient grounds to question the broad generalizations often made concerning community structure on rocky shores. Menge and Sutherland (1976) believe that community structure in trophically simple communities is determined by competition and environmental tolerances. This generalization is applicable only to the long-lived species since other factors were found to control the distributions of the less persistent members of the community. Furthermore, it was observed that the complex trophic interactions suggested by Menge and Sutherland (1976) are not necessary to maintain a high species diversity on the shore. In the upper levels, the short lifespan of many algal species and the high degree of temporal variation in both the physical and biological environment can greatly increase the number of species co-existing on the shore.

APPENDIX I: Organisms found within the experimental site on Cumbrae and the numerical code used to identify them in the computer assisted analysis of data.
For algae the nomenclatural references are from Parke and Dixon (1976) and for animals from Bruce et al. (1963).

Species	Numerical code
CHLOROPHYCEAE	
Blidingia marginata (J.Ag.) P.Dang.	402
Blidingia minima (Näg) Kylin	403
Crustal form of Blidingia	40000
Capsosiphon fulvescens (C.Ag.) Setch. et Gardn.	701
Chaetomorpha melagonium (Web. et Mohr) Kütz.	903
Cladophora albida (Huds.) Kütz.	1301
Cladophora rupestris (L.) Kütz.	1314
Cladophora sericea (Huds.) Kütz.	1315
Codiolum gregarium phase	1401
Codiolum petrocelidis phase	1402
Enteromorpha flexuosa (Wulf.)J.Ag.	1804
Enteromorpha intestinalis (L.)Link	1805
Enteromorpha linza (L.)J.Ag.	1807
Enteromorpha prolifera (O.F. Mull.)J.Ag.	1808
Monostroma oxyspermum (Kütz.)Doty	2205
Percursaria percursa (C.Ag.)Rosenv.	2501
Prasiola stipitata Suhr	2802
Pseudendoclonium submarinum Wille	3001
Rhizoclonium riparium (Roth.)Harv. (includes former R.implexum)	3305 3303
Rosenvingiella polyrhiza (Rosenv.)Silva	3401
Spongomorpha arcta (Dillw.)Kütz.	201
Ulothrix consociata Wille	4001
Ulothrix flacca (Dillw.)Thur.	4002
Ulothrix pseudoflacca Wille	4003
Ulva lactuca L.	4101
Ulvella lens Cruan frat.	4201
Urospora penicilliformis (Roth)Aresch.	4302
Unidentifiable green crusts possibly Monostroma sp.	{40200 40100

Species	Numerical code
PRASINOPHYCEAE	
Prasinocladus marinus (Cienk.)Waern	4401
PHAEOPHYCEAE	
Ascophyllum nodosum (L.)Le Jol.	5001
Ectocarpus sp.	7500
Elachista fucicola (Vell.)Aresch.	7602
Fucus spiralis L.	8004
Fucoid germlings	8000
Giffordia/*Pilayella* sp.	8100
Halothrix lumbricalis (Kütz.)Reinke	8501
Litosiphon filiformis (Reinke)Batt.	9901
Pelvetia canaliculata (L.)Dcne et Thur.	10901
Ralfsia verrucosa (Aresch.)J.Ag.	11805
Sphacelaria fusca (Huds.) S.F.Gray	12505
Stityosiphon tortilis (Rupr.)Reinke	13003
Uniseriate creeping filaments	9201
RHODOPHYCEAE	
Audouinella sp.	100
Audouinella purpurea (Lightf.)Woelkerling	26202
Ceramium shuttleworthianum (Kütz.)Rabenh.	16321
Gigartina stellata (Stackh.)Batt.	20003
Hildenbrandia rubra(Sommerf.)Menegh.	21702
Petrocelis cruenta J.Ag.	24101
Porphyra linearis Grev.	25303
Porphyra umbilicalis (L.)J.Ag.	25306
CYANOPHYCEAE	
Rivularia sp.	29800
Crust of blue green-algae genera identified in crust *Anacystis*, *Calothrix*, *Microcoleus*, *Nostoc*, *Oscillatoria*, *Schizothrix*, *Spirulina*	27800

Species	Numerical code
LICHENS	
Lichina sp.	41000
Verrucaria sp.	60000
PORIFERA	
Halichondria panicea Pallas	51000
Hymeniacidon perlevis Montagu	52000
CRUSTACEA	
Balanus balanoides L.	50000
MOLLUSCA	
Mytilidae (mussels)	55000

APPENDIX II: Species abundances and fertility in the sampling quadrats within the experimental site on Cumbrae.

The data is presented first by sampling date, then by strip and finally by level on the shore. Cleared strips are numbered from 1 to 11 in the order of clearing, which was as follows:

Strip 1	9 August 1974	7	4 June 1975
2	25 September 1974	8	18 July 1975
3	24 November 1974	9	2 September 1975
4	10 December 1974	10	2 September 1975
5	10 February 1975	11	15 January 1976
6	8 April 1975		

The control strip is numbered 101 and strips sampled before clearing are prefixed by '10'; thus strip 7 before clearing has a number of 107. The levels are numbered from 1 to 8 in and correspond to the following heights above L.A.T.:

Level 1	3.04m	5	2.49m
2	2.86	6	2.37
3	2.70	7	2.17
4	2.61	8	1.89

Species are identifed by the numerical code given in Appendix I. A removable card listing the species and their codes can be found attached to the back cover. The format of the data for each species is presented as follows:

00000-0-0

Species - Coverage of substratum using the scale of 0 - 4:

- 0 = present only in scrape sample
- 1 = cover up to 24%
- 2 = 25 - 49%
- 3 = 50 - 74%
- 4 = 75 - 100%

- Fertility

- 1 = plants found in reproductive phase
- 0 = no plants found in reproductive phase

25 SEPTEMBER 1974

STRIP 1

LEVEL 1	701-0-0	1805-0-0	27800-1-0	
LEVEL 2	701-4-1	1805-0-0	27800-1-0	
LEVEL 3	1805-4-1			
LEVEL 4	403-0-0	1805-4-1	27800-1-0	
LEVEL 5	403-0-0	1805-4-1	1808-0-0	27800-1-0
LEVEL 6	1314-0-0	1805-4-1	27800-1-0	
LEVEL 8	1805-4-1	4002-0-0	27800-1-0	

4 OCTOBER 1974

STRIP 1

LEVEL 1	701-0-0	1805-0-0	27800-1-0		
LEVEL 2	701-4-1	1401-0-0	4302-0-0	27800-1-0	
LEVEL 3	403-0-1	701-0-1	1401-0-0	1805-4-1	27800-1-0
LEVEL 4	403-1-0	701-0-0	1805-4-0	27800-1-0	
LEVEL 5	403-0-1	701-0-1	1805-4-1	1808-0-0	
LEVEL 6	701-0-0	1805-4-1			
LEVEL 8	701-1-0	1314-0-0	1805-4-1	1807-0-0	16321-0-0

STRIP 2

LEVEL 1	701-1-0	4003-0-0	27800-1-0
LEVEL 2	701-1-0	4003-0-0	27800-1-0
LEVEL 3	701-1-0	4003-0-0	27800-1-0
LEVEL 4	701-1-0	4003-0-0	27800-1-0
LEVEL 5	701-1-0	4003-0-0	27800-1-0
LEVEL 6	701-1-0	4003-0-0	27800-1-0
LEVEL 7	701-1-0	4003-0-0	27800-1-0
LEVEL 8	701-1-0	4003-0-0	27800-1-0

19 NOVEMBER 1974

STRIP 1

LEVEL 1	701-4-1	1805-0-0	4003-0-1	4302-1-0	8000-0-0	27800-1-0
LEVEL 2	701-4-1	1805-0-1	4003-1-1	4302-0-1	8000-0-0	27800-1-0
LEVEL 3	701-1-1	1805-4-1				
LEVEL 4	701-0-1	1805-4-1	3001-0-0			
LEVEL 5	701-0-1	1805-3-1	8000-0-0	20003-0-0		
LEVEL 6	1314-0-0	1805-2-1				
LEVEL 8	903-0-0	1314-1-0	1805-2-1	16321-0-0		

STRIP 2

LEVEL 1	701-1-0	27800-1-0
LEVEL 2	701-1-0	27800-1-0
LEVEL 3	701-1-0	27800-1-0
LEVEL 4	701-1-0	27800-1-0
LEVEL 5	701-1-0	27800-1-0
LEVEL 6	701-1-0	27800-1-0
LEVEL 7	701-1-0	27800-1-0
LEVEL 8	701-1-0	27800-1-0

10 DECEMBER 1974

STRIP 1

LEVEL 1	701-1-1	1805-1-0	4003-0-1	8000-0-0	27800-1-0
LEVEL 2	701-2-1	1805-1-1	4003-0-0	27800-1-0	
LEVEL 3	701-1-1	1805-4-1			
LEVEL 4	1805-4-1				
LEVEL 5	1805-2-1	3001-0-0			
LEVEL 6	1314-1-0	1805-1-1	27800-1-0		
LEVEL 8	1314-1-0	1805-0-1	16321-0-0	27800-1-0	

STRIP 2

LEVEL 1	701-0-0	8000-0-0	4003-0-0	27800-1-0	
LEVEL 2	701-0-0	8000-0-0	4003-0-0	27800-1-0	
LEVEL 3	701-0-0	8000-0-0	4003-0-0	27800-1-0	
LEVEL 4	701-0-0	8000-0-0	4003-0-0	27800-1-0	
LEVEL 5	701-0-0	1805-0-0	4003-0-0	8000-0-0	27800-1-0
LEVEL 6	701-0-0	1805-0-0	4003-0-0	8000-0-0	27800-1-0
LEVEL 7	701-0-0	1805-0-0	4003-0-0	8000-0-0	27800-1-0
LEVEL 8	701-0-0	1805-0-0	4003-0-0	8000-0-0	27800-1-0

17 JANUARY 1975

STRIP 1							
LEVEL 1	1805-0-1	4003-0-0	8000-0-0	27800-3-0			
LEVEL 2	1805-1-1	40000-0-0	8000-0-0	27800-1-0			
LEVEL 3	1805-4-1	40000-0-0	8000-0-0	26201-0-0	27800-1-0		
LEVEL 4	1805-3-1	27800-0-0					
LEVEL 5	1805-1-0	40000-1-0	8000-0-0	27800-0-0			
LEVEL 6	1314-0-0	1805-1-0	40000-1-0	8000-0-0	27800-0-0		
LEVEL 8	1314-0-0	1805-1-0	1809-0-0	40000-1-0	4101-1-0	8000-0-0	27800-0-0
STRIP 2							
LEVEL 1	1805-0-0	4003-0-0	8000-0-0	27800-3-0			
LEVEL 2	40000-3-0	4003-0-0	27800-3-0				
LEVEL 3	701-0-0	40000-4-0	8000-0-0	27800-1-0			
LEVEL 4	701-0-0	1805-0-0	40000-4-0	4003-0-0	8000-0-0	27800-1-0	
LEVEL 5	40000-4-0	27800-1-0					
LEVEL 6	1805-0-0	40000-4-0	27800-1-0				
LEVEL 7	1314-0-0	1805-0-0	40000-3-0	27800-1-0			
LEVEL 8	1805-0-0	40000-3-0	8000-0-0	27800-1-0			
STRIP 3							
LEVEL 1	3001-0-0						
LEVEL 2	3001-0-0						
LEVEL 3	3001-0-0						
LEVEL 4	3001-0-0						

10 FEBRUARY 1975

STRIP 101								
LEVEL 1	10901-2-0	4003-2-1	4302-0-1	27800-4-0				
LEVEL 2	4003-2-1	8000-0-0	10901-1-0	21702-0-0	27800-1-0	8004-4-0		
LEVEL 3	1314-0-0	4003-0-0	8000-1-0	8004-4-0	10901-1-0	21702-0-0	27800-1-0	24101-1-0
LEVEL 4	8004-2-0	21702-2-1	27800-1-0	11805-0-0	24101-1-0			
LEVEL 5	1314-0-0	8004-2-0	11805-1-0	21702-2-0	24101-2-0	27800-0-0		
LEVEL 6	8000-0-0	8004-4-0	11805-0-0	20003-1-0	21702-1-0	24101-2-0		
LEVEL 7	8004-1-0	20003-2-0	21702-1-0	24101-1-0	27800-1-0	11805-1-0	50000-1-0	
LEVEL 8	4003-0-0	8004-1-0	11805-1-0	20003-1-0	21702-2-0	27800-0-0	50000-1-0	
STRIP 1								
LEVEL 1	1805-0-1	40000-0-0	8000-0-0	27800-4-0				
LEVEL 2	1805-2-1	40000-0-0	4003-0-0	8000-0-0	27800-2-0			
LEVEL 3	1805-3-1	40000-1-0	27800-1-0					
LEVEL 4	1805-1-1	40000-3-0	8000-0-0	27800-1-0				
LEVEL 5	1805-0-0	1314-1-1	8000-0-0	27800-1-0				
LEVEL 6	1314-0-1	1805-0-1	40000-0-0	4101-1-0	8000-0-0	27800-1-0		
LEVEL 8	1314-1-0	1805-0-1	4101-2-0					
STRIP 2								
LEVEL 1	701-1-1	40000-3-0	27800-1-0					
LEVEL 2	701-0-0	1805-0-0	2205-0-0	40000-3-0	4003-0-0	8000-0-0	27800-1-0	
LEVEL 3	701-0-0	2205-0-0	40000-4-0	27800-0-0				
LEVEL 4	2205-1-0	40000-4-0	8000-0-0	27800-0-0				
LEVEL 5	2205-0-0	40000-4-0	27800-0-0					
LEVEL 6	40000-4-0	8000-0-0	27800-0-0					
LEVEL 7	40000-4-0	27800-0-0						
LEVEL 8	40000-4-0	27800-0-0						
STRIP 3								
LEVEL 1	1314-0-1	1805-0-0	2802-0-1	4003-1-1	4302-0-1	7500-0-0	27800-1-0	
LEVEL 2	1314-0-1	1805-0-0	2802-0-1	4003-1-1	4302-0-1	7500-0-0	27800-1-0	
LEVEL 3	1314-0-0	1805-0-0	2205-1-0	3001-0-0	4003-0-0	4302-0-0	7500-0-0	27800-1-0
LEVEL 4	1314-0-0	1805-0-0	2205-1-0	3001-0-0	4003-0-0	4302-0-0	7500-0-0	27800-1-0

STRIP 4

LEVEL 1	4302-0-0	40000-0-0	27800-1-0
LEVEL 2	4302-0-0	40000-0-0	27800-1-0
LEVEL 3	4302-0-0	40000-0-0	27800-1-0
LEVEL 4	4302-0-0	40000-0-0	27800-1-0
LEVEL 5	4302-0-0	40000-0-0	27800-1-0
LEVEL 6	4302-0-0	40000-0-0	27800-1-0
LEVEL 7	4302-0-0	40000-0-0	27800-1-0
LEVEL 8	4302-0-0	40000-0-0	27800-1-0

10 MARCH 1975

STRIP 101								
LEVEL 1	4003-0-0	4302-0-0	8000-4-0	10901-1-0	27800-1-0			
LEVEL 2	3001-0-0	8004-4-0	21702-1-0	27800-1-0				
LEVEL 3	1805-0-0	3001-0-0	8004-3-0	21702-1-0	24101-1-0	27800-0-0	10901-1-0	
LEVEL 4	1805-0-0	3001-0-0	4003-0-0	8004-4-0	11805-0-0	21702-1-0	24101-2-0	27800-0-0
LEVEL 5	3001-1-0	8004-2-0	11805-0-0	20003-1-0	21702-1-0	24101-1-0		
LEVEL 6	3001-0-0	11805-3-0	21702-0-0	24101-0-0	8004-4-0			
LEVEL 7	3001-0-0	2205-0-0	11805-3-1	20003-1-0	21702-0-0	24101-1-0	27800-0-0	8004-1-0
	50000-1-0							
LEVEL 8	3001-0-0	11805-3-0	27800-0-0	8004-1-0	50000-1-0	20003-1-0		
STRIP 1								
LEVEL 1	701-0-0	1805-1-0	40000-1-0	4003-0-0	4302-0-0	8000-1-0	27800-4-0	
LEVEL 2	1805-2-1	40000-1-0	8000-0-0	27800-1-0				
LEVEL 3	1805-4-1	40000-0-0	8000-1-0	21702-0-0				
LEVEL 4	1805-4-1	40000-0-0	8000-1-0	21702-0-0				
LEVEL 5	1805-4-1	40000-0-0	4302-0-0	8000-0-0	20003-0-0	27800-0-0		
LEVEL 6	1314-0-0	1805-1-0	40000-0-0	8000-0-0	20003-0-0	24101-0-0	27800-0-0	
LEVEL 8	903-0-0	1314-0-0	4101-1-0	8000-0-0	16321-0-0	20003-0-0	27800-0-0	
STRIP 2								
LEVEL 1	1805-0-0	40000-1-0	4003-0-0	4302-0-0	8000-0-0	27800-1-0		
LEVEL 3	701-2-0	1805-1-0	40000-1-0	4003-0-0	7500-0-0	11805-2-0	27800-1-0	
LEVEL 4	701-4-0	1805-1-0	40000-0-0	4003-0-0	7500-0-0	11805-2-0	27800-1-0	
LEVEL 5	403-0-0	701-4-0	1805-0-0	2205-0-0	40000-0-0	11805-1-0	21702-0-0	27800-0-0
LEVEL 6	40000-2-0	8000-0-0	11805-2-0	20003-1-0	21702-2-0			
LEVEL 7	701-0-0	1805-0-0	40000-2-0	8000-1-0	11805-1-0	21702-1-0	27800-1-0	
LEVEL 8	1805-0-0	2205-0-0	40000-4-0	27800-1-0				
STRIP 4								
LEVEL 1	701-0-0	1805-0-0	2205-0-0	40000-1-0	4003-0-0	4302-0-0	7500-0-0	27800-1-0
LEVEL 2	701-0-0	1805-0-0	2205-0-0	40000-1-0	4003-0-0	4302-0-0	7500-0-0	27800-1-0
LEVEL 3	701-0-0	1805-0-0	2205-0-0	40000-1-0	4003-0-0	4302-0-0	7500-0-0	27800-1-0
LEVEL 4	701-0-0	1805-0-0	2205-0-0	40000-1-0	4003-0-0	4302-0-0	7500-0-0	27800-1-0

LEVEL 5	1805-0-0	40000-1-0	4003-0-0	4302-0-0	27800-1-0	2205-0-0
LEVEL 6	1805-0-0	40000-1-0	4003-0-0	4302-0-0	27800-1-0	2205-0-0
LEVEL 7	1805-0-0	40000-1-0	4003-0-0	4302-0-0	27800-1-0	2205-0-0
LEVEL 8	1805-0-0	40000-1-0	4003-0-0	4302-0-0	27800-1-0	2205-0-0

8 APRIL 1975

STRIP 101								
LEVEL 1	701-0-0	4003-0-0	8000-3-0	10901-1-0	27800-2-0			
LEVEL 2	9201-0-0	1805-0-0	4002-0-0	4003-0-0	4302-0-0	8000-0-0	8004-4-0	7500-0-0
	11805-0-0	10901-1-0	21702-0-0	27800-0-0				
LEVEL 3	1805-0-0	4302-0-0	8004-1-0	7500-0-0	11805-0-0	21702-1-0	24101-1-0	27800-0-0
	10901-1-0							
LEVEL 4	8004-3-0	20003-0-0	21702-1-0	24101-3-0				
LEVEL 5	8004-2-0	11805-0-0	20003-2-0	21702-1-0	24101-1-0			
LEVEL 6	9201-0-0	403-0-0	8004-3-0	11805-2-0	20003-1-0	27800-0-0		
LEVEL 7	1314-1-0	1805-0-0	2205-0-0	8004-1-0	7500-0-0	11805-1-1	24101-2-0	27800-0-0
	50000-1-0							
LEVEL 8	701-0-0	1805-0-0	4003-0-0	4302-0-0	8004-1-0	20003-2-0	27800-1-0	50000-1-0
STRIP 106								
LEVEL 1	3401-0-0	4003-0-0	8000-0-0	27800-1-0				
LEVEL 2	7500-0-0	8004-0-0	11805-0-0	10901-1-0	27800-4-0			
LEVEL 3	8004-3-0							
LEVEL 4	11805-1-0	24101-2-0						
LEVEL 5	5001-4-1							
LEVEL 6	3001-0-0	8004-1-0	20003-2-0	27800-1-0				
LEVEL 7	11805-1-1	20003-1-0	21702-1-0	24101-1-0				
LEVEL 8	8004-1-0	20003-2-0	27800-0-0					
STRIP 1								
LEVEL 1	903-0-0	4003-0-0	8000-1-0	27800-4-0				
LEVEL 2	1805-1-1	8004-0-0	10901-0-0	27800-3-0				
LEVEL 3	1805-4-1	40000-0-0	8000-0-0					
LEVEL 4	9201-0-0	403-0-0	701-0-0	1805-4-1	7500-0-0	8000-0-0		
LEVEL 5	9201-0-0	403-0-0	1805-4-1	7500-0-0	8000-1-0	11805-0-0	20003-0-0	27800-0-0
LEVEL 6	1314-1-0	1805-0-0	40000-0-0	7500-0-0	11805-1-0	27800-0-0		
LEVEL 8	903-0-1	1314-1-1	1805-1-1	1808-0-0	2205-0-0	4003-0-0	8000-1-0	7500-0-0
	11805-0-0	27800-1-0						

STRIP 2

LEVEL 1	1401-0-0	1805-1-0	2205-0-0	2802-0-0	4003-0-0	7500-0-0	11805-0-0	27800-2-0
LEVEL 2	403-0-0	701-0-0	1805-2-1	1808-0-0	8000-0-0	7500-0-0	27800-1-0	
LEVEL 3	701-4-1	1808-0-0	7500-0-0	27800-0-0				
LEVEL 4	403-0-0	701-4-1	1805-1-0	1808-0-0	4003-0-0	7500-0-0	11805-0-0	27800-0-0
LEVEL 5	9201-0-0	403-0-0	701-4-1	1805-0-0	2205-0-0	11805-0-0	27800-1-0	
LEVEL 6	9201-0-0	403-0-0	701-0-1	1805-0-0	11805-4-0	27800-0-0		
LEVEL 7	9201-0-0	403-0-0	1808-0-0	2205-0-0	3001-0-0	4003-0-0	7500-0-0	11805-3-0
	27800-1-0							
LEVEL 8	403-0-0	4003-0-0	4302-0-0	8000-0-0	27800-3-0			

STRIP 4

LEVEL 1	4003-0-0	4302-0-0	27800-1-0					
LEVEL 2	4003-0-0	4302-0-0	27800-1-0	40000-1-0				
LEVEL 3	1808-0-0	4003-1-0	4302-0-0	8000-0-0	11805-0-0	27800-1-0	40000-1-0	
LEVEL 4	4003-1-1	4302-0-1	27800-1-0	40000-1-0				
LEVEL 5	701-0-0	2205-0-0	4002-0-1	4003-0-1	11805-1-0	27800-0-0	40000-2-0	
LEVEL 6	9201-0-0	4003-0-0	11805-0-0	27800-1-0	40000-2-0			
LEVEL 7	201-0-0	2205-0-0	4003-0-0	11805-1-0	40000-3-1			
LEVEL 8	403-0-0	201-0-0	2205-0-0	4003-0-0	11805-1-1	24101-0-0	27800-1-0	40000-3-0

STRIP 5

LEVEL 1	4003-0-0	4302-0-0	27800-1-0	40000-2-0				
LEVEL 2	201-0-0	4003-0-0	4302-0-0	40000-1-0				
LEVEL 3	4002-0-0	4003-2-0	4302-1-0	27800-1-0	40000-1-0			
LEVEL 4	2802-0-0	4003-1-1	4302-2-1	8000-0-0	40000-1-0			
LEVEL 5	2802-0-0	4003-1-1	4302-2-1	8000-0-0	40000-1-0			
LEVEL 6	403-0-0	701-0-0	1805-0-0	2205-0-0	4003-0-0	4302-0-0	7500-2-0	27800-1-0
	40000-0-0							
LEVEL 7	201-0-0	4002-1-0	4302-1-0	7500-2-0	27800-0-0	40000-1-0		
LEVEL 8	201-1-0	2802-0-0	4003-0-0	4302-1-0	27800-0-0	40000-2-0		

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STRIP 101								
LEVEL 1	4003-0-0	8000-3-0	10901-1-0	27800-1-0				
LEVEL 2	1805-0-0	4003-0-1	4302-0-0	8004-4-0	8000-0-0	11805-0-1	10901-1-0	21702-0-0
	27800-1-0	40000-0-0						
LEVEL 3	1805-0-0	2205-0-0	3001-0-0	4003-0-0	8004-2-0	11805-1-0	27800-1-0	9201-0-0
	21702-1-0							
LEVEL 4	403-0-0	1805-0-0	8004-4-0	11805-0-0	21702-1-0	24101-2-0	27800-0-0	40000-0-0
	9201-0-0	50000-1-0						
LEVEL 5	1805-0-0	4003-0-0	8000-0-0	8004-2-0	11805-1-0	20003-2-0	21702-1-0	24101-1-0
	27800-1-0	40000-0-0	50000-1-0					
LEVEL 6	403-0-0	1805-1-0	8004-4-0	11805-2-1	21702-1-0	24101-1-0	27800-0-0	9201-0-0
	50000-2-0							
LEVEL 7	201-1-0	1805-0-0	2205-0-0	4003-0-1	4302-0-1	8004-2-0	8100-0-0	20003-1-0
	21702-0-0	24101-1-0	27800-0-0	50000-2-0				
LEVEL 8	201-1-0	1805-0-0	8004-1-0	8100-1-0	11805-2-0	20003-2-0	21702-0-0	24101-1-0
	27800-2-0	9201-0-0	50000-3-0	16321-0-0				
STRIP 1								
LEVEL 1	1805-0-0	4003-0-1	4302-0-1	8000-1-0	27800-4-0			
LEVEL 2	403-0-1	701-0-0	1805-0-0	2205-0-0	4302-0-0	8000-1-0	27800-4-0	
LEVEL 3	1805-4-0	4003-0-1	4302-0-0	8000-0-0	21702-0-1	9201-0-0	27800-0-0	
LEVEL 4	701-0-0	201-0-0	8000-0-0	1805-4-0	3001-0-0	27800-0-0	50000-1-0	
LEVEL 5	403-0-0	701-0-0	201-0-0	1805-4-0	2205-0-0	40000-0-0	8000-0-0	11805-0-0
	9201-0-1	7500-0-0	50000-1-0					
LEVEL 6	403-1-0	1805-2-0	4003-0-0	8000-2-0	27800-0-0	20003-0-0	9201-0-0	50000-2-0
LEVEL 7	1315-0-1	1805-3-0	1808-0-0	8000-1-0	8100-0-0	11805-1-0	16321-0-0	27800-0-0
	40000-0-0	9201-0-0	50000-2-0	20003-1-0				
LEVEL 8	403-0-0	1315-0-0	1805-3-0	2205-1-0	4003-0-0	8000-1-0	11805-0-0	16321-0-0
	20003-1-0	21702-0-1	9201-0-0	40000-0-0	50000-3-0			
STRIP 2								
LEVEL 1	403-0-0	2205-0-0	4003-1-1	4302-0-1	8000-0-0	27800-4-0	40000-0-0	
LEVEL 2	403-1-0	701-0-0	1805-1-0	4002-0-1	4003-1-1	4302-0-1	8000-0-0	27800-2-0
LEVEL 3	403-2-0	701-0-1	1805-2-1	1808-0-0	2802-0-0	4003-0-0	8000-0-0	27800-0-0

	40000-1-0	9201-0-0						
LEVEL 4	403-2-0	701-0-0	1805-3-0	1808-0-0	4003-0-0	7602-0-0	8000-1-0	7500-0-0
	27800-0-0	40000-0-0	50000-1-0					
LEVEL 5	403-2-0	1805-3-0	1808-1-0	2205-0-0	4003-0-1	4302-0-1	8000-1-0	7500-0-0
	27800-0-0	40000-1-0	50000-1-0					
LEVEL 6	403-2-1	701-0-0	1805-3-1	1808-1-0	4002-0-0	4003-0-1	4302-0-1	11805-0-0
	8000-0-0	21702-0-0	27800-1-0	40000-1-0	50000-2-0			
LEVEL 7	403-2-1	701-0-1	1805-3-1	1808-1-0	4002-0-0	4003-0-1	4302-0-1	8000-0-0
	11805-2-0	21702-0-0	27800-1-0	40000-0-0	50000-2-0			
LEVEL 8	403-2-1	1805-2-1	1808-1-0	4003-0-0	4302-0-0	11805-1-0	20003-0-0	21702-0-0
	27800-0-0	9201-0-0	40000-0-0	50000-3-0				
STRIP 3								
LEVEL 1	4003-0-0	4302-0-0	27800-4-0	40000-1-0				
LEVEL 2	4003-1-1	27800-2-0	40000-3-0					
LEVEL 3	403-0-0	701-1-1	1805-0-0	2205-0-0	4002-1-1	4003-1-1	4302-1-1	8000-0-0
	27800-2-0	40000-1-1						
LEVEL 4	403-0-0	701-0-1	1805-0-0	2205-0-0	4002-2-1	4003-2-1	4302-0-1	8000-0-0
	27800-0-0	40000-1-0	50000-1-0					
STRIP 4								
LEVEL 1	2802-0-0	4302-0-0	27800-2-0	40000-2-1				
LEVEL 2	701-0-0	4003-1-0	8000-0-0	27800-2-0	40000-2-0			
LEVEL 3	701-0-0	4003-2-1	4302-0-1	8000-0-0	27800-2-0	40000-1-0		
LEVEL 4	701-0-1	1805-0-0	2205-0-0	3001-0-0	4003-2-1	4302-0-1	8000-0-0	27800-1-0
	40000-1-0	50000-1-0						
LEVEL 5	701-0-1	2205-0-0	4003-1-1	4302-0-1	8000-0-0	27800-2-0	40000-2-0	50000-1-0
LEVEL 6	403-0-0	4003-1-1	4302-0-1	11805-1-0	27800-1-0	40000-2-0	9201-0-0	50000-2-0
LEVEL 7	403-0-1	701-0-1	201-1-0	1805-1-0	1808-0-0	2205-0-0	4003-0-1	4302-0-0
	8000-0-0	11805-1-0	27800-1-0	40000-1-0	50000-2-0			
LEVEL 8	403-0-0	201-2-0	1805-2-0	1807-0-0	1808-0-0	4003-0-0	8000-0-0	11805-1-0
	27800-1-0	40000-2-0	50000-3-0					
STRIP 5								
LEVEL 1	1805-0-0	27800-1-0						
LEVEL 2	4302-0-1	8000-0-0	27800-0-0	40000-1-1				
LEVEL 3	4003-0-0	4302-2-1	27800-0-0	40000-1-0	8000-0-0			
LEVEL 4	4003-1-1	4302-3-1	8000-0-0	27800-1-0	40000-1-0	50000-1-0		

LEVEL 5	4002-0-0	4003-2-1	4302-2-1	8000-0-0	27800-0-0	50000-1-0	40000-2-0	
LEVEL 6	201-0-0	3001-0-0	4002-1-1	4003-4-1	4302-2-1	27800-0-0	40000-2-0	50000-2-0
LEVEL 7	201-3-0	1805-0-0	4003-1-1	8100-1-0	27800-0-0	40000-1-0	50000-2-0	
LEVEL 8	201-4-1	4003-1-0	4302-0-0	27800-0-0	40000-1-0	50000-3-0		
STRIP 6								
LEVEL 1	403-0-0	1805-0-0	27800-0-0					
LEVEL 2	403-0-0	1805-0-0	27800-0-0	21702-0-0				
LEVEL 3	403-0-0	1805-0-0	27800-0-0	21702-0-0				
LEVEL 4	1805-0-0	27800-0-0	50000-1-0					
LEVEL 5	4003-0-0	4302-0-1	27800-1-0	40000-0-0	50000-1-0			
LEVEL 6	4003-1-1	4302-1-1	27800-0-0	40000-2-0	50000-2-0			
LEVEL 7	403-0-0	1805-0-0	4003-1-1	4302-1-1	8000-0-0	27800-0-0	40000-2-0	50000-3-0
LEVEL 8	3001-1-1	4003-0-1	4302-1-1	8000-0-0	27800-0-0	40000-3-0	50000-4-0	

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STRIP 107

LEVEL 1	8000-1-0	27800-1-0	40000-0-0					
LEVEL 2	4003-0-0	8000-3-0	11805-0-0	27800-1-0	9201-0-0	50000-0-0		
LEVEL 3	8000-2-0	8004-1-0	11805-0-0	27800-1-0	9201-0-0			
LEVEL 4	1402-0-1	8004-2-0	11805-0-0	21702-2-0	24101-1-0	27800-1-0	40000-0-0	9201-0-0
LEVEL 5	403-1-0	4003-0-0	8000-0-0	9201-0-0	8004-2-0	11805-1-1	21702-1-1	24101-2-0
	27800-1-0	40000-0-0						
LEVEL 6	5001-1-0	8004-2-0	11805-1-1	20003-2-0	21702-1-0	24101-1-0	27800-0-0	40000-0-0
	9201-0-0	50000-2-0						
LEVEL 7	8004-1-0	20003-3-0	24101-1-0	27800-0-0	50000-3-0			
LEVEL 8	4201-0-0	40000-0-0	11805-0-0	16321-1-0	20003-4-0	21702-0-0	24101-0-0	27800-0-0
	50000-3-0							

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STRIP 101								
LEVEL 1	4003-0-0	4201-0-0	8000-1-0	10901-0-0	27800-1-0	40000-0-0	9201-0-0	
LEVEL 2	1402-0-0	8004-2-0	9201-0-C	10901-2-0	27800-0-0	21702-1-0	8000-1-0	
LEVEL 3	1402-0-1	4003-0-0	4302-0-1	8000-2-0	8004-1-0	21702-2-0	27800-1-0	40000-1-0
LEVEL 4	403-0-0	4003-0-1	8000-1-0	8004-2-0	9201-0-0	11805-0-0	21702-0-0	27800-2-0
	40000-0-0							
LEVEL 5	4003-0-0	4302-0-0	8004-2-0	9201-0-0	11805-2-1	20003-1-0	27800-0-0	40000-0-0
LEVEL 6	403-0-0	1805-0-0	1808-0-0	5001-1-0	8000-0-0	8004-2-0	9201-0-0	11805-1-0
	20003-1-0	21702-1-0	24101-1-0	8100-0-0	27800-0-0	40000-0-0	50000-1-0	
LEVEL 7	1315-0-0	1805-0-0	1808-0-0	2205-0-0	8000-0-0	8004-2-0	8100-0-0	9201-0-0
	11805-1-0	20003-1-0	24101-0-0	27800-1-0	40000-0-0	50000-1-0		
LEVEL 8	403-0-1	1805-1-1	8004-1-0	9201-0-0	11805-2-0	20003-2-0	27800-1-0	40000-0-0
	50000-2-0							
STRIP 1								
LEVEL 1	4003-0-0	8000-1-0	27800-3-0	40000-1-0				
LEVEL 2	1805-0-0	2205-0-0	4003-0-0	8000-1-0	27800-3-0	40000-0-0		
LEVEL 3	403-0-0	1805-4-0	3001-0-0	4003-0-0	8000-0-0	27800-1-0	40000-0-0	
LEVEL 4	1805-4-0	2205-0-0	3001-0-0	4003-0-0	8000-1-0	27800-1-0	40000-0-0	50000-0-0
LEVEL 5	403-2-0	701-0-0	1805-1-0	2205-0-0	8000-3-0	27800-1-0	40000-0-0	50000-0-0
LEVEL 6	403-2-0	1805-1-0	1808-0-0	2205-0-0	8000-2-0	21702-0-0	27800-1-0	40000-1-1
	9201-0-0	50000-1-0						
LEVEL 7	403-2-0	903-0-0	1315-0-1	1805-0-0	1808-1-0	2205-0-0	4003-0-0	8000-0-0
	8100-0-0	20003-1-0	27800-1-0	40000-1-0	50000-1-0			
LEVEL 8	403-1-0	1315-0-0	1805-1-0	1808-1-0	2205-0-1	3001-0-0	8000-2-0	8100-0-0
	11805-0-0	20003-1-0	21702-0-0	27800-1-0	40000-0-0	9201-0-0	50000-2-0	
STRIP 2								
LEVEL 1	1805-0-0	4002-0-0	4003-0-0	4302-0-0	8000-0-0	27800-0-0		
LEVEL 2	701-0-1	903-0-0	1805-0-0	1808-0-0	2205-0-0	4003-0-1	4302-0-0	9201-0-0
	27800-1-0	40000-2-0						
LEVEL 3	402-0-0	403-0-0	701-0-1	1808-0-0	2205-0-0	4003-0-0	4302-0-0	8000-0-0
	27800-2-0	40000-2-1	50000-0-0					
LEVEL 4	701-0-0	1805-3-0	1808-2-1	4003-0-0	8000-0-0	8100-0-0	27800-0-0	40000-0-0

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   LEVEL 5      403-0-0    701-0-0   1805-3-0   1808-2-0    2205-0-0   4003-0-0   4302-0-0   8000-0-0
               8100-0-0  27800-0-0  40000-1-0  50000-0-0
   LEVEL 6      403-2-1    701-0-0   1805-1-0   1808-1-0    4002-0-1   4003-0-1   8000-0-0   9201-0-0
              21702-0-0  27800-1-0  40000-2-0  50000-1-0
   LEVEL 7      403-2-1   1805-1-0   1808-1-0   4003-0-0    8000-0-0   9201-0-0  11805-0-0  27800-1-0
              40000-2-0  50000-1-0  21702-1-0
   LEVEL 8      403-3-1   1805-1-1   1808-1-0   4003-0-0    8000-0-0   9201-0-0  16321-0-0  20003-0-0
              21702-1-0  27800-0-0  40000-2-0  50000-1-0

 STRIP   3
   LEVEL 1    40000-0-0  27800-0-0
   LEVEL 2    40000-1-0  27800-0-0
   LEVEL 3      403-0-0    701-1-1   1805-0-0   1808-0-0    4002-0-1   4003-0-1   4302-0-1  40000-2-7
              27800-1-0
   LEVEL 4      403-1-0    701-1-1   1808-0-0   4003-1-1    4302-0-1   8000-0-0  40000-2-0  27800-1-0
              21702-0-0

 STRIP   4
   LEVEL 1    27800-0-0
   LEVEL 2    27800-1-0  40000-1-0
   LEVEL 3     4003-1-1   4302-1-1   8000-0-0   9201-0-0   27800-1-0  40000-3-0  50000-0-0
   LEVEL 4      403-0-0    701-1-1   1808-0-0   2205-0-0    4003-0-0   4302-0-0  27800-2-0  40000-3-0
              50000-0-0
   LEVEL 5      701-1-1   2205-0-0   4003-0-0   4302-0-1    8000-0-0  27800-2-0  40000-3-0  50000-0-0
   LEVEL 6      403-0-0   1808-0-0   4003-0-0   9201-0-0   27800-1-0  40000-1-0  50000-0-0
   LEVEL 7      201-1-0    403-4-1   1808-0-0   4003-0-0    8000-0-0   9201-0-0  27800-2-0  40000-1-0
              50000-1-0
   LEVEL 8      201-2-0    403-4-1   4003-0-0   8000-0-0    9201-0-0  27800-2-0  40000-1-0  50000-1-0

 STRIP   5
   LEVEL 1        0-0-0
   LEVEL 2    27800-0-0  40000-0-0
   LEVEL 3     4003-0-0   4302-0-0  27800-0-0  40000-1-0
   LEVEL 4     2205-0-0   4003-1-1   4302-0-1  27800-0-0   40000-2-0
   LEVEL 5     4003-1-1   4302-1-1   8000-0-0  40000-3-0   27800-0-0  50000-1-0
   LEVEL 6     4003-1-1   4201-0-0   4302-1-1  27800-1-0   40000-4-0  50000-1-0
   LEVEL 7      201-4-0    701-0-0   1808-0-1   4003-1-0    4201-0-0   4302-0-1   8000-0-0   9201-0-0
              40000-2-0  27800-0-0  50000-1-0
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LEVEL 8	201-4-0	701-0-1	2205-0-1	4003-0-0	4201-0-0	8000-0-0	40000-2-0	27800-1-0
	50000-1-0							
STRIP 6								
LEVEL 1	0-0-0							
LEVEL 3	50000-0-0							
LEVEL 4	50000-1-0							
LEVEL 5	3001-0-0	4003-0-1	4302-0-1	8000-0-0	27800-0-0	40000-2-0	50000-3-0	
LEVEL 6	4003-0-0	4302-0-0	8000-0-0	27800-1-0	40000-3-0	50000-3-0		
LEVEL 7	701-0-0	4003-0-0	4302-0-0	8000-0-0	27800-1-0	40000-3-0	50000-3-0	
LEVEL 8	701-0-0	4003-0-1	4302-0-0	8000-0-0	27800-0-0	40000-4-0	50000-3-0	
STRIP 7								
LEVEL 1	0-0-0							
LEVEL 4	9201-0-0	27800-0-0	40000-0-0					
LEVEL 5	3001-0-0	4302-0-0	27800-0-0	40000-0-0				
LEVEL 6	403-1-0	1808-0-0	3001-0-0	4302-0-0	27800-0-0	40000-0-0		
LEVEL 7	403-4-0	1808-0-0	3001-0-0	4302-0-0	27800-0-0	40000-0-0		
LEVEL 8	403-4-0	1808-0-0	4003-0-0	4302-0-0	8000-0-0	11805-0-0	27800-0-0	40000-0-0

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STRIP 108

LEVEL 1	10901-2-0	27800-0-0	60000-0-0					
LEVEL 2	903-0-1	1805-0-0	3001-0-0	4201-0-0	10901-1-0	40000-2-0	27800-0-0	
LEVEL 3	3305-0-1	8000-0-0	8004-3-0	27800-1-0	21702-0-0	24101-2-0		
LEVEL 4	2802-0-0	3305-0-1	8000-0-0	8004-4-0	9201-0-0	24101-3-1	27800-0-0	50000-1-0
LEVEL 5	8000-0-0	8004-3-0	9201-0-0	11805-1-0	24101-2-0	27800-0-0	50000-1-0	
LEVEL 6	1314-1-0	1315-1-0	3001-0-0	1805-0-1	4302-0-0	5001-2-0	8000-0-0	8004-2-0
	27800-1-0							
LEVEL 7	1314-4-0	5001-2-0	20003-1-0	21702-0-0	27800-1-0			
LEVEL 8	1314-1-1	1805-2-0	3305-0-0	4001-0-0	4003-0-1	4201-0-0	8000-0-0	8004-1-0
	20003-1-0	27800-0-0						

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STRIP 101								
LEVEL 1	8000-0-0	10901-1-0	27800-1-0					
LEVEL 2	8000-1-0	10901-2-0	27800-1-0	29800-0-0				
LEVEL 3	4201-0-0	8000-3-0	9201-0-0	11805-1-0	27800-1-0	29800-0-0	40000-0-0	
LEVEL 4	8000-4-0	9201-0-1	11805-1-0	21702-1-0	27800-0-0			
LEVEL 5	8000-2-0	9201-0-0	11805-1-0	21702-1-0	20003-1-0	40000-0-0	27800-0-0	29800-0-0
LEVEL 6	403-0-0	1805-0-0	5001-1-0	8000-0-0	8004-4-0	20003-1-0	24101-1-0	40000-0-0
	27800-0-0	29800-0-0	50000-0-0					
LEVEL 7	1301-0-0	3001-0-1	8000-0-0	8004-3-0	9201-0-0	11805-1-1	21702-0-0	24101-1-0
	20003-3-0	27800-0-0	29800-0-0					
LEVEL 8	903-1-0	1301-0-0	1805-0-0	3001-0-0	4201-0-0	8004-2-0	20003-2-0	27800-0-0
STRIP 1								
LEVEL 1	2205-0-0	4003-0-0	8000-1-0	27800-3-0	40000-1-0			
LEVEL 2	1805-0-0	4302-0-0	8000-1-0	27800-3-0	40000-1-0			
LEVEL 3	403-0-0	1808-0-0	8000-2-0	21702-0-0	27800-3-0	40000-1-0	29800-0-0	
LEVEL 4	403-0-0	1805-0-0	1808-0-0	2205-0-0	8000-4-0	27800-1-0	4003-0-0	40000-0-0
	29800-1-0							
LEVEL 5	8000-4-0	9201-0-0	11805-0-0	21702-0-0	27800-1-0	40000-0-0	50000-0-0	
LEVEL 6	403-0-0	4201-0-0	8000-4-0	11805-1-1	27800-0-0	40000-1-0	20003-0-0	21702-1-0
	24101-0-0							
LEVEL 7	1301-0-0	1314-0-0	1805-0-0	4201-0-0	8000-4-0	11805-1-0	50000-0-0	40000-0-0
	29800-0-0	16321-0-0						
LEVEL 8	903-0-0	1301-1-0	1314-0-0	3001-0-0	8000-2-0	11805-1-0	16321-0-0	20003-1-1
	21702-0-0	27800-1-0	29800-0-0					
STRIP 2								
LEVEL 1	40000-0-0	27800-1-0						
LEVEL 2	403-1-0	701-1-0	1805-0-0	2205-0-0	4003-0-0	9201-0-0	40000-1-1	27800-1-0
	29800-2-0							
LEVEL 3	403-0-1	701-0-0	1805-0-0	2205-0-0	4003-0-0	4302-0-0	8000-0-0	9201-0-0
	11805-0-0	40000-1-0	29800-2-0					
LEVEL 4	1805-2-0	3001-0-0	4003-0-1	8000-1-0	27800-3-0	40000-1-0	29800-0-0	
LEVEL 5	1805-0-0	8000-3-0	9201-0-0	11805-0-0	40000-1-0	27800-1-0	29800-1-0	

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   LEVEL 6      8000-2-0   9201-0-0  40000-1-0
   LEVEL 7      8000-1-0  11805-0-0  40000-0-0  27800-1-0
   LEVEL 8      8000-1-0   9201-0-0  20003-0-0  24101-0-0  27800-0-0  40000-0-0

STRIP   3
   LEVEL 1     27800-0-0  40000-0-0
   LEVEL 2     27800-1-0  40000-1-0
   LEVEL 3      4003-0-1   8000-0-0  27800-2-0  40000-3-0
   LEVEL 4       701-0-0   1805-4-1   1808-0-0   2205-0-0   4003-0-0   8000-0-0  27800-2-0  40000-1-0
               29800-1-0

STRIP   4
   LEVEL 1     27800-0-0
   LEVEL 2     40000-0-0  27800-2-0  29800-0-0
   LEVEL 3      4003-0-0   8000-0-0  40000-1-0  27800-3-0  29800-1-0
   LEVEL 4      4003-0-0   8000-0-0   9201-0-0  40000-3-0  27800-1-0  29800-1-0
   LEVEL 5       403-0-0   4003-0-0   8000-1-0   9201-0-0  40000-2-0  27800-1-0  29800-0-0
   LEVEL 6      4003-0-0   8000-1-0  11805-0-0  40000-1-0  27800-0-0  29800-0-0  50000-1-0
   LEVEL 7       403-0-1   1301-0-0   4003-0-0   8000-2-0  11805-0-0  50000-1-0  40000-1-0  27800-0-0
               29800-0-0
   LEVEL 8       403-0-1   8000-1-0   9201-0-0  11805-1-0  40000-1-0  27800-1-0  50000-1-0  29800-0-0

STRIP   5
   LEVEL 1     40000-1-0  27800-0-0
   LEVEL 2     40000-2-0  27800-0-0
   LEVEL 3     40000-2-1  27800-1-0
   LEVEL 4      4003-0-0   8000-0-0  40000-2-0  27800-1-0  29800-1-0
   LEVEL 5       403-0-0    701-0-1   4003-0-0   8000-1-0  40000-3-0  27800-1-0   1401-0-0  29800-1-0
               50000-1-0
   LEVEL 6      1401-0-0   4003-0-0   8000-1-0  40000-1-0  27800-0-0  29800-1-0  50000-2-0
   LEVEL 7      1808-0-0   4003-0-0   8000-1-0  40000-1-0  27800-1-0  29800-0-0  50000-0-0
   LEVEL 8      1301-0-0   4201-0-0   8000-0-0  40000-0-0  27800-1-0  29800-0-0  21702-0-0

STRIP   6
   LEVEL 1     40000-0-0  27800-0-0
   LEVEL 2     40000-1-0  27800-0-0
   LEVEL 3     40000-2-0  27800-0-0
   LEVEL 4       403-0-0    701-0-1   8000-0-0  40000-3-1  50000-1-0  27800-0-0
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LEVEL 5	701-0-0	4302-0-0	8000-0-0	40000-1-0	50000-3-0			
LEVEL 6	403-0-0	701-0-1	1805-0-0	4003-0-0	8000-2-0	40000-2-0	27800-1-0	50000-2-0
	29800-0-0							
LEVEL 7	403-0-1	701-0-1	4003-0-0	8000-2-0	50000-2-0	40000-2-0	27800-1-0	29800-1-0
LEVEL 8	4003-0-0	8000-3-0	50000-1-0	40000-2-0	27800-1-0	29800-1-0		

STRIP 7

LEVEL 1	27800-0-0						
LEVEL 2	27800-0-0	40000-0-0					
LEVEL 3	701-0-0	8000-0-0	40000-0-0	27800-1-0			
LEVEL 4	403-0-0	701-4-1	4003-0-0	8000-0-0	40000-2-0	27800-1-0	
LEVEL 5	403-0-0	701-4-1	1808-0-0	4003-0-0	8000-0-0	40000-2-0	27800-0-0
LEVEL 6	403-0-0	4003-0-0	8000-1-0	40000-2-0	27800-0-0	50000-1-0	
LEVEL 7	403-3-0	1805-0-0	1808-0-0	8000-1-0	40000-0-1	27800-0-0	
LEVEL 8	403-3-0	1805-1-0	4003-0-0	8000-1-0	40000-0-0	27800-0-0	

STRIP 8

LEVEL 1	27800-0-0					
LEVEL 2	27800-0-0	40000-1-0				
LEVEL 3	27800-0-0	40000-2-0				
LEVEL 4	27800-0-0	40000-3-0	403-0-0	701-0-0		
LEVEL 5	403-0-0	701-1-0	1805-0-0	4302-0-0	40000-3-0	27800-1-0
LEVEL 6	701-1-1	1805-0-0	4302-0-0	8000-0-0	40000-3-0	27800-1-0
LEVEL 8	701-0-0	1805-0-0	1808-1-0	8000-0-0	27800-3-0	

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STRIP 110

LEVEL 1	27800-0-0						
LEVEL 2	8000-1-0	27800-1-0	29800-0-0				
LEVEL 3	8000-3-0	27800-0-0	50000-1-0	21702-2-0			
LEVEL 4	8004-4-0	50000-2-0	27800-0-0	20003-0-0	21702-1-0	24101-1-0	
LEVEL 5	8004-2-0	50000-3-0	27800-0-0	20003-1-0	24101-0-0		
LEVEL 6	8004-1-0	50000-4-0	27800-0-0	20003-1-0	24101-0-0		
LEVEL 7	50000-4-0	27800-0-0	16321-0-0	20003-1-0	24101-0-0		
LEVEL 8	50000-3-0	20003-2-0					

STRIP 109

LEVEL 1	27800-0-0						
LEVEL 2	8000-1-0	10901-1-0	27800-1-0				
LEVEL 3	8000-3-0	11805-0-0	21702-1-0	29800-1-0	50000-1-0	27800-2-0	
LEVEL 4	5001-2-0	8004-1-0	21702-1-0	29800-0-0	60000-1-0	27800-1-0	
LEVEL 5	8000-0-0	8004-3-0	50000-2-0	21702-2-0	60000-0-0	27800-1-0	
LEVEL 6	4003-0-0	8004-3-0	20003-1-0	50000-3-0	29800-0-0	40000-0-0	27800-0-0
LEVEL 7	8004-2-0	20003-2-0	24101-0-0	50000-2-0	27800-0-0		
LEVEL 8	8004-2-0	20003-2-0	50000-3-0	29800-0-0	27800-0-0		

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STRIP 1								
LEVEL 1	4302-0-1	8000-0-0	10901-1-0	27800-3-0	40000-1-1			
LEVEL 2	1805-0-0	4003-0-0	4302-0-0	8000-1-0	10901-1-0	27800-3-0	40000-1-0	29800-0-0
LEVEL 3	403-0-0	1805-0-0	4003-0-1	8000-2-0	27800-2-0	40000-0-0	29800-0-0	
LEVEL 4	403-0-0	8000-3-0	21702-0-0	27800-1-0	40000-0-0			
LEVEL 5	8004-4-0	24101-1-0	27800-1-0	29800-0-0				
LEVEL 6	8004-4-0	11805-1-0	27800-0-0	50000-1-0				
LEVEL 7	403-0-0	1805-0-0	8004-4-0	11805-0-0	50000-1-0	29800-0-0	27800-0-0	52000-1-0
LEVEL 8	403-0-0	8004-4-0	9201-0-0	11805-0-1	50000-2-0	51000-0-0		
STRIP 3								
LEVEL 1	3001-0-0	27800-1-0						
LEVEL 2	11805-0-0	27800-2-0						
LEVEL 3	403-0-0	4003-0-0	4302-0-0	27800-4-0	29800-1-0	40100-0-0		
LEVEL 4	403-1-1	1805-2-0	4302-0-0	8000-0-0	29800-1-0	27800-2-0	40000-1-0	
STRIP 4								
LEVEL 1	27800-2-0	40100-0-0						
LEVEL 2	27800-1-0	40000-1-1						
LEVEL 3	4003-0-0	8000-0-0	27800-1-0	40000-1-1	29800-1-0			
LEVEL 4	701-0-0	4003-0-0	8000-0-0	9201-0-0	40000-2-1	27800-2-0	29800-2-0	
LEVEL 5	403-0-0	701-0-0	1805-0-0	8000-1-0	9201-0-0	29800-1-0	50000-1-0	40000-2-0
	27800-2-0							
LEVEL 6	4201-0-0	8000-4-0	9201-0-0	11805-0-0	50000-1-0	29800-1-0	40000-0-0	27800-1-0
LEVEL 7	903-0-0	8000-4-0	9201-0-0	11805-0-0	50000-1-0	27800-1-0	29800-0-0	40000-0-1
LEVEL 8	8000-1-0	50000-1-0	27800-1-0	40000-0-0	20003-1-0	24101-1-0		
STRIP 5								
LEVEL 1	40000-1-0	27800-0-0						
LEVEL 2	40000-1-0	27800-1-0						
LEVEL 3	40000-2-1	27800-1-0						
LEVEL 4	4003-0-0	8000-0-0	29800-0-0	40000-3-1	27800-1-0			
LEVEL 5	4003-0-0	8000-2-0	29800-1-0	50000-1-0	40000-1-0	27800-1-0		
LEVEL 6	8000-3-0	50000-2-0	29800-1-0	40000-1-0	27800-1-0			

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   LEVEL 7     8000-3-0  50000-1-0  40000-1-0  27800-1-0   9201-0-0  11805-0-0
   LEVEL 8     1301-1-0   8000-1-0  11805-0-0  40000-0-0  27800-0-0

STRIP   6
   LEVEL 1    27800-1-0
   LEVEL 2      701-0-0  27800-1-0  40000-1-1
   LEVEL 3      701-0-0   4003-0-0  40000-2-1  27800-1-0
   LEVEL 4      701-0-0  40000-2-1  27800-1-0  40200-1-0
   LEVEL 5     4003-0-0   8000-0-0  50000-2-0  27800-1-0  40000-3-0
   LEVEL 6      701-0-0   8000-2-0  50000-2-0  29800-1-0  27800-1-0  40000-1-0
   LEVEL 7     8000-4-0  50000-2-0  29800-1-0  40000-0-0  27800-1-0  11805-0-0
   LEVEL 8     8000-4-0  40000-0-0  27800-0-0  50000-2-0  29800-1-0

STRIP   7
   LEVEL 1    27800-1-0
   LEVEL 2      701-0-0  40000-1-0  27800-1-0
   LEVEL 3      701-0-1   4003-0-0   8000-0-0  40000-1-0  27800-2-0
   LEVEL 4    40100-1-0    701-1-1   4003-0-0   8000-1-0  40000-1-1  27800-1-0
   LEVEL 5    40100-0-0    701-0-1   8000-1-0  40000-1-1  27800-1-0
   LEVEL 6      403-1-0   8000-2-0  27800-0-0  29800-0-0  40000-1-0
   LEVEL 7      403-3-0   1805-1-0   8000-1-0  27800-1-0  40000-0-0
   LEVEL 8      403-1-0   1301-0-0   1805-1-0   1808-0-0   8000-1-0  20003-0-0  11805-1-0  40000-0-1
              27800-1-0

STRIP   8
   LEVEL 1    27800-0-0
   LEVEL 2      701-1-0  40000-0-0  27800-0-0
   LEVEL 3      701-1-0  40000-2-0  27800-0-0
   LEVEL 4      701-1-0   8000-0-0  27800-1-0  40000-3-1
   LEVEL 5      403-0-0    701-1-1   8000-0-0  27800-1-0  40000-3-1
   LEVEL 6      701-0-1   1805-1-0   1808-0-0   8000-1-0  27800-1-0  40000-3-0
   LEVEL 7      701-0-0   1805-1-1   8000-1-0  27800-3-0  40000-0-0
   LEVEL 8     1805-1-1   8000-1-0  27800-1-0

STRIP   9
   LEVEL 1        0-0-0
   LEVEL 4      701-0-0   3001-0-0
   LEVEL 5      701-0-0
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LEVEL 6	701-0-0	1805-0-0	3001-1-0	4003-0-0	27800-0-0
LEVEL 7	701-0-0	1805-0-0	3001-1-0	27800-1-0	
LEVEL 8	701-1-0	1805-1-0	3001-0-0	4003-0-1	27800-2-0

STRIP 10

LEVEL 1	0-0-0				
LEVEL 4	701-0-0	3001-0-0			
LEVEL 5	701-0-0	1805-0-0	4003-0-0	3001-0-0	
LEVEL 6	701-0-0	1805-0-0	3001-0-0	4003-0-0	
LEVEL 7	701-0-0	1805-0-0	3001-1-0	4003-0-0	27800-0-0
LEVEL 8	701-0-0	1805-1-0	3001-0-0	4003-0-1	27800-2-0

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STRIP 101								
LEVEL 1	1805-0-0	8000-0-0	10901-1-0	11805-0-0	27800-4-0			
LEVEL 2	1805-0-0	9201-0-0	8000-0-0	8004-1-0	10901-2-0	11805-2-0	29800-1-0	27800-2-0
LEVEL 3	8000-0-0	8004-3-0	11805-1-0	29800-1-0	27800-1-0			
LEVEL 4	8004-4-0	9201-0-0	11805-2-0	27800-1-0	29800-0-0	52000-2-0	20003-1-0	
LEVEL 5	8000-0-0	8004-4-0	9201-0-0	11805-2-0	50000-1-0	27800-0-0	40100-0-0	52000-1-0
	20003-1-0							
LEVEL 6	5001-1-0	8000-0-0	8004-4-0	50000-1-0	27800-0-0	24101-2-1	20003-2-0	
LEVEL 7	8000-0-0	8004-4-0	11805-0-0	50000-1-0	51000-0-0	29800-0-0	27800-1-0	16321-0-0
	20003-1-0	24101-0-0						
LEVEL 8	903-0-0	1301-0-0	1314-0-0	1805-0-0	8004-4-0	27800-0-0	20003-2-0	24101-1-0
STRIP 1								
LEVEL 1	1805-0-0	2802-0-0	4003-0-1	8000-0-0	10901-1-0	27800-4-0		
LEVEL 2	1805-0-0	8000-2-0	27800-1-0	40000-1-0	10901-1-0			
LEVEL 3	403-0-0	8000-3-0	40000-0-0	29800-1-0	27800-1-0			
LEVEL 4	403-0-0	8004-4-0	11805-0-0	27800-2-0	20003-1-0			
LEVEL 5	1805-0-0	8000-0-0	8004-4-0	9201-0-0	11805-1-0	27800-1-0	20003-1-0	
LEVEL 6	8004-4-0	11805-0-0	27800-1-0	51000-1-0	20003-1-0			
LEVEL 7	8004-4-0	27800-1-0	51000-2-0	20003-1-0				
LEVEL 8	903-0-0	1301-0-0	1314-1-0	1805-0-0	8004-4-0	27800-0-0	16321-0-0	20003-2-0
STRIP 2								
LEVEL 1	4302-0-1	27800-3-0	40100-1-0					
LEVEL 2	4003-0-0	8000-0-0	29800-0-0	27800-3-0	40100-1-0			
LEVEL 3	40000-1-0	8000-1-0	29800-1-0	27800-3-0				
LEVEL 4	40000-0-0	4302-0-0	8000-0-0	8004-4-0	27800-1-0	9203-1-0	9201-0-0	
LEVEL 5	40000-0-0	8000-0-0	8004-4-0	11805-1-0	40100-0-0	27800-1-0	21702-0-0	
LEVEL 6	40000-0-0	8000-0-0	8004-4-0	9201-0-0	11805-1-0	27800-0-0	21702-0-0	
LEVEL 7	40000-2-0	4302-0-0	8004-1-0	11805-1-0	27800-0-0			
LEVEL 8	40000-2-0	8004-4-0	9201-0-0	11805-1-0	27800-0-0			
STRIP 4								
LEVEL 1	40000-1-0	4302-0-1	27800-3-0	40100-1-0	40200-1-0			

LEVEL 2	40000-1-0	8000-0-0	9201-0-0	29800-1-0	27800-1-0			
LEVEL 3	40000-0-0	1805-0-0	8000-4-0	9201-0-0	29800-2-0	40100-0-0	27800-0-0	
LEVEL 4	8000-4-0	9201-0-0	50000-1-0	29800-1-0	40100-0-0	27800-1-0		
LEVEL 5	40000-0-0	8000-4-0	27800-1-0	9201-1-0	11805-1-0	50000-1-0	40100-0-0	
LEVEL 6	40000-0-0	1805-0-0	8000-4-0	9201-0-0	11805-0-0	50000-1-0	29800-0-0	40100-0-0
	27800-1-0	20003-1-0						
LEVEL 7	8000-4-0	24101-0-0	11805-0-0	29800-1-0	27800-1-0	20003-2-0	21702-0-0	
LEVEL 8	8000-2-0	24101-0-0	9201-0-0	50000-1-0	29800-0-0	27800-1-0	16321-0-0	20003-3-0

STRIP 5

LEVEL 1	40000-0-0	701-0-1	1401-0-0	27800-4-0	25303-0-0			
LEVEL 2	40000-0-0	701-1-1	4003-0-1	4302-0-0	8000-0-0	40200-0-0	27800-4-0	
LEVEL 3	40000-1-0	4002-0-1	4003-0-1	8000-1-0	40100-0-0	27800-1-0		
LEVEL 4	40000-0-0	1401-0-0	8000-3-0	9201-0-0	11805-0-0	29800-0-0	27800-2-0	40100-0-0
LEVEL 5	40000-0-0	8000-4-0	9201-0-0	50000-1-0	29800-1-0	40100-0-0	27800-0-0	
LEVEL 6	1401-0-0	8000-4-0	11805-1-0	50000-2-0	27800-0-0	29800-1-0		
LEVEL 7	40000-0-0	8000-4-0	9201-0-0	11805-1-0	50000-1-0	29800-1-0		
LEVEL 8	1301-0-0	4003-0-0	8000-1-0	9201-0-0	11805-3-0	27800-0-0		

STRIP 6

LEVEL 1	4003-0-0	4302-0-1	27800-4-0					
LEVEL 2	701-0-0	1805-0-0	4302-0-0	8000-0-0	29800-0-0	27800-4-0		
LEVEL 3	4302-0-0	8000-0-0	27800-4-0					
LEVEL 4	40000-0-0	40100-0-1	40200-1-1	4003-0-1	4302-0-1	8000-1-0	27800-3-0	29800-0-0
	50000-0-0							
LEVEL 5	40000-1-0	403-0-0	8000-4-0	50000-1-0	29800-0-0	40200-0-0	27800-0-0	
LEVEL 6	40000-0-0	1314-0-0	8000-4-0	24101-0-0	50000-2-0	29800-0-0	40100-0-0	27800-0-0
LEVEL 7	4003-0-0	8000-4-0	9201-0-0	24101-0-0	50000-2-0	40100-0-0	27800-0-0	
LEVEL 8	4003-0-0	8000-4-0	9201-0-0	11805-0-0	20003-1-0	24101-0-0	27800-3-0	

STRIP 7

LEVEL 1	40000-0-1	701-0-1	4302-0-1	8000-0-0	27800-4-0			
LEVEL 2	701-1-1	2205-0-0	4003-0-1	4302-0-0	8000-0-0	27800-4-0		
LEVEL 3	1805-1-1	8000-2-0	40100-0-0	27800-2-0	52000-1-0			
LEVEL 4	1805-0-0	8000-4-0	29800-0-0	27800-1-0	40100-0-0			
LEVEL 5	40000-0-0	8000-4-0	29800-0-0	27800-0-0				
LEVEL 6	40000-3-0	8000-1-0	9201-0-0	20003-0-0	24101-0-0	50000-0-0	29800-0-0	27800-0-0
LEVEL 7	40000-3-0	8000-1-0	11805-0-0	20003-0-0	24101-0-0	27800-0-0		

LEVEL 8	40000-3-0	1805-0-0	8000-1-0	11805-0-0	20003-1-0	24101-0-0	27800-0-0	
STRIP 8								
LEVEL 1	701-1-1	40000-4-0	27800-1-0					
LEVEL 2	701-1-1	40000-3-0	27800-1-0					
LEVEL 3	40000-1-0	403-0-1	701-1-1	27800-3-0				
LEVEL 4	403-1-1	701-0-1	1805-1-0	4302-0-0	8000-1-0	40000-1-0	27800-3-0	
LEVEL 5	1805-1-0	4302-0-1	8000-2-0	40000-1-0	27800-1-0			
LEVEL 6	1805-3-1	8000-1-0	27800-1-0					
LEVEL 7	1805-3-1	8000-1-0	27800-1-0	40100-0-0				
LEVEL 8	1805-3-1	4302-0-0	8000-0-0	16321-0-0	27800-1-0	40100-0-0		
STRIP 9								
LEVEL 1	40000-1-0	701-0-1	1805-2-0	4003-0-1	27800-3-0			
LEVEL 2	40000-3-0	403-1-1	701-1-1	1805-2-1	4002-0-1	4003-0-1	8000-0-0	40100-0-0
	27800-1-0	25303-0-0						
LEVEL 3	40000-3-0	403-1-1	701-2-1	1805-0-1	4002-0-1	4003-0-1	8000-0-0	27800-1-0
LEVEL 4	40000-1-0	701-0-1	1805-0-0	4003-0-1	52000-1-0	27800-1-0		
LEVEL 5	40000-2-0	1805-0-0	8000-0-0	27800-1-0				
LEVEL 6	40000-2-0	701-0-0	1805-0-0	8000-0-0	27800-0-0	40100-0-0		
LEVEL 7	40000-2-0	1805-1-1	8000-0-0	9201-0-0	27800-0-0			
LEVEL 8	403-0-0	1805-2-1	9201-0-0	52000-2-0	27800-0-0			
STRIP 10								
LEVEL 1	40000-1-0	1805-1-0	8000-0-0	27800-2-0				
LEVEL 2	40000-3-0	701-1-1	1805-1-0	4002-0-1	4003-0-1	4302-0-1	27800-1-0	
LEVEL 3	40000-3-0	701-1-1	1805-1-0	4003-0-1	8000-0-0	27800-1-0	40100-0-0	
LEVEL 4	40000-1-0	403-0-1	701-0-1	1805-0-0	4003-0-1	8000-0-0	27800-1-0	
LEVEL 5	40000-2-0	403-0-0	1805-0-0	8000-0-0	52000-0-0	27800-0-0		
LEVEL 6	40000-2-0	1805-0-0	8000-0-0	9201-0-0	27800-0-0			
LEVEL 7	40000-2-0	1805-1-0	2802-0-0	9201-0-0	11805-0-0	27800-0-0		
LEVEL 8	40000-0-0	1805-2-1	9201-0-0	52000-2-0	27800-0-0			

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STRIP 101								
LEVEL 1	40000-1-0	4003-0-0	8000-0-0	8004-1-0	10901-1-0	27800-4-0	9201-0-0	
LEVEL 2	4201-0-0	8000-0-0	8004-1-0	10901-1-0	11805-1-0	29800-0-0	9201-0-1	27800-1-0
	24101-1-0							
LEVEL 3	40000-0-0	8004-4-0	11805-1-0	27800-1-0	29800-0-0	24101-2-0		
LEVEL 4	40000-0-0	1805-0-0	8000-0-0	8004-4-0	9201-0-0	11805-1-0	52000-1-0	27800-1-0
LEVEL 5	8000-0-0	8004-4-0	9201-0-0	11805-1-0	24101-1-0	27800-0-0	50000-1-0	
LEVEL 6	1805-0-0	8000-0-0	8004-4-0	9201-0-0	11805-1-0	24101-0-0	51000-1-0	52000-0-0
	27800-0-0	50000-1-0	5001-1-0					
LEVEL 7	8004-3-0	50000-1-0	51000-1-0	20003-2-0	24101-2-0			
LEVEL 8	40000-0-0	903-0-0	1314-1-0	1805-0-0	8000-0-0	8004-3-0	11805-0-0	27800-1-0
	50000-1-0	16321-1-0	20003-1-0					
STRIP 1								
LEVEL 1	4003-0-1	8000-1-0	10901-1-0	27800-2-0	40100-0-0			
LEVEL 2	40000-2-0	8000-2-0	27800-2-0	10901-1-0	3001-0-0			
LEVEL 3	40000-1-0	4201-0-0	8000-4-0	9201-0-0	11805-0-0	27800-1-0	29800-0-0	21702-0-0
LEVEL 4	40000-0-0	4201-0-0	8000-0-0	8004-4-0	9201-0-0	11805-1-0		
LEVEL 5	8000-0-0	8004-4-0	50000-1-0	27800-0-0				
LEVEL 6	40000-0-0	8000-0-0	8004-4-0	51000-1-0	27800-0-0	11805-1-0	50000-1-0	
LEVEL 7	40000-0-0	903-0-0	1314-2-0	1805-0-0	8000-0-0	8004-4-0	51000-1-0	50000-1-0
	27800-0-0	20003-1-0						
LEVEL 8	100-0-0	903-0-0	1301-0-0	1314-2-0	8000-0-0	8004-4-0	13003-0-0	20003-1-0
	27800-0-0	50000-1-0						
STRIP 2								
LEVEL 1	40000-0-0	4003-0-0	8000-0-0	9201-1-0	27800-3-0			
LEVEL 2	40000-1-0	4302-0-0	8000-1-0	11805-0-0	27800-3-0			
LEVEL 3	403-1-0	8000-2-0	9201-0-0	11805-1-0	21702-1-0	29800-0-0	27800-1-0	
LEVEL 4	40000-1-0	8004-4-0	11805-1-0	50000-1-0	27800-0-0			
LEVEL 5	40000-1-0	8004-4-0	11805-1-0	50000-1-0	21702-0-0			
LEVEL 6	40000-0-0	8004-4-0	11805-2-0	50000-1-0	27800-0-0			
LEVEL 7	40000-1-0	8004-1-0	9201-0-0	11805-3-0	27800-0-0	21702-0-0		
LEVEL 8	40000-1-0	8000-0-0	8004-4-0	11805-1-0	50000-1-0	20003-1-0	24101-1-0	

STRIP 4								
LEVEL 1	40000-1-0	701-0-0	4003-0-1	4302-0-1	27800-3-0	40200-0-0		
LEVEL 2	40000-1-0	8000-1-0	9201-0-0	11805-0-0	27800-2-0			
LEVEL 3	40000-1-0	8000-4-0	9201-0-0	11805-0-0	29800-1-0	27800-1-0		
LEVEL 4	40000-0-0	8000-4-0	9201-0-0	27800-1-0				
LEVEL 5	40000-2-0	8000-2-0	11805-0-0	29800-0-0	27800-0-0	50000-1-0		
LEVEL 6	40000-3-0	1805-0-0	8000-0-0	11805-1-0	50000-1-0	27800-0-0		
LEVEL 7	40000-2-0	4003-0-0	8000-3-0	9201-0-0	11805-0-0	50000-1-0	27800-0-0	20003-2-0
LEVEL 8	8000-3-0	11805-0-0	16321-0-0	20003-3-0	24101-0-0	50000-1-0	27800-0-0	
STRIP 5								
LEVEL 1	40000-1-0	1401-0-1	4003-0-0	27800-4-0	40100-0-0	40200-0-0	25303-0-0	
LEVEL 2	40000-1-0	4003-0-0	4401-0-0	8000-3-0	11805-0-0	27800-4-0		
LEVEL 3	40000-1-0	4003-0-0	8000-4-0	40200-0-0	27800-4-0			
LEVEL 4	40000-0-0	8000-4-0	11805-0-0	29800-0-0	27800-1-0			
LEVEL 5	40000-0-0	8000-4-0	11805-0-0	50000-1-0				
LEVEL 6	40000-0-0	8000-4-0	11805-1-0	50000-1-0				
LEVEL 7	40000-0-0	8000-3-0	9201-0-0	11805-1-0	50000-1-0			
LEVEL 8	40000-1-0	1805-0-0	8000-1-0	11805-3-0	50000-1-0	27800-0-0		
STRIP 6								
LEVEL 1	40000-1-0	403-0-1	701-0-0	1401-2-1	25303-0-0	27800-3-0	40200-0-0	
LEVEL 2	40000-2-0	1401-0-1	4003-0-0	27800-3-0	40200-0-0			
LEVEL 3	40000-1-0	8000-1-0	27800-1-0	40200-0-1				
LEVEL 4	40000-1-0	8000-2-0	29800-0-0	27800-1-0				
LEVEL 5	40000-1-0	1805-0-0	8000-4-0	50000-2-0	27800-0-0			
LEVEL 6	40000-1-0	8000-4-0	9201-0-0	11805-0-0	50000-2-0	27800-0-0		
LEVEL 7	40000-1-0	8000-4-0	11805-1-0	50000-2-0	27800-0-0			
LEVEL 8	40000-1-0	8000-4-0	11805-1-0	50000-2-0	27800-0-0			
STRIP 7								
LEVEL 1	40000-0-0	2802-0-0	4003-0-0	4302-0-1	27800-4-0	25303-1-0		
LEVEL 2	4302-0-0	27800-4-0	40100-0-0	25303-0-0				
LEVEL 3	1805-0-0	8000-4-0	27800-2-0	40100-0-0				
LEVEL 4	1314-0-0	8000-4-0	11805-0-0	40100-0-0	27800-0-0			
LEVEL 5	40000-0-0	4201-0-0	8000-4-0	27800-0-0	40100-0-0			
LEVEL 7	40000-2-0	1805-0-0	8000-4-0	11805-1-0	27800-0-0			

LEVEL 8	40000-2-0	1805-0-0	8000-4-0	11805-1-0	29800-0-0	27800-0-0	20003-0-0	
STRIP 8								
LEVEL 1	40000-2-0	701-0-0	27800-2-0	40100-0-0				
LEVEL 2	40000-2-0	701-0-1	1805-0-0	4003-0-0	8000-0-0	27800-3-0	40100-0-0	
LEVEL 3	40000-1-0	403-0-0	701-0-0	8000-3-0	27800-3-0			
LEVEL 4	40000-1-0	1805-0-0	8000-4-0	27800-0-0	40100-0-0			
LEVEL 5	40000-1-0	1805-0-0	8000-4-0	27800-0-0				
LEVEL 6	40000-1-0	1805-0-0	8000-4-0	27800-0-0				
LEVEL 7	40000-2-0	1805-1-0	1401-0-0	8000-1-0	9201-0-0	27800-0-0		
LEVEL 8	40000-1-0	1805-1-0	8000-1-0	27800-0-0	60000-3-0			
STRIP 9								
LEVEL 1	40000-0-0	4002-0-1	4003-0-1	4302-0-0	4401-0-0	8000-0-0	27800-3-0	25303-1-0
LEVEL 2	40000-1-0	403-0-1	701-0-1	1805-2-0	4003-0-0	4302-0-0	8000-0-0	27800-3-0
LEVEL 3	40000-3-0	701-0-1	1805-1-0	4003-0-0	4302-0-0	8000-0-0	27800-1-0	
LEVEL 4	40000-2-0	1805-1-0	8000-0-0	27800-0-0				
LEVEL 5	40000-2-0	1805-0-0	4003-0-0	8000-0-0	11805-0-0	27800-0-0		
LEVEL 6	40000-3-0	1805-0-0	11805-1-0	27800-0-0				
LEVEL 7	40000-3-0	1805-0-0	11805-1-0	27800-0-0				
LEVEL 8	40000-3-0	1805-0-0	11805-0-0	27800-0-0				
STRIP 10								
LEVEL 1	40000-0-0	701-0-1	4002-0-0	4003-0-1	4302-0-1	27800-3-0	25303-1-0	
LEVEL 2	40000-1-0	701-0-1	1805-3-0	4002-0-1	4003-0-0	4302-0-0	8000-0-0	27800-3-0
LEVEL 3	40000-2-0	701-0-1	1805-2-0	4302-0-0	8000-0-0	27800-1-0		
LEVEL 4	40000-2-0	1805-1-0	7500-0-0	8000-0-0	52000-0-0	40200-0-0		
LEVEL 5	40000-2-0	1805-0-0	8000-1-0	11805-0-0	27800-0-0			
LEVEL 6	40000-2-0	1805-0-0	11805-1-0	27800-0-0				
LEVEL 7	40000-3-0	1805-0-0	8000-0-0	11805-1-0	27800-0-0			
LEVEL 8	40000-3-0	1805-0-0	11805-1-0	27800-0-0				
STRIP 11								
LEVEL 1	40000-1-0	4003-0-0	8000-0-0	27800-4-0	9201-0-0			
LEVEL 2	40000-0-0	8000-0-0	8004-2-0	11805-1-0	27800-3-0	29800-0-0		
LEVEL 3	40000-0-0	8000-0-0	8004-2-0	11805-1-0	27800-1-0	29800-0-0	24101-2-0	
LEVEL 4	40000-0-0	8000-0-0	8004-3-0	9201-0-0	11805-1-0	27800-1-0	52000-0-0	24101-2-0
LEVEL 5	8000-0-0	8004-4-0	9201-0-0	11805-0-0	27800-0-0	50000-1-0	24101-2-0	

LEVEL 6	1805-0-0	8000-0-0	8004-4-0	9201-0-0	11805-0-0	20003-0-0	24101-0-0	50000-1-0
	27800-0-0	52000-0-0						
LEVEL 7	8004-4-0	20003-1-0	24101-0-0	50000-2-0	27800-0-0			
LEVEL 8	903-0-0	1314-1-0	1805-0-0	5001-1-0	8000-0-0	8004-1-0	11805-2-0	16321-0-0
	20003-1-0	50000-2-0	27800-0-0					

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STRIP 11

LEVEL 1	3001-0-0	27800-0-0	
LEVEL 2	3001-0-0	4003-0-1	27800-0-0
LEVEL 3	3001-0-0	4003-0-1	27800-0-0
LEVEL 4	3001-0-0	4302-0-1	
LEVEL 5	3001-0-0	4302-0-1	
LEVEL 6	3001-0-0		
LEVEL 7	3001-0-0		
LEVEL 8	3001-0-0	4003-0-0	27800-0-0

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STRIP 101								
LEVEL 1	40000-0-0	4003-0-0	8000-1-0	9201-0-0	11805-0-0	10901-1-0	27800-3-0	40100-0-0
LEVEL 2	40000-0-0	403-0-0	1805-0-0	4003-0-0	8000-3-0	10901-1-0	11805-1-0	27800-3-0
	9201-0-0							
LEVEL 3	40000-0-0	1805-0-0	4003-0-0	8000-4-0	9201-0-0	10901-0-0	11805-1-0	24101-1-0
	27800-1-0							
LEVEL 4	40000-0-0	8004-3-0	9201-0-0	11805-1-0	24101-1-0	27800-1-0	29800-0-0	
LEVEL 5	40000-0-0	1805-0-0	8004-3-0	11805-1-0	20003-0-0	24101-1-0	27800-0-0	50000-1-0
LEVEL 6	40000-0-0	8004-3-0	11805-1-0	20003-1-0	24101-1-0	50000-1-0	51000-1-0	27800-0-0
	5001-1-0							
LEVEL 7	40000-0-0	1314-1-0	27800-0-0	8004-3-0	11805-1-0	20003-1-0	24101-1-0	51000-1-0
	50000-1-0							
LEVEL 8	40000-0-0	903-0-0	1301-0-0	1314-1-0	4003-0-0	8004-3-0	11805-0-0	20003-1-0
	27800-0-0	50000-1-0						
STRIP 1								
LEVEL 1	40000-0-0	4003-0-0	8000-1-0	10901-1-0	27800-3-0			
LEVEL 2	40000-0-0	8000-3-0	10901-1-0	11805-1-0	27800-2-0			
LEVEL 3	40000-0-0	4003-0-0	8004-3-0	10901-1-0	11805-1-0	27800-1-0	29800-0-0	24101-1-0
LEVEL 4	40000-0-0	8004-3-0	9201-0-0	11805-1-0	27800-1-0	24101-1-0		
LEVEL 5	4003-0-0	7500-0-0	8004-3-0	11805-2-0	27800-0-0	50000-1-0	24101-0-0	
LEVEL 6	8004-3-0	11805-1-0	51000-1-0	50000-1-0	27800-0-0	20003-0-0	24101-1-0	
LEVEL 7	40000-1-0	1314-1-0	5001-1-0	8004-3-0	11805-1-0	20003-1-0	24101-1-0	27800-0-0
	50000-1-0	51000-1-0						
LEVEL 8	40000-0-0	903-1-0	1314-1-0	8000-0-0	8004-3-0	9201-0-0	20003-1-0	50000-1-0
	27800-0-0							
STRIP 2								
LEVEL 1	40000-0-0	4002-0-0	4003-0-0	8000-0-0	40100-0-0	27800-4-0		
LEVEL 2	40000-2-0	403-0-0	4302-0-0	8000-3-0	9201-0-0	11805-0-0	40100-0-0	27800-2-0
LEVEL 3	40000-2-0	403-0-0	1805-0-0	8004-3-0	9201-0-0	11805-0-0	29800-0-0	27800-2-0
	21702-0-0							
LEVEL 4	40000-2-0	1805-0-0	8004-3-0	11805-1-0	27800-0-0			
LEVEL 5	40000-1-0	8004-3-0	11805-2-0	21702-0-0	27800-0-0	50000-1-0		

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   LEVEL 6    40000-0-0   1805-0-0   8004-3-0  11805-4-0  27800-0-0  50000-1-0
   LEVEL 7    40000-1-0    403-0-0   1805-0-0   8004-1-0  11805-3-0  27800-1-0  50000-1-0
   LEVEL 8     1301-0-0   1314-0-0   1805-0-0   8004-3-0  11805-1-0  13003-0-0  16321-0-0  20003-0-0
              24101-2-0  50000-1-0  27800-0-0

STRIP   4
   LEVEL 1    40000-1-0    701-0-0   4003-1-1   4302-1-0  25303-0-0  40200-0-0  27800-4-0
   LEVEL 2    40000-0-0   4003-0-0   4302-0-1   8000-1-0  11805-0-0  40200-0-0  27800-4-0
   LEVEL 3    40000-0-0    403-0-0   8000-4-0   9201-0-0  24101-0-0  29800-0-0  27800-1-0
   LEVEL 4    40000-0-0   8000-4-0  11805-1-0  27800-0-0
   LEVEL 5    40000-2-0    403-0-0   8000-2-0  11805-2-0  29800-0-0  27800-1-0
   LEVEL 6    40000-2-0   8000-2-0   9201-1-1  11805-1-0  24101-0-0  50000-1-0  27800-0-0
   LEVEL 7    40000-1-0   8000-4-0  11805-1-0  20003-2-0  50000-1-0
   LEVEL 8    40000-2-0   8000-1-0  11805-1-0  20003-1-0  50000-1-0  27800-0-0

STRIP   5
   LEVEL 1    40000-1-0   4002-0-0   4003-1-0   4302-0-1   8000-0-0  25303-1-0  27800-4-0
   LEVEL 2    40000-0-0   4002-0-0   4003-0-1   7500-0-0   8000-2-0  40200-0-0  27800-4-0
   LEVEL 3    40000-0-0   8000-4-0  11805-1-0  27800-1-0
   LEVEL 4    40000-0-0   8000-4-0  11805-1-0  27800-1-0  29800-0-0
   LEVEL 5    40000-0-0   8000-3-0  27800-1-0  50000-1-0
   LEVEL 6    40000-2-0   8000-3-0  11805-2-0  27800-0-0
   LEVEL 7      403-2-0   9201-0-0  11805-2-0  27800-0-0  50000-1-0
   LEVEL 8    40000-2-0    403-0-0   9201-0-0  11805-3-0   1805-0-0  27800-0-0

STRIP   6
   LEVEL 1    40000-0-0    403-0-0   1401-0-0   4003-1-0   4302-1-0  25303-0-0  27800-4-0  40200-0-0
   LEVEL 2    40000-1-0    701-0-0   4003-0-1   8000-1-0  40200-0-0  27800-4-0
   LEVEL 3    40000-1-0   8000-4-0  27800-1-0
   LEVEL 4    40000-1-0   8000-4-0  11805-0-0  27800-0-0  50000-1-0
   LEVEL 5    40000-2-0    403-0-0   8000-1-0  11805-1-0  27800-0-0  50000-2-0
   LEVEL 6    40000-3-0    403-0-0   4003-0-0   8000-1-0  11805-1-0  24101-0-0  27800-0-0  50000-2-0
   LEVEL 7    40000-3-0    403-0-0   1805-0-0   8000-1-0  11805-1-0  20003-1-0  27800-0-0  40200-0-0
              50000-2-0
   LEVEL 8    40000-1-0    403-0-0   7500-0-0   8000-1-0  11805-2-0  20003-1-0  21702-0-0  27800-0-0
              50000-2-0

STRIP   7
```

```
   LEVEL 1   40000-0-0     403-0-0    2802-1-0    4002-0-0    4003-1-1    4302-0-0   27800-4-0   40200-0-0
             25303-1-0
   LEVEL 2   40000-0-0    2802-1-1    4002-0-1    4003-0-1    4302-0-1    7500-0-0    8000-0-0   27800-4-0
             40200-0-0   25303-1-0
   LEVEL 3   40000-0-0    8000-4-0   27800-1-0
   LEVEL 4   40000-1-0    1805-0-0    8000-4-0   11805-1-0   27800-0-0
   LEVEL 5   40000-1-0    1805-0-0    8000-4-0    9201-0-0   11805-1-0
   LEVEL 6   40000-2-0    8000-4-0   11805-1-0   27800-0-0
   LEVEL 7   40000-2-0     403-0-0    8000-4-0   11805-1-0   27800-0-0
   LEVEL 8   40000-2-0    1805-0-0    8000-2-0   11805-2-0   27800-0-0

STRIP   8
   LEVEL 1   40000-0-0    4003-0-0    4302-1-1   40200-0-0   27800-4-0
   LEVEL 2     403-0-0   40000-0-0     701-0-1    1805-0-0    4302-0-0    8000-0-0   27800-4-0   25303-0-0
   LEVEL 3   40000-2-1     403-0-0    4302-0-1    8000-1-0   27800-3-0
   LEVEL 4   40000-1-0     403-0-0    4003-0-0    8000-3-0   27800-2-0   40200-0-0    1805-0-0
   LEVEL 5   40000-1-0    8000-4-0   27800-0-0
   LEVEL 6   40000-1-0     403-0-0    1805-0-0    8000-4-0    9201-0-0   27800-1-0
   LEVEL 7   40000-1-0     403-1-0    1314-0-0    1805-1-0    2205-0-0    8000-1-0   11805-1-0   13003-0-0
             27800-1-0
   LEVEL 8   40000-1-0    1805-1-0    7500-0-0    8000-0-0   27800-0-0

STRIP   9
   LEVEL 1   40000-0-0     701-0-0    4002-1-1    4003-1-1    4302-0-1    8000-0-0   27800-4-0   25303-1-0
   LEVEL 2   40000-1-0     403-0-0     701-0-0    1805-1-1    4002-0-1    4003-0-1    4302-0-0    8000-0-0
             11805-0-0   27800-4-0   40200-0-0   25303-1-0
   LEVEL 3   40000-1-0    1805-3-0    4003-0-1    7500-0-0    8000-1-0   52000-0-0   27800-3-0   40200-0-0
   LEVEL 4   40000-2-0    1805-0-0    4003-0-0    8000-1-0    9201-0-0   11805-1-0   27800-1-0   40200-0-0
   LEVEL 5   40000-3-0     403-0-0    1805-0-0    8000-1-0   11805-1-0   27800-0-0
   LEVEL 6   40000-3-0     403-0-0    1805-0-0    8000-1-0   11805-1-0   27800-0-0
   LEVEL 7   40000-3-0     403-0-0    1805-0-0   11805-2-0   27800-0-0   40200-0-0
   LEVEL 8   40000-3-0    1805-0-0   11805-2-0   27800-1-0

STRIP  10
   LEVEL 1   40000-0-0    2802-1-1    3401-1-1    4002-0-1    4003-1-1    4302-1-1   27800-4-0   25303-1-0
   LEVEL 2   40000-1-0     403-0-0    1805-2-1    4002-0-1    4003-0-1    4302-0-1    7500-0-0    8000-0-0
             27800-4-0   40200-0-0   25303-1-0
   LEVEL 3   40000-1-0     403-0-0    1805-4-1    4003-0-0    7500-0-0    8000-0-0    9201-0-0   11805-0-0
```

	27800-1-0	25303-0-0					
LEVEL 4	40000-2-0	1805-0-0	8000-1-0	9201-0-0	11805-2-0	27800-0-0	
LEVEL 5	40000-3-0	403-0-0	1805-0-0	8000-1-0	11805-2-0	27800-0-0	
LEVEL 6	40000-3-0	403-0-0	1805-0-0	8000-0-0	9201-0-0	11805-2-0	27800-0-0
LEVEL 7	40000-3-0	403-0-0	1805-0-0	9201-0-0	11805-2-0	27800-0-0	
LEVEL 8	40000-3-0	1314-0-0	1805-0-0	9201-0-0	11805-2-0	27800-1-0	
STRIP 11							
LEVEL 1	40000-0-0	403-0-0	4003-1-1	4302-0-1	27800-0-0		
LEVEL 2	40000-0-0	4003-1-1	4302-0-1	27800-0-0			
LEVEL 3	40000-1-0	4003-1-0	4302-0-0	27800-0-0			
LEVEL 4	40000-1-0	4003-1-0	4302-0-0	40200-0-0	27800-0-0		
LEVEL 5	40000-1-0	1805-0-0	4003-0-1	4302-0-1	27800-0-0		
LEVEL 6	40000-2-0	40200-0-0	4002-0-0	4302-0-0	9201-0-0	27800-0-0	
LEVEL 7	40000-3-0	403-0-0	4003-0-0	4302-0-0	9201-0-0	27800-0-0	
LEVEL 8	40000-3-0	1314-0-0	4003-0-1	4201-0-0	11805-0-0	27800-0-0	

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STRIP 101								
LEVEL 1	40000-1-0	4003-0-0	4302-0-0	8000-1-0	9201-0-0	10901-1-0	27800-4-0	
LEVEL 2	40000-0-0	8004-1-0	9201-0-0	11805-2-0	10901-1-0	27800-1-0	50000-1-0	
LEVEL 3	40000-0-0	8004-3-0	9201-0-0	11805-2-1	21702-0-0	27800-1-0	50000-1-0	
LEVEL 4	40000-0-0	403-0-0	8004-4-0	11805-2-0	20003-0-0	24101-1-0	27800-0-0	50000-1-0
LEVEL 5	40000-0-0	403-0-0	7500-0-0	8000-0-0	8004-4-0	11805-2-1	24101-1-0	27800-0-0
	50000-3-0							
LEVEL 6	40000-0-0	403-0-0	1301-0-0	5001-1-0	7500-0-0	8000-0-0	8004-4-0	11805-1-0
	24101-0-0	27800-0-0	50000-3-0					
LEVEL 7	903-0-0	1301-0-0	1314-1-0	1805-1-0	1808-0-0	4101-0-0	7500-0-0	8004-3-0
	9901-0-0	100-0-0	16321-0-0	20003-1-0	27800-0-0	50000-3-0		
LEVEL 8	40000-0-0	903-1-0	1301-1-0	1314-1-0	1805-1-0	1808-0-0	11805-1-0	16321-1-0
	50000-3-0							
STRIP 1								
LEVEL 1	40000-0-0	4003-0-0	10901-1-0	27800-4-0				
LEVEL 2	40000-1-0	8004-1-0	10901-1-0	27800-2-0	50000-1-0			
LEVEL 3	40000-1-0	403-0-0	1805-0-0	7500-0-0	8004-4-0	27800-0-0	50000-1-0	
LEVEL 4	40000-0-0	1805-0-0	4302-0-0	8004-4-0	11805-2-1	27800-1-0	50000-1-0	
LEVEL 5	40000-0-0	403-0-0	1805-0-0	7500-0-0	8004-4-0	11805-2-0	24101-1-0	27800-0-0
	50000-3-0							
LEVEL 6	40000-0-0	403-0-0	1301-0-0	1805-0-0	7500-0-0	8000-0-0	8004-4-0	9201-0-1
	11805-1-0	27800-1-0	50000-3-0	51000-1-0				
LEVEL 7	40000-0-0	1301-1-0	1805-1-0	5001-1-0	7500-0-0	8004-3-0	20003-1-0	27800-0-0
	50000-3-0	51000-0-0						
LEVEL 8	903-1-0	1301-1-0	1314-0-0	1805-1-0	1808-0-0	3305-0-0	7500-0-0	100-0-0
	20003-1-0	27800-1-0	50000-3-0					
STRIP 2								
LEVEL 1	40000-0-0	4003-0-0	4302-0-0	27800-4-0	40100-0-0	10901-1-0		
LEVEL 2	40000-1-0	4003-0-1	4302-0-0	8000-0-0	8004-1-0	10901-1-0	25303-0-0	27800-3-0
	40100-0-0	50000-1-0						
LEVEL 3	40000-0-0	4003-0-0	8004-4-0	11805-1-0	27800-2-0	29800-0-0	50000-1-0	
LEVEL 4	7500-0-0	8000-0-0	8004-4-0	11805-2-0	21702-0-0	27800-1-0	50000-1-0	

LEVEL 5	40000-0-0	8004-4-0	11805-1-0	24101-1-0	27800-1-0	50000-3-0		
LEVEL 6	40000-0-0	403-0-0	1805-0-0	7500-0-0	8004-4-0	8501-0-0	11805-1-1	27800-1-0
	50000-3-0							
LEVEL 7	40000-1-0	403-0-0	1805-4-0	4003-0-0	7500-0-0	8000-0-0	11805-1-1	27800-1-0
	50000-3-0							
LEVEL 8	40000-0-0	903-1-0	1301-0-0	1314-1-0	1805-1-0	4003-0-0	20003-1-0	27800-0-0
	50000-3-0							
STRIP 4								
LEVEL 1	40000-0-0	701-0-0	4302-0-0	27800-4-0				
LEVEL 2	40000-0-0	403-0-0	4003-0-0	4302-0-0	8000-1-0	11805-0-0	27800-4-0	50000-1-0
LEVEL 3	40000-0-0	8000-3-0	27800-1-0	50000-1-0				
LEVEL 4	8004-4-0	11805-0-0	27800-1-0	50000-1-0	41000-0-0			
LEVEL 5	403-1-0	1808-0-0	4003-0-1	8004-4-0	11805-1-0	20003-0-0	27800-1-0	29800-0-0
	50000-3-0							
LEVEL 6	40000-1-0	403-0-0	1314-0-0	4003-0-0	8004-4-0	9201-0-0	11805-1-0	27800-1-0
	50000-3-0							
LEVEL 7	40000-1-0	1808-0-0	7500-0-0	8004-4-0	9201-0-0	11805-1-0	27800-0-0	50000-3-0
LEVEL 8	1301-1-0	1314-0-0	1805-2-0	4003-0-0	8004-2-0	9201-0-0	11805-1-0	100-0-0
	20003-1-0	27800-1-0	50000-3-0					
STRIP 5								
LEVEL 1	40000-0-0	4003-1-1	4302-0-1	27800-4-0				
LEVEL 2	40000-1-0	701-0-0	4002-1-1	4003-1-1	4302-1-1	8000-1-0	27800-4-0	50000-1-0
LEVEL 3	40000-1-0	8000-3-0	29800-0-0	27800-1-0	50000-1-0			
LEVEL 4	40000-0-0	8004-4-0	11805-1-0	27800-1-0	50000-1-0			
LEVEL 5	40000-0-0	1805-0-0	8004-4-0	11805-1-0	27800-0-0	50000-4-0		
LEVEL 6	40000-0-0	1314-0-0	4302-0-1	8004-4-0	11805-1-0	27800-0-0	50000-4-0	
LEVEL 7	40000-0-0	403-0-0	7500-0-0	8004-4-0	11805-1-0	27800-0-0	50000-3-0	
LEVEL 8	40000-0-0	1805-1-0	4003-0-1	4302-0-0	8000-0-0	11805-2-0	27800-1-0	50000-3-0
STRIP 7								
LEVEL 1	40000-0-0	4003-0-0	4302-1-1	27800-4-0				
LEVEL 2	40000-0-0	4002-1-1	4003-1-1	4302-1-1	8000-1-0	27800-4-0	50000-1-0	
LEVEL 3	40000-0-0	4003-0-0	4302-0-1	8000-3-0	27800-3-0	50000-1-0		
LEVEL 4	40000-0-0	8004-4-0	11805-0-0	27800-0-0	50000-1-0			
LEVEL 5	40000-1-0	8004-4-0	11805-0-0	27800-0-0	50000-4-0			
LEVEL 6	40000-1-0	7500-0-0	8004-4-0	11805-0-0	27800-0-0	50000-4-0		

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   LEVEL 7    40000-2-0   1314-0-0   1805-0-0   8004-4-0  11805-0-0  27800-0-0  50000-3-0
   LEVEL 8    40000-1-0    403-0-0   1314-0-0   1805-0-0   1808-0-0   7500-0-0  11805-1-0  20003-1-0
              24101-1-0  27800-0-0  29800-0-0  50000-3-0

STRIP  8
   LEVEL 1    40000-0-0   4003-0-0  27800-1-0
   LEVEL 2    40000-1-0    701-0-0   8000-1-0  27800-3-0  50000-1-0
   LEVEL 3    40000-1-0   2802-0-0   4302-0-0   8000-0-0  27800-4-0  50000-1-0
   LEVEL 4    40000-1-0    403-0-0   4302-0-1   8000-2-0   9201-0-0  27800-4-0  40100-0-0  50000-1-0
   LEVEL 5    40000-0-0   8000-4-0  27800-1-0  50000-3-0
   LEVEL 6    40000-0-0   4003-0-0   4302-0-0   8000-4-0  27800-1-0  50000-3-0
   LEVEL 7    40000-1-0    403-0-0   1301-1-0   1805-1-0   4003-0-0   4101-1-0   4302-0-1   8000-2-0
              16321-0-0  20003-1-0  27800-1-0  50000-3-0
   LEVEL 8    40000-1-0    403-0-0    903-0-0   1301-1-1   1314-1-0   1805-3-0   3305-0-0   8000-0-0
              20003-1-0  27800-0-0  50000-3-0

STRIP  9
   LEVEL 1    40000-0-0   2802-0-0   4002-0-1   4003-0-1   4302-1-1  27800-4-0
   LEVEL 2    40000-1-0   1805-4-0   1808-0-0   4002-1-1   4003-1-1   4302-1-1   8000-1-0  25303-1-0
              27800-2-0  50000-1-0
   LEVEL 3    40000-1-0    403-0-0    701-0-0   1805-1-0   4002-0-0   4003-0-0   4302-0-1   7500-0-0
               8000-2-0   9201-0-0  27800-2-0  50000-1-0
   LEVEL 4    40000-3-0    403-1-1    701-0-0   1805-1-0   4002-0-1   4003-0-1   4302-0-0   7602-0-0
               8000-2-0  11805-0-0  27800-2-0  50000-1-0
   LEVEL 5    40000-2-0    403-4-1    701-0-0   1805-0-0   4002-0-0   4003-0-0   8000-1-0  27800-1-0
              50000-3-0
   LEVEL 6    40000-2-0    403-3-1   1805-0-0   1808-0-0   2802-0-0   4003-0-1   4302-0-0   8000-2-0
              27800-1-0  50000-3-0
   LEVEL 7    40000-2-0    403-3-1    402-0-0    701-0-0   1805-1-0   1808-0-0   4003-0-1   4302-0-0
               7500-0-0   8000-1-0  11805-0-0  27800-1-0  50000-3-0
   LEVEL 8    40000-1-0    403-1-0   1805-3-0   4003-0-0   4302-0-0   7500-0-0   8000-0-0  27800-1-0
              50000-3-0

STRIP  10
   LEVEL 1    40000-0-0    701-0-0   4003-0-0   4302-1-1  25303-0-0  27800-4-0
   LEVEL 2    40000-1-0    701-0-0   1805-4-0   4003-0-1   4302-0-1   8000-0-0  25303-1-0  27800-4-0
              50000-1-0
   LEVEL 3    40000-1-0    403-0-0   1805-4-0   8000-2-0   9201-0-0  27800-2-0  50000-1-0
```

LEVEL 4	40000-2-0	403-2-1	701-0-1	1805-1-0	4003-0-1	8000-4-0	11805-0-0	27800-1-0
	50000-1-0							
LEVEL 5	40000-3-0	403-1-1	1805-0-0	4003-0-0	7500-0-0	7602-0-0	8000-3-0	11805-0-0
	27800-1-0	50000-3-0						
LEVEL 6	40000-2-0	403-1-1	1805-0-0	1808-0-0	4003-0-0	11805-1-0	27800-1-0	50000-3-0
LEVEL 7	40000-2-0	403-4-1	1805-0-0	1808-0-0	4003-0-0	4302-0-0	8000-1-0	11805-0-0
	27800-1-0	50000-3-0						
LEVEL 8	40000-1-0	403-1-0	1314-1-0	1805-1-0	4003-0-0	9901-0-1	11805-1-0	27800-1-0
	50000-3-0							
STRIP 11								
LEVEL 1	40000-1-0	701-0-0	4003-0-0	27800-1-0				
LEVEL 2	40000-0-0	701-0-0	4003-0-0	4302-0-0	27800-1-0	50000-1-0		
LEVEL 3	40000-1-0	701-0-0	4003-0-1	4302-0-1	27800-2-0	40100-0-0	50000-1-0	
LEVEL 4	40000-1-0	701-1-1	4003-0-1	4302-0-1	27800-2-0	50000-1-0		
LEVEL 5	40000-1-0	701-2-1	4003-0-1	4302-0-1	27800-1-0	50000-3-0		
LEVEL 6	40000-2-0	403-0-0	701-1-1	1805-1-0	1808-0-0	4002-0-1	4003-0-1	4302-0-1
	8000-0-0	9201-0-0	11805-0-0	40100-0-0	27800-1-0	50000-3-0		
LEVEL 7	40000-2-0	403-1-1	701-1-1	1805-2-0	4002-0-1	4003-0-1	4302-0-1	8000-0-0
	9201-0-0	11805-0-0	27800-1-0	50000-3-0				
LEVEL 8	40000-2-0	403-0-1	701-1-1	1314-1-0	1805-3-0	4002-0-1	4302-0-1	4003-0-1
	11805-0-0	27800-1-0	50000-3-0					

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STRIP 101								
LEVEL 1	40000-0-0	4003-0-0	10901-1-0	27800-2-0				
LEVEL 2	40000-0-0	8000-1-0	10901-1-0	27800-2-0				
LEVEL 3	40000-0-0	1805-0-0	8000-3-0	10901-1-0	29800-0-0	27800-2-0		
LEVEL 4	40000-0-0	8004-4-0	9201-0-0	11805-2-0	50000-1-0	27800-1-0		
LEVEL 5	5001-1-0	8000-0-0	8004-4-0	9201-0-0	11805-1-0	20003-1-0	24101-1-0	50000-1-0
	27800-0-0							
LEVEL 6	403-0-0	1314-0-0	1805-1-0	5001-1-0	8000-0-0	8004-4-0	9201-0-0	11805-2-0
	12505-0-0	20003-1-0	51000-0-0	50000-1-0	27800-0-0			
LEVEL 7	903-1-0	1301-0-0	1314-0-0	1805-1-0	8000-0-0	8004-3-0	20003-1-0	50000-1-0
	55000-0-0	27800-0-0						
LEVEL 8	903-0-0	1301-0-0	1314-1-0	1805-2-0	8004-3-0	24101-1-0	50000-1-0	27800-0-0
	51000-0-0							
STRIP 1								
LEVEL 1	40000-0-0	4003-0-0	10901-1-0	27800-2-0				
LEVEL 2	40000-0-0	8000-1-0	9201-0-0	10901-1-0	27800-2-0	50000-0-0		
LEVEL 3	8000-3-0	9201-0-0	50000-0-0	40100-0-0	27800-2-0			
LEVEL 4	40000-0-0	8004-4-0	11805-2-0	27800-1-0	50000-1-0			
LEVEL 5	5001-1-0	7500-0-0	8000-0-0	8004-4-0	11805-2-0	20003-1-0	21702-0-0	24101-1-0
	50000-1-0	27800-0-0						
LEVEL 6	903-0-0	1301-0-0	1314-0-0	1805-1-0	5001-1-0	7500-0-0	8000-0-0	8004-4-0
	11805-2-0	16321-0-0	20003-1-0	24101-0-0	50000-1-0	27800-0-0	51000-0-0	
LEVEL 7	40000-0-0	903-1-0	1805-1-0	3305-0-0	8000-0-0	8004-4-0	11805-0-0	16321-1-0
	20003-1-0	24101-1-0	50000-1-0	55000-0-0	27800-0-0			
LEVEL 8	1314-1-0	1805-1-0	8004-4-0	12505-0-0	20003-1-0	24101-1-0	50000-1-0	27800-0-0
STRIP 2								
LEVEL 1	40000-0-0	27800-2-0	10901-1-0					
LEVEL 2	40000-0-0	4302-0-0	8000-1-0	27800-2-0	10901-1-0			
LEVEL 3	40000-0-0	4003-0-0	8000-4-0	9201-0-0	10901-1-0	11805-1-0	27800-1-0	29800-0-0
LEVEL 4	40000-0-0	8004-4-0	9201-0-0	11805-2-0	50000-1-0	27800-0-0		
LEVEL 5	8004-4-0	9201-0-0	11805-1-0	20003-1-0	50000-1-0	27800-0-0		
LEVEL 6	40000-0-0	903-0-0	1301-0-0	1805-1-0	5001-1-0	8000-0-0	8004-4-0	11805-2-0

	20003-1-0	24101-1-0	50000-1-0	55000-0-0	51000-0-0	27800-0-0		
LEVEL 7	403-0-0	903-1-0	1805-1-0	3305-0-0	7500-0-0	8000-0-0	8004-3-0	11805-1-0
	20003-1-0	50000-2-0	27800-1-0					
LEVEL 8	1301-0-0	1314-1-0	1805-1-0	3305-1-0	7500-0-0	8000-0-0	8004-4-0	12505-0-0
	16321-1-0	20003-1-0	24101-1-0	50000-1-0	27800-0-0			
STRIP 4								
LEVEL 1	40000-0-0	701-0-0	27800-1-0	10901-1-0				
LEVEL 2	8000-1-0	10901-4-0	27800-1-0					
LEVEL 3	40000-0-0	8000-4-0	40100-0-0	50000-0-0	41000-0-0			
LEVEL 4	8000-0-0	8004-4-0	9201-0-0	11805-0-0	24101-1-0	50000-1-0	27800-0-0	
LEVEL 5	8004-2-0	11805-1-0	20003-2-0	24101-1-0	50000-1-0	41000-1-0	27800-0-0	
LEVEL 6	40000-0-0	1805-1-0	8000-1-0	8004-1-0	9201-0-0	11805-1-1	12505-0-0	20003-4-0
	50000-1-0	29800-0-0	27800-0-0	55000-0-0				
LEVEL 7	40000-0-0	1301-0-0	1314-0-0	1805-1-0	8004-4-0	11805-1-1	16321-0-0	20003-1-0
	50000-1-0	29800-0-0	51000-0-0	27800-0-0				
LEVEL 8	40000-0-0	903-0-0	1301-0-0	1314-1-0	1805-2-0	1808-0-0	7500-0-0	8000-0-0
	8004-2-0	24101-0-0	50000-1-0	27800-0-0				
STRIP 5								
LEVEL 1	40000-1-1	4302-0-0	27800-3-0	40100-0-0				
LEVEL 2	40000-0-0	8000-2-0	27800-3-0					
LEVEL 3	8000-4-0	11805-0-0	50000-0-0	27800-0-0				
LEVEL 4	40000-0-0	8004-4-0	9201-0-0	11805-0-0	50000-1-0	41000-0-0		
LEVEL 5	7500-0-0	8004-4-0	11805-1-0	50000-1-0	27800-0-0	41000-0-0		
LEVEL 6	7500-0-0	8004-4-0	11805-1-0	50000-2-0	55000-0-0	40000-0-0	27800-0-0	
LEVEL 7	40000-0-0	903-0-0	1805-1-0	7500-0-0	8000-0-0	8004-4-0	9201-0-0	11805-2-0
	29800-0-0	50000-1-0	27800-0-0					
LEVEL 8	8000-0-0	11805-2-0	40100-0-0	27800-1-0				
STRIP 7								
LEVEL 1	2802-0-0	4302-0-0	27800-4-0					
LEVEL 2	40000-0-0	8000-2-0	27800-4-0					
LEVEL 3	40000-0-0	8000-4-0	9201-0-0	11805-1-0	50000-1-0	27800-0-0		
LEVEL 4	40000-0-0	8004-4-0	11805-0-0	50000-3-0	27800-0-0			
LEVEL 5	40000-0-0	1805-0-0	8004-4-0	9201-0-0	50000-4-0	41000-0-0		
LEVEL 6	40000-0-0	8004-4-0	11805-0-0	50000-4-0	55000-0-0	27800-0-0		
LEVEL 7	40000-0-0	8004-4-0	11805-0-0	50000-4-0				

LEVEL 8	8004-2-0	11805-1-0	50000-3-0	27800-0-0				
STRIP 8								
LEVEL 1	40000-1-0	27800-2-0						
LEVEL 2	40000-1-0	27800-2-0						
LEVEL 3	40000-0-0	4003-0-0	8000-2-0	11805-0-0	27800-2-0			
LEVEL 4	40000-0-0	8000-4-0	27800-0-0	50000-2-0				
LEVEL 5	40000-0-0	8000-4-0	50000-3-0	27800-0-0				
LEVEL 6	40000-0-0	8000-4-0	20003-1-0	50000-3-0	27800-0-0			
LEVEL 7	40000-0-0	1314-1-0	1805-2-0	3305-0-0	8000-0-0	11805-0-0	20003-0-0	24101-0-0
	50000-3-0	27800-0-0						
LEVEL 8	903-0-1	1804-1-0	1805-2-0	3305-0-0	7500-0-0	8000-0-0	12505-0-0	100-0-0
	16321-0-0	20003-0-0	27800-0-0					
STRIP 9								
LEVEL 1	40000-0-0	27800-2-0						
LEVEL 2	40000-0-0	2501-0-0	3305-0-0	4302-0-0	8000-0-0	25306-1-0	27800-3-0	
LEVEL 3	8000-4-0	11805-0-0	27800-1-0	50000-1-0				
LEVEL 4	40000-0-0	8000-4-0	24101-1-0	50000-1-0	27800-0-0			
LEVEL 5	40000-0-0	1805-0-0	8000-4-0	11805-1-1	21702-0-0	50000-1-0	27800-0-0	
LEVEL 6	40000-0-0	1805-4-0	8000-1-0	11805-1-1	50000-1-0	27800-0-0		
LEVEL 7	40000-1-0	1805-0-0	8000-0-0	11805-1-0	50000-1-0			
LEVEL 8	40000-0-0	1805-1-0	8000-0-0	11805-1-0	50000-1-0	27800-0-0		
STRIP 10								
LEVEL 1	4302-0-0	25306-0-0	27800-1-0	40100-0-0				
LEVEL 2	40000-1-0	403-1-1	4003-1-0	4302-0-0	8000-1-0	27800-3-0	40100-0-0	
LEVEL 3	40000-0-0	8000-4-0	11805-1-0	27800-0-0	50000-1-0			
LEVEL 4	40000-0-0	403-0-0	1805-0-0	8000-4-0	11805-1-0	27800-0-0		
LEVEL 5	40000-0-0	1805-0-0	8000-4-0	11805-0-0	50000-3-0	27800-0-0	55000-0-0	
LEVEL 6	40000-0-0	403-0-0	8000-4-0	11805-0-0	55000-0-0	50000-3-0		
LEVEL 7	403-0-0	1805-0-0	8000-4-0	11805-0-0	20003-1-0	24101-0-0	50000-3-0	
LEVEL 8	11805-1-1	50000-1-0	27800-0-0					
STRIP 11								
LEVEL 1	701-0-0	27800-4-0	40100-0-0					
LEVEL 2	27800-4-0	40100-1-0						
LEVEL 3	40000-0-0	701-1-1	4003-0-0	4302-0-0	8000-0-0	27800-4-0	40100-1-0	

LEVEL 4	40000-1-0	701-0-1	1805-1-0	4003-0-0	8000-0-0	40100-1-0	27800-2-0
LEVEL 5	40000-1-0	1805-1-0	8000-0-0	27800-0-0			
LEVEL 6	40000-1-0	1805-1-1	8000-0-0	9201-0-0	11805-0-0	50000-1-0	27800-0-0
LEVEL 7	40000-1-0	8000-0-0	9201-0-0	11805-0-0	27800-0-0		
LEVEL 8	7500-0-0	8000-0-0	27800-1-0				

APPENDIX III: Computer programs used in data analysis.

The data used in these programs is punched in the following format, with at least two cards for each sample:

First Card: (A6, I2, I4, 2X, I3, 2X, I1, 2X, I2)

Variables (in order): Months, Day, Year, Strip Number, Level, Number of species in sample.

Subsequent Cards: (12X, 7(I7, I1, I1))

Variables (in order): Species code, cover value, fertility.

Program 1: Calculation of similarities (written by Dr. William Sharp of the Glasgow University Computing Service)

The data was first stored on disc in the following format:

(1X, I2, I2, I2, I3, I1, I2, I2, I2, 7(IX, I7, I1))

The variable are: Last two digits of year of sample, Month, Day, Strip, Level, number of cards for this sample, sequence number of first species on this card, sequence number of last species on this card, 7(species code number, species cover value).

Samples are defined by the three parameters CUT(=strip), DATE, and LEVEL. Similarities may be calculated. .

Calculation of Similarities. (Deck B)

Samples are defined by the three parameters CUT, DATE and LEVEL.

Similarities may be calculated using any one of these as a control parameter.

e.g. using CUT as a control parameter implies that similarities are calculated first for all samples with the lowest value of CUT, then for all samples with the next lowest value of CUT and so on.

Similarly for DATE and LEVEL.

The similarity coefficient between any pair of samples is defined as -

$$s = \frac{2c}{D + E}$$

where

$C = \Sigma$ smaller cover values for species in common

$D = \Sigma$ cover values for first sample

$E = \Sigma$ cover values for second sample

Operation of the program is best described by an example. Suppose similarities are required using CUT as the control parameter. The following steps are performed:-

(i) The data file is copied and recorded (if necessary) into the sequence

CUT ascending cut values	(DATE (ascending DATE (values for fixed (CUT	(LEVEL (ascending LEVEL values for fixed (CUT and DATE

(This reordering is done using the IBM Sort Program)

(ii) Suppose samples for the first CUT value are identified by

$$S_{11} \quad S_{12} \; S_{13} \qquad\qquad S_{1N}$$

These are copied to a second temporary file, and similarities are calculated in the following order:-

$S_{11} - S_{11}$

$S_{10} - S_{11}$, $S_{12} - S_{12}$

$S_{13} - S_{11}$, $S_{13} - S_{12}$, $S_{13} - S_{13}$

.
.
.
.
.

$S_{1N} - S_{11}$, $S_{1N} - S_{12}$, $S_{1N} - S_{13}$, ... $S_{1N} - S_{1N}$

(iii) The similarity coefficients are output as a lower triangular matrix.

(note that the similarities are symmetric and the diagonal elements of the matrix are all 2).

The samples for the next CUT value are taken and the corresponding matrix calculated and OUTPUT and so on.

IMPLEMENTATION

```
// - -  JOB  - -
// S1∇EXEC∇SORT
// SORTIN∇DD∇DSN = GBTVØ2, LEVEL, DISP = SHR
// SORTOUT∇DD∇DSN =  TEMP, UNIT 2 SCRATCH, SPACE = (TRK,(1,Ø,2)),
// ∇DCB = (RECFM = FB, LRECL = 8Ø, BLKSIZE = 312Ø), DISP = (,PASS)
// SYSIN∇DD∇*
      }SORT CONTROL CARD
// S2∇EXEC∇FORTRAN G
// G.SYSIN∇DD∇*
       DECK B
      }
       FORTRAN SOURCE
// G.FTØ1FØØ1∇DD∇DSN = TEMP, DISP = (OLD,DELETE)
// G.FTØ2FØØT∇DD∇UNIT = SCRATCH, SPACE = (TRK,(1Ø,1)),
// ∇DCB = (RECFM = VBS, BLKSIZE = 24ØØ)
//  FTØ4FØØ1∇DD∇UNIT = SCRATCH, SPACE = (TRK,(1Ø,1)),
// ∇DCB = (RECFM = VBS, BLKSIZE = 24ØØ)
// G.FT/Ø8FØØ1∇DD∇UNIT = SCRATCH, SPACE = (TRK, (5,5)),
// ∇DCB = (RECFM = VBS, BLKSIZE = 25ØØ)
// G.SYSIN∇DD∇*
    }PROGRAM DATA CARD
//
```

NOTES

(1) All cards start in column 1

(2) NO spaces to be left unless indicated by ∇

(3) Files used

- (i) SORTIN - basic data file, input to SORT program
- (ii) SORTOUT - sorted file (temporary file)
- (iii) G.FTØ1FØØ1 - sorted file used for similarity calculations
- (iv) G.FTØ2FØØ1 - file for storing sample for a given value of the control parameter
- (v) G.FTØ4FØØ1 - used for storing similarities
- (vi) G.FTØ8FØØ1 - holds similarities during output of large similarity matrices.

Data Cards Required

Each choice of control parameter requires a SORT control card and a program data card, used as a pair.

Control Parameter	DATE	(sorted sequence DATE { CUT { LEVEL)

SORT CARD

$_\nabla$SORT$_\nabla$FIELDS = (2,2,A,4,2,A,6,2,A,8,3,A,11,1,A,14,2,A),FORMAT = FI

Program Card

$\nabla\nabla\nabla^{1}$

Control Parameter	CUT	(sorted sequence CUT {DATE { LEVEL)

SORT CARD

SORT$_\nabla$FIELDS = (8,3,A,2,2,A,4,2,A,6,2,A,11,1,A,14,2,A),FORMAT = FI

Program Card

$\nabla\nabla\nabla^{2}$

Control Parameter	LEVEL	(sorted sequence LEVEL {DATE [CUT)

SORT CARD

$_\nabla$SORT$_\nabla$FIELDS = (11,1,A,2,2,A,4,2,A,6,2,A,8,3,A,74,2,A),FORMAT = FI

Program Card

$\nabla\nabla\nabla^{3}$

Program 2: Tabulation of the frequency with which species were observed on sampling days. The original cards were ordered by date, with the following control cards:

First card, at the beginning of data for each sampling day -

AAAAAA11111111111111 999

Last card, at the end of data for each day -

(A6, I2, I4), two blanks, then 111 1 666

The variables are: Month, Day, Year

Program 3: Tabulation of species observed to be in their reproductive phase. The control cards are the same as for program 2.

```
C     TABULATION OF SEASONAL OCCURRENCES AMONG THE ALGAE ON COLEBRAE
      DIMENSION NUM(8),ICOUNT(8),FREQ(8,30)
      INTEGER DUM(8,30,2), DAY, DIVER, YR, SPEC(20)
    2 READ (5,100) MON, MTH, DAY, YR, ISWA, LEV, DIVER
  100 FORMAT (2A3,I2,I4,2X,I3,2X,I1,2X,I2)
      M = 0
      IF (ISWA .EQ. 0) GO TO 2
      IF (DIVER .NE. 99) GO TO 3
      DO 4 I=1,8
      DO 4 J=1,30
      DO 4 K=1,2
    4 DUM(I,J,K) = 0
      DO 5 I=1,8
      ICOUNT(I) = 0
    5 NUM(I) = 0
      GO TO 2
    3 IF (DIVER .NE. 88) GO TO 10
      IF (LEV .EQ. 0) STOP
      WRITE (6,101) DAY, MON, MTH, YR
  101 FORMAT ('1'/////////20X,I3,1X,2A3,1X,I4//18X,5HLEVEL,3X,1H1,11X,
     11H2,11X,1H3,11X,1H4,11X,1H5,11X,1H6,11X,1H7,11X,1H8/23X,
     261H*************************************************************,
     326H**************************     )
      DO 15 I=1,30
      DO 15 J=1,8
   15 FREQ(J,I) = FLOAT(DUM(J,I,2))/ICOUNT(J)
      DO 6 I=1,30
      WRITE (6,102) ((DUM(J,I,1),FREQ(J,I)),J=1,8)
  102 FORMAT (1H ,18X,8(I5,1H-,F4.2,2X))
    6 CONTINUE
      WRITE (6,104) (NUM(I),I=1,8)
  104 FORMAT('0',23X,8(I2,10X)/54X,23HTOTAL NUMBER OF SPECIES)
      GO TO 2
   10 READ (5,103) (SPEC(I),I=1,DIVER)
  103 FORMAT (1(12X,7(I7,2X)))
      ICOUNT(LEV) = ICOUNT(LEV) + 1
      DO 40 I=1,DIVER
      M = 0
      DO 20 J=1,30
      IF (SPEC(I) .EQ. DUM(LEV,J,1)) GO TO 30
      GO TO 20
   30 DUM(LEV,J,2) = DUM(LEV,J,2) + 1
      M = 1
   20 CONTINUE
      IF (M .EQ. 1) GO TO 40
      NUM(LEV) = NUM(LEV) + 1
      N = NUM(LEV)
      DUM(LEV,N,1) = SPEC(I)
      DUM(LEV,N,2) = DUM(LEV,N,2) + 1
   40 CONTINUE
      GO TO 2
      END
```

APPENDIX IV: The frequencies with which species were observed at the 8 levels on each sampling day.

Species are identified by their code number (see Appendix I), and the frequency is given as a fraction of the total number of samples on the appropriate level.

Data from the control and strip 2 are missing for 26 September, 1976.

Data format:

```
         00000-0.00
          /      \
Species code - frequency
```

To help in identifying species, a removable card giving the code numbers is attached to the back cover.

17 JAN. 1975

LEVEL 1	2	3	4	5	6	7	8
1805-0.67	1805-0.33	1805-0.33	1805-0.67	1805-0.50	1314-0.50	1314-1.00	1314-0.50
4003-0.67	40000-0.67	40000-0.67	27800-0.67	40000-1.00	1805-1.00	1805-1.00	1805-1.00
8000-0.67	8000-0.33	8000-0.67	701-0.33	8000-0.50	40000-1.00	40000-1.00	1809-0.50
27800-0.67	27800-0.67	26201-0.33	40000-0.33	27800-1.00	8000-0.50	27800-1.00	40000-1.00
3001-0.33	4003-0.33	27800-0.67	4003-0.33		27800-1.00		4101-0.50
	3001-0.33	701-0.33	8000-0.33				8000-1.00
		3001-0.33	3001-0.33				27800-1.00
5	6	7	7	4	5	4	7

TOTAL NUMBER OF SPECIES

10 FEB. 1975

LEVEL 1	2	3	4	5	6	7	8
10901-0.20	4003-0.80	1314-0.40	8004-0.20	1314-0.50	8000-0.75	8004-0.33	4003-0.25
4003-0.40	8000-0.60	4003-0.40	21702-0.20	8004-0.25	8004-0.25	20003-0.33	8004-0.25
4302-0.60	10901-0.20	8000-0.20	27800-1.00	11805-0.25	11805-0.25	21702-0.33	11805-0.25
27800-1.00	21702-0.20	8004-0.20	11805-0.20	21702-0.25	20003-0.25	24101-0.33	20003-0.25
1805-0.40	27800-1.00	10901-0.20	24101-0.20	24101-0.25	21702-0.25	27800-1.00	21702-0.25
40000-0.60	8004-0.20	21702-0.20	1805-0.40	27800-1.00	24101-0.25	11805-0.33	27800-0.75
8000-0.20	1805-0.60	27800-1.00	40000-0.60	1805-0.25	1314-0.25	50000-0.33	50000-0.25
701-0.20	40000-0.60	24101-0.20	8000-0.40	8000-0.25	1805-0.25	40000-0.67	1314-0.25
1314-0.20	701-0.20	1805-0.40	2205-0.40	2205-0.25	40000-0.75	4302-0.33	1805-0.25
2802-0.20	2205-0.20	40000-0.60	1314-0.20	40000-0.50	4101-0.25		4101-0.25
7500-0.20	1314-0.20	701-0.20	3001-0.20	4302-0.25	27800-0.75		40000-0.50
	2802-0.20	2205-0.40	4003-0.20		4302-0.25		4302-0.25
	4302-0.40	3001-0.20	4302-0.40				
	7500-0.20	4302-0.40	7500-0.20				
		7500-0.20					
11	14	15	14	11	12	9	12

TOTAL NUMBER OF SPECIES

10 MAR. 1975

LEVEL 1	2	3	4	5	6	7	8
4003-1.00	3001-0.33	1805-1.00	1805-1.00	3001-0.25	3001-0.25	3001-0.33	3001-0.25
4302-1.00	8004-0.33	3001-0.25	3001-0.25	8004-0.25	11805-0.50	2205-0.67	11805-0.25
8000-0.75	21702-0.33	8004-0.25	4003-0.75	11805-0.50	21702-0.50	11805-0.67	27800-1.00
10901-0.25	27800-1.00	21702-0.50	8004-0.25	20003-0.50	24101-0.50	20003-0.33	8004-0.25
27800-1.00	1805-0.67	24101-0.25	11805-0.50	21702-0.50	8004-0.25	21702-0.67	50000-0.25
701-0.50	40000-0.67	27800-0.75	21702-0.50	24101-0.25	1314-0.25	24101-0.33	20003-0.50
1805-0.75	8000-0.33	10901-0.25	24101-0.25	1805-0.75	1805-0.50	27800-1.00	903-0.25
40000-0.75	701-0.33	40000-0.75	27800-0.75	40000-0.75	40000-0.75	8004-0.33	1314-0.25
2205-0.25	2205-0.33	8000-0.25	40000-0.75	4302-0.50	8000-0.50	50000-0.33	4101-0.25
7500-0.25	4003-0.33	701-0.50	8000-0.25	8000-0.25	20003-0.50	701-0.33	8000-0.25
	4302-0.33	4003-0.50	701-0.50	27800-0.75	27800-0.50	1805-0.67	16321-0.25
	7500-0.33	7500-0.50	7500-0.50	403-0.25	4003-0.25	40000-0.67	1805-0.50
		11805-0.25	2205-0.25	701-0.25	4302-0.25	8000-0.33	2205-0.50
		2205-0.25	4302-0.25	2205-0.50	2205-0.25	4003-0.33	40000-0.50
		4302-0.25		4003-0.25		4302-0.33	4003-0.25
							4302-0.25
10	12	15	14	15	14	15	16

TOTAL NUMBER OF SPECIES

8 APRIL 1975

LEVEL 1	2	3	4	5	6	7	8
701-0.17	9201-0.17	1805-0.33	8004-0.17	8004-0.17	9201-0.50	1314-0.20	701-0.17
4003-1.00	1805-0.50	4302-0.50	20003-0.17	11805-0.67	403-0.50	1805-0.20	1805-0.33
8000-0.50	4002-0.17	8004-0.33	21702-0.17	20003-0.33	8004-0.33	2205-0.60	4003-0.83
10901-0.17	4003-0.50	7500-0.33	24101-0.33	21702-0.17	11805-0.67	8004-0.20	4302-0.50
27800-1.00	4302-0.50	11805-0.33	11805-0.33	24101-0.17	20003-0.33	7500-0.60	8004-0.33
3401-0.17	8000-0.33	21702-0.17	9201-0.17	5001-0.17	27800-1.00	11805-0.80	20003-0.33
903-0.17	8004-0.50	24101-0.17	403-0.33	9201-0.33	3001-0.17	24101-0.40	27800-1.00
1401-0.17	7500-0.50	27800-0.67	701-0.33	403-0.33	1314-0.17	27800-0.60	50000-0.17
1805-0.17	11805-0.33	10901-0.17	1805-0.33	1805-0.33	1805-0.50	50000-0.20	903-0.17
2205-0.17	10901-0.50	40000-0.50	7500-0.33	7500-0.17	40000-0.50	20003-0.20	1314-0.17
2802-0.17	21702-0.17	8000-0.33	8000-0.33	8000-0.33	7500-0.33	21702-0.20	1808-0.17
7500-0.17	27800-0.83	701-0.17	1808-0.17	27800-0.50	701-0.33	9201-0.20	2205-0.33
11805-0.17	403-0.17	1808-0.33	4003-0.50	701-0.33	4003-0.33	403-0.20	8000-0.33
4302-0.33	701-0.17	4003-0.33	27800-0.33	2205-0.33	2205-0.17	1808-0.20	7500-0.17
40000-0.17	1808-0.17	4002-0.17	4302-0.33	4002-0.17	4302-0.17	3001-0.20	11805-0.33
	40000-0.33		40000-0.33	4003-0.33		4003-0.40	403-0.33
	201-0.17		2802-0.17	40000-0.33		201-0.40	201-0.33
				2802-0.17		40000-0.40	24101-0.17
				4302-0.17		4002-0.20	40000-0.33
						4302-0.20	2802-0.17
15	17	15	17	19	15	20	20

TOTAL NUMBER OF SPECIES

15 MAY 1975

LEVEL 1	2	3	4	5	6	7	8
4003-0.57	1805-0.57	1805-0.71	403-0.43	1805-0.50	403-0.67	201-0.50	201-0.50
8000-0.43	4003-0.57	2205-0.29	1805-0.86	4003-0.83	1805-0.50	1805-1.00	1805-0.67
10901-0.14	4302-0.57	3001-0.14	8004-0.14	8000-0.83	8004-0.17	2205-0.33	8004-0.17
27800-1.00	8004-0.14	4003-0.86	11805-0.14	8004-0.17	11805-0.50	4003-0.83	8100-0.17
1805-0.43	8000-0.71	8004-0.14	21702-0.14	11805-0.33	21702-0.33	4302-0.67	11805-0.67
4302-0.57	11805-0.14	11805-0.14	24101-0.14	20003-0.17	24101-0.17	8004-0.17	20003-0.50
403-0.29	10901-0.14	27800-1.00	27800-1.00	21702-0.17	27800-1.00	8100-0.50	21702-0.50
2205-0.14	21702-0.29	9201-0.43	40000-0.71	24101-0.17	9201-0.50	20003-0.33	24101-0.17
40000-0.43	27800-1.00	21702-0.43	9201-0.14	27800-0.83	50000-1.00	21702-0.33	27800-0.83
2802-0.14	40000-0.57	4302-0.57	50000-1.00	40000-1.00	4003-0.83	24101-0.17	9201-0.50
	403-0.43	8000-0.71	701-0.57	50000-1.00	8000-0.33	27800-1.00	50000-1.00
	701-0.43	403-0.43	201-0.14	403-0.33	20003-0.17	50000-1.00	16321-0.33
	2205-0.14	701-0.43	8000-0.71	701-0.33	701-0.17	1315-0.17	403-0.50
	4002-0.14	1808-0.14	3001-0.29	201-0.17	1808-0.17	1808-0.50	1315-0.17
		2802-0.14	1808-0.14	2205-0.50	4002-0.33	8000-0.67	2205-0.17
		40000-0.57	4003-0.57	9201-0.17	4302-0.67	11805-0.50	4003-0.83
		4002-0.14	7602-0.14	7500-0.33	40000-0.67	16321-0.17	8000-0.50
			7500-0.14	1808-0.17	201-0.17	40000-0.83	40000-0.83
			2205-0.29	4302-0.67	3001-0.17	9201-0.17	1808-0.33
			4002-0.14	4002-0.17		403-0.50	4302-0.50
			4302-0.43			701-0.33	1807-0.17
						4002-0.17	3001-0.17
10	14	17	21	20	19	22	22

TOTAL NUMBER OF SPECIES

30 JUNE 1975

LEVEL 1	2	3	4	5	6	7	8
4003-0.38	1402-0.17	1402-0.14	403-0.38	4003-0.71	403-0.71	1315-0.29	403-0.71
4201-0.13	8004-0.17	4003-0.86	4003-0.75	4302-0.86	1805-0.43	1805-0.43	1805-0.43
8000-0.38	9201-0.33	4302-0.71	8C00-0.50	8004-0.14	1808-0.71	1808-0.86	8004-0.14
10901-0.13	10901-0.17	8000-0.57	8004-0.13	9201-0.14	5001-0.14	2205-0.29	9201-0.57
27800-0.63	27800-1.00	8004-0.14	9201-0.25	11805-0.14	8000-0.57	8000-0.86	11805-0.43
40000-0.38	21702-0.17	21702-0.14	11805-0.13	20003-0.14	8004-0.14	8004-0.14	20003-0.43
9201-0.13	8000-0.33	27800-0.86	21702-0.25	27800-1.00	9201-0.57	8100-0.29	27800-1.00
1805-0.13	1805-0.33	40000-0.86	27800-0.88	40000-1.00	11805-0.14	9201-0.57	40000-1.00
4002-0.13	2205-0.33	403-0.43	40000-0.88	403-0.29	20003-0.14	11805-0.29	50000-0.86
4302-0.13	4003-0.33	1805-0.29	1805-0.25	701-0.43	21702-0.43	20003-0.29	1315-0.14
	40000-0.83	3001-0.14	2205-0.38	1805-0.29	24101-0.14	24101-0.14	1808-0.43
	701-0.17	402-0.14	3001-0.13	2205-0.43	8100-0.14	27800-1.00	2205-0.29
	903-0.17	701-0.29	50000-0.38	8000-0.71	27800-1.00	40000-1.00	3001-0.14
	1808-0.17	1808-0.29	701-0.38	50000-0.71	40000-1.00	50000-0.86	8000-0.86
	4302-0.17	2205-0.14	1808-0.38	1808-0.14	50000-0.86	403-0.57	8100-0.14
		50000-0.43	8100-0.13	8100-0.14	2205-0.14	903-0.14	21702-0.29
		4002-0.14	4302-0.38	3001-0.29	701-0.14	4003-0.71	4003-0.71
		9201-0.14			4002-0.14	21702-0.14	16321-0.14
					4003-0.57	201-0.29	201-0.29
					4201-0.14	701-0.29	701-0.29
					4302-0.43	4201-0.14	4201-0.14
					3001-0.14	4302-0.43	4302-0.29
						3001-0.14	
10	15	18	17	17	22	23	22

TOTAL NUMBER OF SPECIES

28 AUGUST 1975

LEVEL 1	2	3	4	5	6	7	8
8000-0.22	8000-0.22	4201-0.11	8000-0.89	8000-0.88	403-0.50	1301-0.43	903-0.25
10901-0.11	10901-0.11	8000-0.67	9201-0.22	9201-0.50	1805-0.38	3001-0.14	1301-0.38
27800-1.00	27800-1.00	9201-0.22	11805-0.11	11805-0.38	5001-0.13	8000-1.00	1805-0.38
2205-0.11	29800-0.33	11805-0.22	21702-0.11	21702-0.25	8000-1.00	8004-0.14	3001-0.25
4003-0.11	1805-0.22	27800-0.89	27800-1.00	20003-0.13	8004-0.13	9201-0.14	4201-0.25
40000-0.56	4302-0.11	29800-0.44	403-0.44	40000-1.00	20003-0.25	11805-0.57	8004-0.13
	40000-0.89	40000-1.00	1805-0.33	27800-0.88	24101-0.25	21702-0.14	20003-0.38
	403-0.11	403-0.22	1808-0.22	29800-0.50	40000-1.00	24101-0.14	27800-1.00
	701-0.11	1808-0.11	2205-0.22	50000-0.38	27800-0.88	20003-0.14	1314-0.13
	2205-0.11	21702-0.11	4003-0.67	1805-0.25	29800-0.50	27800-0.86	8000-0.88
	4003-0.11	701-0.22	40000-0.89	403-0.50	50000-0.63	29800-0.71	11805-0.25
	9201-0.11	1805-0.11	29800-0.56	4003-0.38	4201-0.13	1314-0.14	16321-0.13
		2205-0.11	3001-0.11	701-0.50	11805-0.25	1805-0.29	21702-0.25
		4003-0.33	701-0.44	1401-0.13	21702-0.13	4201-0.14	29800-0.50
		4302-0.11	50000-0.11	4302-0.25	9201-0.13	50000-0.57	9201-0.25
				1808-0.13	4003-0.50	40000-0.86	24101-0.13
					1401-0.13	16321-0.14	40000-0.63
					701-0.25	403-0.43	403-0.25
					4302-0.13	4003-0.43	50000-0.25
						1808-0.29	4003-0.25
						701-0.14	701-0.13
							1808-0.13
6	12	15	15	16	19	21	22

TOTAL NUMBER OF SPECIES

26 SEPT. 1975

LEVEL 1	2	3	4	5	6	7	8
4302-0.11	1805-0.14	403-0.29	403-0.22	8004-0.13	8004-0.13	403-0.25	403-0.25
8000-0.11	4003-0.14	1805-0.14	8000-0.67	24101-0.13	11805-0.25	1805-0.63	8004-0.13
10901-0.11	4302-0.14	4003-0.71	21702-0.11	27800-0.75	27800-0.88	8004-0.13	9201-0.13
27800-0.78	8000-0.14	8000-0.43	27800-0.78	29800-0.38	50000-0.50	11805-0.50	11805-0.38
40000-0.22	10901-0.14	27800-1.00	40000-0.78	403-0.25	4201-0.13	50000-0.50	50000-0.38
3001-0.11	27800-1.00	40000-0.86	1805-0.11	701-0.63	8000-0.63	29800-0.38	51000-0.13
40100-0.11	40000-0.86	29800-0.43	4302-0.11	1805-0.25	9201-0.13	27800-1.00	8000-0.63
	29800-0.14	4302-0.14	29800-0.33	8000-0.63	29800-0.50	52000-0.13	27800-0.88
	11805-0.14	40100-0.14	701-0.67	9201-0.13	40000-0.63	903-0.13	40000-0.50
	701-0.43	701-0.43	4003-0.33	50000-0.38	701-0.50	8000-0.63	20003-0.25
			9201-0.11	40000-0.63	403-0.13	9201-0.25	24101-0.13
			40200-0.11	4003-0.38	1805-0.38	40000-0.63	1301-0.25
			40100-0.11	40100-0.13	1808-0.13	701-0.38	29800-0.13
			3001-0.22	3001-0.13	3001-0.25	3001-0.25	1805-0.50
					4003-0.25	4003-0.13	1808-0.13
							701-0.25
							3001-0.25
							4003-0.25
7	10	10	14	14	15	15	18

TOTAL NUMBER OF SPECIES

27 NOV. 1975

LEVEL 1	2	3	4	5	6	7	8
1805-0.40	1805-0.50	8000-0.90	8004-0.30	8000-1.00	5001-0.10	8000-0.70	903-0.20
8000-0.40	9201-0.20	8004-0.10	9201-0.40	8004-0.30	8000-0.90	8004-0.30	1301-0.30
10901-0.20	8000-0.80	11805-0.10	11805-0.30	9201-0.40	8004-0.30	11805-0.60	1314-0.20
11805-0.10	8004-0.10	29800-0.40	27800-1.00	11805-0.40	50000-0.50	50000-0.30	1805-0.60
27800-1.00	10901-0.20	27800-1.00	29800-0.50	50000-0.40	27800-1.00	51000-0.20	8004-0.30
2802-0.10	11805-0.10	403-0.30	52000-0.20	27800-1.00	24101-0.30	29800-0.30	27800-1.00
4003-0.30	29800-0.40	40000-0.70	20003-0.20	40100-0.40	20003-0.40	27800-0.90	20003-0.50
4302-0.40	27800-1.00	1805-0.40	403-0.30	52000-0.20	11805-0.40	16321-0.10	24101-0.40
40100-0.20	40000-0.60	9201-0.10	40000-0.60	20003-0.20	51000-0.10	20003-0.40	16321-0.30
40000-0.60	4003-0.50	40100-0.40	4302-0.30	1805-0.40	40000-0.60	24101-0.40	40000-0.30
40200-0.10	40100-0.20	4002-0.20	8000-0.70	40000-0.80	9201-0.40	40000-0.50	9201-0.60
701-0.40	701-0.60	4003-0.30	9203-0.10	21702-0.10	21702-0.10	4302-0.10	11805-0.40
1401-0.10	4302-0.40	4302-0.10	50000-0.20	29800-0.30	1805-0.40	21702-0.10	8000-0.50
25303-0.10	40200-0.10	52000-0.10	40100-0.40	403-0.20	29800-0.40	9201-0.40	50000-0.10
	2205-0.10	701-0.30	1401-0.10	40200-0.10	40100-0.30	4003-0.10	29800-0.10
	403-0.10		40200-0.10	4302-0.10	1401-0.10	40100-0.20	4003-0.20
	4002-0.20		4003-0.30		1314-0.10	1805-0.30	4302-0.10
	25303-0.10		1805-0.40		701-0.10	2802-0.10	40100-0.10
			701-0.30				403-0.10
							52000-0.20
14	18	15	19	16	18	18	20

TOTAL NUMBER OF SPECIES

15 JAN. 1976

LEVEL 1	2	3	4	5	6	7	8
40000-0.91	4201-0.09	40000-0.82	40000-0.91	8000-0.91	1805-0.60	8004-0.36	40000-0.73
4003-0.82	8000-0.82	8004-0.18	1805-0.36	8004-0.36	8000-0.70	50000-0.55	903-0.27
8000-0.45	8004-0.18	11805-0.45	8000-0.91	9201-0.18	8004-0.40	51000-0.18	1314-0.27
8004-0.09	10901-0.18	27800-1.00	8004-0.36	11805-0.64	9201-0.30	20003-0.36	1805-0.64
10901-0.18	11805-0.45	29800-0.45	9201-0.36	24101-0.18	11805-0.90	24101-0.18	8000-0.82
27800-1.00	29800-0.18	24101-0.18	11805-0.55	27800-0.82	24101-0.20	40000-0.82	8004-0.36
9201-0.27	9201-0.18	4201-0.09	52000-0.27	50000-0.64	51000-0.20	903-0.09	11805-0.82
40100-0.27	27800-1.00	8000-0.91	27800-0.82	40000-0.73	52000-0.20	1314-0.09	27800-0.91
701-0.36	24101-0.09	9201-0.27	4201-0.09	21702-0.09	27800-0.90	1805-0.45	50000-0.64
4302-0.36	40000-0.82	21702-0.18	50000-0.09	29800-0.09	50000-0.70	8000-0.64	16321-0.27
40200-0.27	3001-0.09	403-0.18	29800-0.18	1805-0.36	5001-0.10	27800-0.82	20003-0.55
1401-0.18	4302-0.36	4003-0.18	1314-0.09	4201-0.09	40000-0.80	9201-0.36	100-0.09
25303-0.45	4003-0.45	40200-0.18	40100-0.18	40100-0.09	20003-0.10	11805-0.64	1301-0.09
403-0.09	4401-0.09	1805-0.27	7500-0.09	4003-0.09		21702-0.09	13003-0.09
2802-0.09	1401-0.09	40100-0.09	40200-0.09			4003-0.09	24101-0.18
4002-0.18	40200-0.09	701-0.27	24101-0.09			1401-0.09	29800-0.09
4401-0.09	40100-0.18	4302-0.18					60000-0.09
	25303-0.09						5001-0.09
	701-0.27						
	1805-0.27						
	403-0.09						
	4002-0.09						
17	22	17	16	14	13	16	18

TOTAL NUMBER OF SPECIES

MARCH 12 1976

LEVEL 1	2	3	4	5	6	7	8
40000-1.000	40000-1.000	40000-1.000	40000-1.000	40000-0.909	40000-0.909	40000-0.909	40000-0.909
403-0.273	4003-0.727	4003-0.455	4003-0.273	1805-0.455	40200-0.091	403-0.727	1314-0.455
4003-1.000	4302-0.636	4302-0.182	4302-0.091	4003-0.182	4002-0.091	4003-0.091	4003-0.182
4302-0.727	27800-1.000	27800-1.000	40200-0.273	4302-0.091	4302-0.091	4302-0.091	4201-0.091
27800-1.000	403-0.455	403-0.364	27800-1.000	27800-0.909	9201-0.364	9201-0.273	11805-0.818
2802-0.182	1805-0.364	1805-0.364	1805-0.455	403-0.364	27800-1.000	27800-0.909	27800-1.000
3401-0.091	4002-0.364	7500-0.182	8000-0.909	8000-0.636	403-0.364	1805-0.455	1805-0.545
4002-0.455	7500-0.273	8000-0.909	9201-0.364	11805-0.727	1805-0.364	11805-0.909	9201-0.273
25303-0.545	8000-0.909	9201-0.364	11805-0.818	9201-0.091	8000-0.636	40200-0.182	7500-0.182
701-0.182	40200-0.545	11805-0.455	403-0.091	50000-0.455	11805-0.818	1314-0.273	8000-0.364
8000-0.455	25303-0.364	25303-0.091	50000-0.091	29800-0.182	4003-0.091	2205-0.091	403-0.182
40200-0.364	701-0.273	52000-0.091	29800-0.182	8004-0.364	24101-0.364	8000-0.364	8004-0.364
1401-0.091	11805-0.455	40200-0.091	24101-0.182	21702-0.182	50000-0.455	13003-0.091	20003-0.455
40100-0.273	2802-0.091	24101-0.273		7500-0.182	8004-0.273	20003-0.364	21702-0.091
10901-0.273	9201-0.182	29800-0.273		24101-0.273	51000-0.182	50000-0.545	50000-0.455
9201-0.182	40100-0.091	21702-0.091		20003-0.182	20003-0.182	8004-0.364	1301-0.182
11805-0.182	10901-0.182	10901-0.182			5001-0.091	5001-0.091	13003-0.091
						24101-0.182	16321-0.091
						51000-0.182	24101-0.091
							903-0.182
17	17	17	13	16	17	19	20

19 MAY 1976

LEVEL 1	2	3	4	5	6	7	8
40000-1.00	40000-1.00	40000-1.00	40000-0.80	40000-0.90	40000-1.00	903-0.10	40000-0.80
4003-0.90	8004-0.30	8004-0.30	403-0.40	403-0.50	403-0.70	1301-0.30	903-0.40
4302-0.70	9201-0.10	9201-0.30	8004-0.60	7500-0.30	1301-0.20	1314-0.20	1301-0.50
8000-0.10	11805-0.20	11805-0.20	11805-0.80	8000-0.40	5001-0.10	1805-0.80	1314-0.80
9201-0.10	10901-0.30	21702-0.10	20003-0.10	8004-0.60	7500-0.40	1808-0.40	1805-1.00
10901-0.30	27800-1.00	27800-1.00	24101-0.10	11805-0.70	8000-0.50	4101-0.20	1808-0.30
27800-1.00	50000-1.00	50000-1.00	27800-1.00	24101-0.30	8004-0.60	7500-0.60	11805-0.60
40100-0.10	4003-0.70	403-0.30	50000-1.00	27800-1.00	11805-0.80	8004-0.50	16321-0.10
701-0.30	4302-0.70	1805-0.30	1805-0.30	50000-1.00	24101-0.10	9901-0.10	50000-1.00
2802-0.10	8000-0.70	7500-0.20	4302-0.40	1805-0.40	27800-1.00	100-0.10	3305-0.20
4002-0.10	25303-0.30	4003-0.40	7500-0.10	1808-0.10	50000-1.00	16321-0.20	7500-0.30
25303-0.10	40100-0.10	29800-0.20	8000-0.40	4003-0.40	1805-0.50	20003-0.30	100-0.20
	403-0.10	8000-0.60	21702-0.10	20003-0.10	9201-0.30	27800-1.00	20003-0.50
	701-0.40	4302-0.40	41000-0.10	29800-0.10	51000-0.10	50000-1.00	27800-0.90
	4002-0.30	2802-0.10	9201-0.10	701-0.20	8501-0.10	40000-0.90	4003-0.60
	1805-0.20	701-0.20	40100-0.10	4002-0.10	1314-0.20	5001-0.10	8004-0.10
	1808-0.10	4002-0.10	701-0.30	7602-0.10	4003-0.50	51000-0.10	9201-0.10
		40100-0.10	4002-0.10	4302-0.10	4302-0.40	403-0.60	4302-0.30
			4003-0.30		1808-0.30	4003-0.50	8000-0.30
			7602-0.10		2802-0.10	8000-0.50	403-0.50
					701-0.10	11805-0.70	24101-0.10
					4002-0.10	9201-0.20	29800-0.10
					40100-0.10	4302-0.40	9901-0.10
						402-0.10	701-0.10
						701-0.20	4002-0.10
						4002-0.10	
12	17	18	20	18	23	26	25

TOTAL NUMBER OF SPECIES

14 AUG. 1976

LEVEL 1	2	3	4	5	6	7	8
40000-0.70	40000-0.80	40000-0.70	40000-0.90	5001-0.20	403-0.20	903-0.40	903-0.30
4003-0.20	8000-0.80	1805-0.10	8004-0.60	8000-0.60	1314-0.20	1301-0.20	1301-0.30
10901-0.40	10901-0.40	8000-1.00	9201-0.40	8004-0.60	1805-0.60	1314-0.30	1314-0.40
27800-1.00	27800-1.00	10901-0.20	11805-0.70	9201-0.30	5001-0.30	1805-0.80	1805-0.60
701-0.20	9201-0.10	29800-0.20	50000-0.80	11805-0.70	8000-0.80	8000-0.80	8004-0.50
4302-0.30	50000-0.10	27800-0.90	27800-0.90	20003-0.40	8004-0.60	8004-0.60	24101-0.40
40100-0.30	4302-0.30	9201-0.30	8000-0.50	24101-0.30	9201-0.30	20003-0.60	50000-0.70
2802-0.10	2501-0.10	50000-0.60	24101-0.20	50000-0.90	11805-0.90	50000-0.90	27800-1.00
25306-0.10	3305-0.10	40100-0.30	41000-0.10	27800-0.90	12505-0.20	55000-0.20	51000-0.10
	25306-0.10	4003-0.30	403-0.10	7500-0.20	20003-0.50	27800-0.70	12505-0.30
	403-0.10	11805-0.60	1805-0.20	21702-0.20	51000-0.30	40000-0.70	20003-0.30
	4003-0.10	41000-0.10	701-0.10	41000-0.30	50000-1.00	3305-0.30	3305-0.20
	40100-0.20	701-0.10	4003-0.10	40000-0.50	27800-0.90	11805-0.90	7500-0.40
		4302-0.10	40100-0.10	1805-0.40	903-0.20	16321-0.20	8000-0.60
				55000-0.10	1301-0.20	24101-0.30	16321-0.20
					7500-0.20	403-0.20	40000-0.20
					16321-0.10	7500-0.20	1808-0.10
					24101-0.20	29800-0.20	11805-0.40
					40000-0.80	51000-0.10	40100-0.10
					55000-0.50	9201-0.20	1804-0.10
					29800-0.10		100-0.10
9	13	14	14	15	21	20	21

TOTAL NUMBER OF SPECIES

APPENDIX V: Matrices of the similarities calculated between all samples from each level on each strip, for the control and the strips on which populations had returned to 'normal'. The time populations returned to normal is indicated by black lines.

The similarities are represented as percentage values. The first matrix on each page is shown with the sampling dates, and these are the same for all matrices on the page unless otherwise mentioned.

<u>3.04 m</u>

Year	Date	F	M	A	M	J	A	N	J	M	M	A
1975	10 Feb	100										
	10 Mar	19	100									
	8 Apr	35	78	100								
	15 May	20	87	87	100							
	30 Jun	14	37	37	45	100						
	28 Aug	27	37	37	45	51	100					
	27 Nov	76	24	47	27	21	40	100				
1976	15 Jan	69	21	42	24	18	33	88	100			
	12 Mar	60	37	62	43	45	44	80	71	100		
	19 May	70	32	53	35	34	33	88	90	82	100	
	14 Aug	47	31	61	37	35	66	66	57	72	57	100

<u>2.86 m</u>

100										
76	100									
80	82	100								
86	88	94	100							
40	47	50	47	100						
24	14	16	29	61	100					
26	20	22	30	43	50	100				
35	28	31	43	31	40	50	100			
17	9	11	20	20	35	44	35	100		
31	25	27	38	27	33	66	66	32	100	
24	14	16	29	31	60	50	40	59	34	100

<u>2.70 m</u>

100										
74	100									
40	66	100								
47	57	40	100							
30	24	31	40	100						
22	0	1	31	50	100					
63	62	17	71	24	27	100				
78	60	25	55	19	21	70	100			
32	13	18	29	47	93	25	30	100		
57	56	15	62	21	24	77	64	23	100	
30	12	16	13	44	75	12	10	71	11	100

<u>2.61 m</u>

100										
53	100									
52	81	100								
50	95	78	100							
53	34	33	33	100						
12	10	10	10	14	100					
35	54	39	52	36	9	100				
44	67	47	64	48	11	80	100			
25	11	10	11	27	71	18	23	100		
40	69	52	75	32	10	74	73	20	100	
40	61	43	67	42	10	81	82	20	92	100

CONTROL

2.49 m

1975	10 Feb	100										
	10 Mar	59	100									
	8 Apr	56	80	100								
	15 May	57	66	84	100							
	30 Jun	47	57	53	56	100						
	28 Aug	25	31	29	36	31	100					
	27 Nov	35	40	38	50	70	22	100				
1976	15 Jan	50	47	44	57	47	13	78	100			
	12 Mar	55	54	50	64	54	15	67	88	100		
	19 May	38	35	33	45	52	10	76	77	66	100	
	14 Aug	45	53	50	61	53	23	80	91	80	71	100
		F	M	A	M	J	A	N	J	M	M	A

2.37 m

100										
59	100									
57	76	100								
64	71	64	100							
57	38	56	56	100						
81	63	63	62	63	100					
81	52	50	58	58	80	100				
61	69	60	67	60	76	69	100			
61	52	70	59	80	76	69	82	100		
54	61	52	73	52	67	62	80	64	100	
61	76	78	80	61	75	69	80	72	71	100

2.17 m

100										
56	100									
50	50	100								
45	45	38	100							
62	50	43	62	100						
57	38	31	47	53	100					
42	32	24	52	70	55	100				
55	36	50	54	50	72	61	100			
50	50	55	60	66	69	67	75	100		
27	27	30	63	50	48	60	53	66	100	
33	33	26	55	62	57	73	63	70	72	100

1.89 m

100										
53	100									
46	43	100								
32	46	50	100							
42	60	66	73	100						
29	27	61	32	42	100					
22	21	47	35	35	67	100				
36	34	50	29	37	47	57	100			
40	38	43	23	30	53	63	89	100		
22	21	12	42	43	12	1	29	22	100	
22	21	24	21	26	34	55	67	74	28	100

CONTROL

STRIP 1

3.04 m

[illegible]																
10/12	51	34	100													
17/1/75	33	15	26	100												
10/2	25	13	21	83	100											
10/3	19	12	32	67	83	100										
8/4	22	12	19	77	93	89	100									
15/5	22	13	19	77	93	89	100	100								
30/6	25	13	21	83	72	82	80	80	100							
28/8	25	13	21	83	72	82	80	80	100	100						
26/9	25	13	20	83	72	71	67	67	86	85	100					
27/11	22	12	19	77	93	78	87	87	67	67	80	100				
15/1/76	33	15	26	60	50	53	61	61	67	67	67	62	100			
12/3	25	13	21	83	72	71	80	80	86	86	86	80	83	100		
19/5	22	12	18	77	93	78	87	87	67	67	80	99	61	80	100	
14/8	39	16	29	66	54	43	50	50	55	55	73	66	88	73	67	100
	S	N	D	J	F	M	A	M	J	A	S	N	J	M	M	A

2.86 m

100															
94	100														
62	57	100													
20	19	57	100												
15	14	36	50	100											
16	15	40	58	73	100										
15	14	36	49	66	36	100									
13	13	16	21	43	16	71	100								
15	14	19	26	51	19	83	85	100							
14	13	17	24	47	34	77	80	92	100						
13	13	16	21	44	31	71	75	86	93	100					
15	14	19	27	18	37	17	29	34	46	57	100				
11	11	13	17	38	27	38	44	50	59	66	75	100			
11	11	13	17	38	14	38	44	50	47	55	63	70	100		
13	12	17	23	46	33	47	40	46	57	66	46	59	47	100	
15	14	20	29	55	21	54	61	72	66	76	55	67	67	67	100

2.70 m

100															
93	100														
93	100	100													
93	87	87	100												
71	67	67	80	100											
93	87	87	87	67	100										
100	93	93	93	72	93	100									
99	92	92	93	71	93	99	100								
93	87	87	99	80	87	93	93	100							
0	0	0	12	25	12	1	1	12	100						
0	0	0	15	16	15	1	1	16	80	100					
0	0	0	14	15	14	1	1	14	50	62	100				
0	0	0	12	25	12	1	1	12	55	53	75	100			
0	0	0	12	13	0	0	1	12	12	14	13	12	100		
0	0	0	1	13	1	1	1	1	12	1	1	11	56	100	
0	0	0	13	13	12	0	1	13	70	85	79	70	12	1	100

2.61 m

100															
93	100														
93	100	100													
77	83	83	100												
27	14	14	17	100											
87	93	93	76	14	100										
93	99	99	82	14	93	100									
87	93	93	76	14	87	92	100								
93	87	87	71	25	93	87	82	100							
12	0	0	1	13	12	1	1	23	100						
15	0	0	0	16	15	1	1	27	79	100					
11	0	0	0	11	0	0	0	10	10	12	100				
0	0	0	0	1	1	1	0	1	1	1	73	100			
12	0	0	0	14	0	0	0	12	12	15	63	75	100		
10	0	0	1	11	0	0	10	10	10	11	69	80	70	100	
10	0	0	0	11	0	0	10	10	10	11	70	[illegible]	[illegible]	[illegible]	[illegible]

2.49 m STRIP 1

	S	N	D	J	F	M	A	M	J	A	S	N	J	M	M	A
19/11	76	100														
10/12	54	74	100													
17/1/75	20	29	39	100												
10/2	20	1	1	4	100											
10/3	93	83	59	23	2	100										
8/4	87	76	54	21	1	93	100									
15/5	86	76	53	20	1	92	87	100								
30/6	22	14	15	18	17	12	22	12	100							
28/8	12	0	0	1	20	1	13	1	66	100						
26/9	12	0	0	0	18	0	0	0	10	12	100					
27/11	11	1	0	1	17	1	2	1	10	12	84	100				
15/1/76	0	0	0	1	1	1	1	13	1	1	82	78	100			
12/3	0	0	0	0	0	0	1	12	1	1	56	63	70	100		
19/5	1	0	0	1	1	1	1	9	1	1	64	61	66	72	100	
14/8	0	1	0	1	1	1	1	10	1	1	69	75	73	78	80	100

2.37 m

100															
55	100														
37	34	100													
21	40	41	100												
21	2	41	6	100											
23	49	51	68	7	100										
1	2	41	5	5	6	100									
33	46	16	17	1	19	1	100								
22	15	31	34	18	19	1	60	100							
0	0	0	17	1	2	17	30	40	100						
0	0	0	0	0	0	18	11	11	11	100					
11	0	15	0	17	1	1	0	10	1	74	100				
0	0	0	1	1	1	17	10	11	11	95	80	100			
0	0	0	0	0	1	18	11	11	11	78	64	84	100		
9	0	11	1	12	1	13	25	17	9	75	72	80	66	100	
9	12	12	13	1	15	13	17	17	9	78	67	75	61	62	100

2.17 m

missing 10 Dec. 1974 to 8 Apr. 1975 (inclusive)

100									
52	100								
13	22	100							
0	22	1	100						
1	11	12	1	100					
10	9	20	0	67	100				
0	17	20	1	72	72	100			
0	25	29	10	55	56	69	100		
9	40	19	1	52	46	52	60	100	
10	26	20	1	73	64	69	62	59	100

1.89 m

100														
50	100													
20	34	100												
18	29	3	100											
0	25	34	29	100										
1	3	5	51	40	100									
33	49	65	30	25	4	100								
47	35	1	13	0	1	24	100							
21	13	15	15	0	1	40	51	100						
13	1	23	1	0	3	37	20	55	100					
0	0	0	0	0	0	0	26	29	0	100				
1	14	16	1	14	2	14	9	9	12	66	100			
0	13	14	1	12	2	13	16	18	12	72	78	100		
0	16	18	2	15	2	16	19	21	13	63	70	76	100	
22	15	17	16	1	2	29	60	57	35	30	11	19	32	100

3.04 m **STRIP 2**

	O	N	D	J	F	M	A	M	J	A	N	J	M	M	A
10 Dec	68	67	100												
17/1/75	29	23	34	100											
10 Feb	44	44	25	17	100										
10 Mar	50	49	66	30	44	100									
8 Apr	33	33	39	66	16	34	100								
15 May	20	20	23	77	14	21	50	100							
30 Jun	4	2	12	4	1	11	3	2	100						
28 Aug	66	66	95	33	26	66	39	22	4	100					
27 Nov	25	25	23	90	15	25	59	71	2	28	100				
15/1/76	25	25	29	91	16	20	59	71	2	29	83	100			
12 Mar	22	22	26	83	15	23	54	93	3	25	76	77	100		
19 May	20	20	22	76	14	21	49	87	2	22	72	71	93	100	
14 Aug	33	33	39	66	19	33	73	50	1	41	60	60	54	66	100

2.86 m

missing 10 Mar. 1975

100														
99	100													
68	67	100												
17	17	18	100											
26	25	30	75	100										
33	33	40	14	21	100									
26	25	30	38	18	41	100								
34	33	40	57	79	26	21	100							
44	44	26	24	32	19	31	38	100						
25	25	29	62	17	20	50	20	16	100					
22	22	25	70	31	18	46	36	28	77	100				
15	15	17	57	47	14	36	53	22	35	50	100			
18	18	21	63	27	15	40	31	25	67	75	40	100		
28	28	33	40	19	22	55	23	17	54	67	50	57	100	

2.70 m

100														
99	100													
68	67	100												
20	20	23	100											
1	1	1	93	100										
37	36	21	24	13	100									
23	23	1	1	1	38	100								
2	1	2	14	15	26	1	100							
25	25	29	57	46	27	1	17	100						
2	1	3	17	19	17	0	20	22	100					
20	20	23	25	14	23	0	14	57	33	100				
22	22	25	14	0	25	0	15	16	2	27	100			
15	15	16	42	33	20	0	12	59	15	42	12	100		
15	14	16	10	1	19	0	1	34	1	30	21	70	100	
17	17	19	12	1	21	0	1	13	2	23	59	10	19	100

2.61 m

100														
99	100													
68	67	100												
21	20	23	100											
0	0	1	87	100										
29	28	16	11	0	100									
21	20	2	1	0	80	100								
1	1	2	2	1	10	12	100							
1	1	2	2	1	11	13	56	100						
17	17	19	23	12	18	12	40	34	100					
18	18	20	12	1	10	0	1	1	11	100				
0	0	0	11	11	9	1	10	1	10	74	100			
0	0	0	36	35	10	1	1	1	11	56	74	100		
14	14	16	10	0	33	1	10	0	9	76	82	57	100	
0	0	0	1	1	26	0	10	0	0	70	86	60	95	100

2.49 m **STRIP 2**

	O	N	D	J	F	M	A	M	J	A	N	J	M	M	A
24/10/74	100														
19 Nov	99	100													
10 Dec	67	66	100												
17/1/75	20	20	22	100											
10 Feb	1	1	1	93	100										
10 Mar	20	20	2	1	1	100									
8 Apr	39	40	23	12	1	66	100								
15 May	1	0	1	10	11	1	1	100							
30 Jun	1	1	2	12	13	2	1	67	100						
28 Aug	20	20	23	25	14	1	13	20	12	100					
27 Nov	18	18	20	12	1	12	12	1	1	12	100				
15/1/76	0	0	0	11	12	12	0	18	11	11	84	100			
12 Mar	0	0	0	11	12	12	1	18	11	12	63	80	100		
19 May	12	12	12	9	0	9	9	8	1	9	75	72	56	100	
14 Aug	0	0	0	0	0	11	1	9	0	1	84	90	70	72	100

2.37 m

100														
99	100													
67	66	100												
20	20	22	100											
1	1	1	93	100										
0	0	0	33	35	100									
1	1	2	1	0	35	100								
13	13	14	18	10	9	1	100							
17	17	20	44	35	30	1	67	100						
0	0	1	17	18	15	0	11	15	100					
0	0	1	1	1	12	14	1	1	1	100				
0	0	0	1	1	29	33	9	10	0	84	100			
0	0	1	1	0	26	70	8	9	0	57	75	100		
12	12	13	9	0	8	10	29	17	0	72	72	52	100	
0	0	1	1	1	32	27	14	16	1	69	84	64	62	100

2.17 m

100														
99	100													
67	66	100												
25	25	29	100											
1	1	1	77	100										
23	23	26	61	43	100									
25	24	28	16	0	30	100								
12	11	13	9	0	18	38	100							
16	15	18	47	33	56	13	52	100						
49	49	65	25	1	45	25	12	16	100					
1	1	1	55	50	67	18	10	38	2	100				
1	1	1	16	15	29	76	26	12	2	50	100			
18	18	20	27	13	38	79	40	31	19	43	87	100		
12	12	13	19	9	28	19	65	31	13	20	18	34	100	
13	13	15	11	0	20	21	41	25	14	22	20	37	43	100

1.89 m

100														
99	100													
67	66	100												
25	25	29	100											
1	1	1	77	100										
20	20	22	65	93	100									
29	28	34	18	0	15	100								
1	0	1	1	0	1	1	100							
1	0	1	34	32	30	1	49	100						
2	2	4	2	1	1	2	1	2	100					
0	0	0	35	33	32	0	9	26	1	100				
0	0	0	11	10	10	0	16	17	1	78	100			
0	0	1	1	0	1	0	18	10	1	57	72	100		
1	0	1	1	1	1	1	55	20	1	0	19	12	100	
0	0	1	1	0	0	0	15	16	1	56	77	59	35	100

<u>3.04 m</u> <u>STRIP 4</u>

		F	M	A	M	J	A	S	N	J	M	M	A
1975	10 Feb	100											
	10 Mar	66	100										
	8 Apr	98	66	100									
	15 May	30	49	29	100								
	30 Jun	4	2	4	1	100							
	28 Aug	4	2	4	1	100	100						
	26 Sep	49	39	49	66	2	2	100					
	27 Nov	23	40	23	57	1	1	55	100				
1976	15 Jan	29	50	29	66	1	1	66	86	100			
	12 Mar	19	34	19	50	0	0	46	67	75	100		
	19 May	26	23	25	46	1	1	59	67	77	83	100	
	14 Aug	66	50	65	25	2	2	39	20	26	17	23	100

<u>2.86 m</u>

100											
66	100										
68	98	100									
25	45	45	100								
67	97	99	44	100							
50	39	40	60	41	100						
67	97	99	44	100	41	100					
50	77	78	40	79	34	79	100				
34	56	56	67	57	75	57	51	100			
23	21	21	41	20	54	20	19	61	100		
21	19	19	38	18	50	18	17	57	94	100	
20	18	18	13	18	17	18	17	28	23	22	100

<u>2.70 m</u>

100											
66	100										
51	78	100									
26	45	60	100								
23	40	55	40	100							
25	44	40	57	27	100						
50	78	67	40	37	60	100					
1	1	1	1	1	12	16	100				
18	33	31	24	23	35	46	80	100			
22	20	19	14	13	14	19	78	89	100		
25	22	21	15	14	15	21	59	71	80	100	
1	1	1	1	1	1	1	82	82	92	72	100

<u>2.61 m</u>

100											
66	100										
51	79	100									
29	51	66	100								
21	37	34	28	100							
25	44	40	31	74	100						
20	36	33	27	66	63	100					
18	16	15	25	11	24	21	100				
23	20	18	15	12	14	13	89	100			
1	1	1	1	1	1	1	78	88	100		
20	18	17	26	11	12	11	21	12	1	100	
0	0	0	14	1	1	1	11	1	1	89	100

2.49 m **STRIP 4**

1975	10 Feb	100											
	10 Mar	67	100										
	8 Apr.	2	34	100									
	15 May	23	41	51	100								
	30 Jun	21	37	47	71	100							
	28 Aug	33	56	66	61	57	100						
	26 Sep	20	36	46	82	67	71	100					
	27 Nov	17	16	14	21	11	25	30	100				
1976	15 Jan	1	22	54	53	38	67	62	45	100			
	12 Mar	18	33	57	44	42	67	53	48	71	100		
	19 May	12	12	11	17	9	11	17	23	10	16	100	
	14 Aug	0	0	14	11	1	0	11	19	12	10	40	100

2.37 m

100											
67	100										
40	66	100									
21	37	62	100								
65	96	66	37	100							
2	40	30	34	41	100						
18	17	15	22	18	32	100					
18	17	15	22	17	32	90	100				
1	23	55	62	23	41	13	13	100			
1	18	47	56	19	50	43	43	63	100		
13	24	22	50	24	23	16	16	27	25	100	
1	1	1	20	1	28	19	28	22	29	23	100

2.17 m

100											
67	100										
1	26	100									
23	41	29	100								
14	27	11	39	100							
2	29	19	32	23	100						
20	18	1	24	19	57	100					
15	14	0	10	8	36	76	100				
1	15	34	21	17	59	57	67	100			
0	13	21	29	16	55	73	80	80	100		
1	13	20	45	15	21	9	0	16	22	100	
1	1	12	32	9	14	11	9	18	25	72	100

1.89 m

100											
67	100										
25	44	100									
12	22	44	100								
13	24	19	39	100							
33	56	50	38	31	100						
34	29	17	19	20	60	100					
18	16	12	15	16	40	53	100				
0	0	1	8	8	25	38	86	100			
1	22	57	44	19	67	51	35	34	100		
12	12	18	64	14	30	30	24	16	27	100	
1	1	1	34	9	16	17	12	11	14	61	100

3.04 m STRIP 5

Date	A	M	J	A	S	N	J	M	M	A
1975 8 April	100									
15 May	39	100								
30 Jun	0	0	100							
28 Aug	40	2	0	100						
26 Sep	40	2	0	100	100					
27 Nov	18	25	0	1	1	100				
1976 15 Jan	33	22	0	22	22	93	100			
12 Mar	29	18	0	18	18	82	88	100		
19 May	18	22	0	1	1	93	87	89	100	
14 Aug	40	28	0	29	29	76	85	75	72	100

2.86 m

100									
96	100								
4	9	100							
49	50	3	100						
65	67	5	41	100					
2	2	1	1	20	100				
14	15	1	13	27	67	100			
1	1	1	1	17	78	87	100		
15	15	1	13	27	67	69	70	100	
1	2	1	1	20	63	76	88	57	100

2.70 m

100									
41	100								
30	42	100							
40	25	40	100						
40	25	40	100	100					
45	30	51	57	57	100				
19	11	13	21	21	33	100			
14	1	1	16	16	33	67	100		
28	17	23	33	33	54	61	71	100	
0	1	1	0	0	20	64	88	67	100

2.61 m

100									
71	100								
44	31	100							
21	29	67	100						
19	27	60	73	100					
1	12	1	16	15	100				
1	12	1	16	15	75	100			
1	12	1	15	14	71	94	100		
0	21	1	14	13	12	12	21	100	
0	12	0	0	0	1	1	1	89	100

2.49 m **STRIP 5**

		A	M	J	A	S	N	J	M	M	A
1975	8 Apr	100									
	15 May	66	100								
	30 Jun	46	67	100							
	28 Aug	15	42	71	100						
	26 Sep	17	24	27	62	100					
	27 Nov	1	11	13	34	63	100				
1976	15 Jan	1	12	13	24	53	94	100			
	12 Mar	1	13	14	38	72	75	80	100		
	19 May	0	8	9	9	9	9	9	9	100	
	14 Aug	0	11	12	11	13	11	12	13	75	100

2.37 m

100									
1	100								
14	43	100							
1	35	24	100						
14	29	27	71	100					
0	21	9	56	78	100				
0	8	10	27	60	85	100			
1	22	27	24	55	52	60	100		
1	19	8	29	23	30	17	8	100	
1	22	9	36	28	35	20	9	84	100

2.17 m

100									
12	100								
12	69	100							
22	15	15	100						
15	21	20	54	100					
0	10	10	16	67	100				
0	11	11	21	80	82	100			
0	11	11	1	14	24	29	100		
1	25	8	1	10	17	20	20	100	
1	9	9	2	11	19	22	42	72	100

1.89 m

100									
22	100								
47	69	100							
2	1	16	100						
1	1	1	6	100					
1	0	1	2	26	100				
16	18	20	2	21	85	100			
46	9	30	1	1	71	75	100		
1	42	19	19	2	38	45	34	100	
1	0	13	39	2	60	50	50	57	100

15/5/75	100						
30 Jun	0	100					
28 Aug	40	0	100				
26 Sep	4	0	5	100			
27 Nov	1	0	1	25	100		
15/1/76	1	0	1	20	62	100	
12 Mar	1	0	1	20	87	56	100
	M	J	A	S	N	J	M

3.04 m

100					
4	100				
2	67	100			
1	1	22	100		
1	23	40	66	100	
1	20	36	67	71	100

missing 30 June 1975

2.86 m

100						
0	100					
2	0	100				
1	0	86	100			
1	0	0	18	100		
2	0	34	57	20	100	
1	0	17	31	13	50	100

2.70 m

100						
98	100					
29	28	100				
1	0	55	100			
1	1	1	33	100		
1	0	19	40	34	100	
20	20	27	15	13	57	100

2.61 m

100						
22	100					
26	85	100				
37	71	53	100			
19	24	27	23	100		
16	42	47	40	90	100	
21	75	57	71	36	53	100

2.49 m

100						
64	100					
67	67	100				
47	50	84	100			
34	29	60	63	100		
42	37	66	70	95	100	
67	76	70	53	40	48	100

2.37 m

100						
76	100					
58	64	100				
28	35	69	100			
30	29	57	90	100		
37	35	61	84	91	100	
58	73	64	35	38	52	100

2.17 m

100						
77	100					
32	35	100				
24	27	64	100			
1	1	50	58	100		
31	34	61	87	56	100	
35	38	30	40	18	57	100

1.89 m

STRIP 6

30/6	100							
28 Aug	0	100						
26 Sep	0	5	100					
27 Nov	0	1	25	100				
15 Jan	0	1	22	93	100			
12 Mar	0	0	18	82	89	100		
19 May	0	1	22	93	88	78	100	
14 Aug	0	1	25	99	93	82	93	100
	J	A	S	N	J	M	M	A
	1975				1976			

3.04 m

100						
5	100					
1	20	100				
1	22	93	100			
1	18	82	87	100		
1	15	70	74	67	100	
1	17	78	82	73	73	100

(missing 30 June 1975)

2.86 m

100						
42	100					
23	50	100				
18	43	67	100			
23	17	50	89	100		
17	41	63	76	63	100	
1	1	35	73	82	60	100

(missing 30 June 1975)

2.70 m

100							
1	100						
2	38	100					
1	11	31	100				
1	1	17	93	100			
1	10	29	82	87	100		
1	1	1	0	1	1	100	
1	0	1	0	1	1	80	100

2.61 m

100							
1	100						
3	16	100					
1	1	21	100				
1	1	21	99	100			
1	11	33	87	87	100		
1	8	11	0	0	8	100	
0	0	0	0	0	1	96	100

2.49 m

100						
2	100					
34	40	100				
1	72	37	100			
1	50	50	47	100		
1	20	10	10	8	100	
1	11	1	1	1	96	100

(missing 15 Jan. 1976)

2.37 m

100							
77	100						
67	86	100					
1	17	15	100				
1	13	11	47	100			
1	13	11	47	100	100		
0	1	1	29	24	23	100	
0	0	0	0	0	0	83	100

2.17 m

100							
72	100						
18	50	100					
1	15	18	100				
1	12	26	45	100			
1	13	29	50	70	100		
1	1	16	26	21	22	100	
1	0	15	1	10	11	66	100

1.89 m

STRIP 7

APPENDIX VI: Matrices of the similarities between all samples at 8 levels on each strip for each sampling date.

Similarities that could not be calculated because of lost samples are marked (?).

Similarities are presented as percentage values and are also grouped as follows:

0 - 19%	60 - 79%
20 - 39%	80 - 100%
40 - 59%	

Contents

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	23	100						
2.70	1	0	100					
2.61	23	13	93	100				
2.49	23	13	93	100	100			
2.37	23	13	93	100	100	100		
2.17	23	13	93	100	100	100	100	
1.89	23	13	93	100	100	100	100	100

STRIP 1 24 SEP 1974

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	89	100						
2.70	12	12	100					
2.61	1	1	93	100				
2.49	1	1	77	83	100			
2.37	0	0	54	60	74	100		
2.17								
1.89	0	0	50	54	66	86		100

STRIP 1 19 NOV 1974

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	75	100						
2.70	36	31	100					
2.61	20	17	93	100				
2.49	33	25	54	60	100			
2.37	66	50	18	20	33	100		
2.17							?	
1.89	40	29	1	1	1	80		100

STRIP 1 10 DEC 1974

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	29	100						
2.70	16	41	100					
2.61	1	29	77	100				
2.49	2	52	21	29	100			
2.37	2	52	21	29	99	100		
2.17							?	
1.89	2	42	19	25	80	80		100

STRIP 1 17 JAN 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	47	100						
2.70	15	62	100					
2.61	15	31	43	100				
2.49	23	26	23	23	100			
2.37	23	26	23	24	52	100		
2.17							?	
1.89	0	1	0	0	34	34		100

STRIP 1 10 FEB 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	40	100						
2.70	22	47	100					
2.61	22	47	100	100				
2.49	13	51	93	93	100			
2.37	19	35	23	23	27	100		
2.17								
1.89	1	2	1	1	2	8		100

STRIP 1 10 MAR 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	71	100						
2.70	0	15	100					
2.61	0	15	99	100				
2.49	13	14	93	93	100			
2.37	1	1	1	1	2	100		
2.17							?	
1.89	34	39	18	19	34	35		100

STRIP 1 8 APR 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	99	100						
2.70	2	1	100					
2.61	1	1	92	100				
2.49	1	2	92	99	100			
2.37	12	12	36	44	45	100		
2.17	11	11	55	63	63	67	100	
1.89	10	10	50	57	57	61	83	100

STRIP 1 15 MAY 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	92	100						
2.70	14	15	100					
2.61	25	28	94	100				
2.49	24	26	23	32	100			
2.37	35	26	23	32	80	100		
2.17	27	16	14	13	45	67	100	
1.89	22	24	22	31	57	67	53	100

STRIP 1 30 JUN 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	99	100						
2.70	87	87	100					
2.61	26	25	45	100				
2.49	27	27	47	93	100			
2.37	24	24	42	73	78	100		
2.17	13	14	35	82	87	88	100	
1.89	28	28	50	49	53	47	53	100

STRIP 1 28 AUG 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	93	100						
2.70	46	58	100					
2.61	16	29	66	100				
2.49	12	12	14	13	100			
2.37	0	0	0	0	78	100		
2.17	0	1	1	1	78	89	100	
1.89	0	0	0	0	73	84	84	100

STRIP 1 26 SEP 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	29	100						
2.70	14	62	100					
2.61	31	12	11	100				
2.49	12	13	12	86	100			
2.37	11	13	12	86	90	100		
2.17	10	11	11	78	82	91	100	
1.89	1	1	0	72	76	76	69	100

STRIP 1 27 NOV 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	66	100						
2.70	28	52	100					
2.61	0	1	1	100				
2.49	1	1	1	87	100			
2.37	1	1	1	89	89	100		
2.17	1	1	1	66	76	78	100	
1.89	1	0	1	69	80	73	96	100

STRIP 1 15 JAN 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	59	100						
2.70	25	32	100					
2.61	14	22	94	100				
2.49	1	11	67	71	100			
2.37	0	11	78	82	78	100		
2.17	1	9	64	67	64	82	100	
1.89	1	1	56	59	66	67	73	100

STRIP 1 12 MAR 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	54	100						
2.70	1	38	100					
2.61	10	32	76	100				
2.49	0	18	64	79	100			
2.37	9	23	67	74	84	100		
2.17	0	19	53	46	67	69	100	
1.89	11	23	11	18	39	48	67	100

STRIP 1 19 MAY 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	88	100						
2.70	50	62	100					
2.61	13	12	10	100				
2.49	0	1	1	84	100			
2.37	0	1	1	84	93	100		
2.17	1	1	1	64	74	74	100	
1.89	0	1	1	67	77	77	88	100

STRIP 1 14 AUG 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	100	100						
2.70	100	100	100					
2.61	100	100	100	100				
2.49	100	100	100	100	100			
2.37	100	100	100	100	100	100		
2.17	100	100	100	100	100	100	100	
1.89	100	100	100	100	100	100	100	100

STRIP 2 24 OCT 1974

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	100	100						
2.70	100	100	100					
2.61	100	100	100	100				
2.49	99	99	99	99	100			
2.37	99	99	99	99	100	100		
2.17	99	99	99	99	100	100	100	
1.89	99	99	99	99	100	100	100	100

STRIP 2 10 DEC 1974

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	92	100						
2.70	72	77	100					
2.61	67	72	93	100				
2.49	72	77	100	93	100			
2.37	72	77	100	93	100	100		
2.17	72	76	100	93	100	100	100	
1.89	72	76	100	93	100	100	100	100

STRIP 2 10 FEB 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86		?						
2.70	37		100					
2.61	15		76	100				
2.49	1		47	80	100			
2.37	17		42	27	12	100		
2.17	45		38	22	15	59	100	
1.89	40		24	10	1	33	53	100

STRIP 2 10 MAR 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	49	100						
2.70	1	2	100					
2.61	18	18	93	100				
2.49	18	18	93	87	100			
2.37	1	2	1	2	2	100		
2.17	21	21	1	2	15	76	100	
1.89	66	23	0	1	16	1	19	100

STRIP 2 8 APR 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	57	100						
2.70	2	32	100					
2.61	1	26	71	100				
2.49	2	23	74	91	100			
2.37	10	31	67	75	84	100		
2.17	9	28	53	69	72	87	100	
1.89	1	22	60	61	64	74	76	100

STRIP 2 15 MAY 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	4	100						
2.70	3	79	100					
2.61	2	2	2	100				
2.49	3	17	16	94	100			
2.37	2	58	51	23	33	100		
2.17	2	54	48	22	31	95	100	
1.89	2	38	34	21	29	82	87	100

STRIP 2 30 JUN 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	25	100						
2.70	1	73	100					
2.61	19	24	15	100				
2.49	23	40	34	34	100			
2.37	1	18	25	28	67	100		
2.17	67	22	2	33	41	34	100	
1.89	5	2	3	19	23	41	66	100

STRIP 2 28 AUG 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	99	100						
2.70	71	72	100					
2.61	14	14	12	100				
2.49	14	14	12	89	100			
2.37	0	1	1	82	94	100		
2.17	1	0	16	15	29	31	100	
1.89	0	0	11	70	80	84	62	100

STRIP 2 27 NOV 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	77	100						
2.70	16	29	100					
2.61	1	12	12	100				
2.49	0	12	12	100	100			
2.37	1	1	11	86	86	100		
2.17	1	15	15	35	35	45	100	
1.89	1	11	11	91	91	78	31	100

STRIP 2 15 JAN 1976

100							
34	100						
33	55	100					
1	30	80	100				
1	10	57	74	100			
1	1	42	55	78	100		
13	20	30	34	63	64	100	
0	1	48	63	70	61	32	100

STRIP 2 12 MAR 1976

100							
71	100						
30	48	100					
10	29	83	100				
9	25	74	74	100			
9	26	77	77	96	100		
9	25	22	22	47	49	100	
1	12	10	10	42	44	50	100

STRIP 2 19 MAY 1976

100							
89	100						
29	40	100					
1	1	10	100				
0	0	10	86	100			
1	1	9	84	80	100		
12	11	18	58	69	64	100	
0	1	0	64	75	76	60	100

STRIP 2 14 AUG 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	100	100						
2.70	100	100	100					
2.61	100	100	100	100				
2.49	99	99	99	99	100			
2.37	99	99	99	99	100	100		
2.17	99	99	99	99	100	100	100	
1.89	99	99	[illegible]	[illegible]	100	100	100	100

STRIP 4 10 MAR 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	68	100						
2.70	51	80	100					
2.61	52	81	99	100				
2.49	2	34	30	29	100			
2.37	40	66	57	57	75	100		
2.17	1	25	23	23	79	60	100	
1.89	25	44	40	40	73	72	92	100

STRIP 4 8 APR 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	92	100						
2.70	61	72	100					
2.61	33	46	77	100				
2.49	85	93	67	58	100			
2.37	53	62	38	53	70	100		
2.17	29	27	28	44	38	70	100	
1.89	36	35	18	[illegible]	[illegible]	64	67	100

STRIP 4 1[illegible] MAY 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	2	100						
2.70	1	40	100					
2.61	1	36	71	100				
2.49	1	36	71	100	100			
2.37	2	97	41	37	36	100		
2.17	0	27	20	37	37	28	100	
1.89	[illegible]	23	18	34	34	24	93	100

STRIP 4 30 JUN 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	2	100						
2.70	1	60	100					
2.61	1	21	43	10[illegible]				
2.49	1	26	34	67	100			
2.37	2	2	22	22	51	100		
2.17	1	2	18	18	41	75	100	
1.89	1	26	34	34	[illegible]0	75	61	100

STRIP 4 2[illegible] AUG 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	40	100						
2.70	33	79	100					
2.61	50	36	50	100				
2.49	50	36	50	78	100			
2.37	15	17	31	22	42	100		
2.17	17	18	18	12	34	95	100	
1.89	25	29	26	15	43	40	43	100

STRIP 4 26 SEP 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	36	100						
2.70	1	17	100					
2.61	11	31	80	100				
2.49	11	15	67	86	100			
2.37	12	17	71	90	86	100		
2.17	10	27	72	81	69	82	100	
1.89	11	16	30	50	48	60	64	100

STRIP 4 27 NOV 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	72	100						
2.70	25	40	100					
2.61	15	31	89	100				
2.49	16	34	48	40	100			
2.37	16	18	13	1	58	100		
2.17	12	24	55	50	74	43	100	
1.89	0	13	48	53	45	12	78	100

STRIP 4 15 JAN 1976

100							
78	100						
11	25	100					
1	13	87	100				
20	23	45	45	100			
11	13	36	47	74	100		
9	10	67	76	43	54	100	
12	14	14	27	59	75	50	100

STRIP 4 12 MAR 1976

100							
87	100						
15	38	100					
12	22	25	100				
9	17	18	75	100			
9	17	18	75	93	100		
1	9	10	70	89	96	100	
9	17	18	42	67	67	62	100

STRIP 4 19 MAY 1976

100							
36	100						
1	12	100					
0	1	1	100				
0	0	1	53	100			
1	10	11	20	54	100		
1	0	1	79	57	44	100	
1	1	1	47	44	30	53	100

STRIP 4 14 AUG 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	2	100						
2.70	1	42	100					
2.61	20	21	62	100				
2.49	0	19	58	63	100			
2.37	0	12	38	46	74	100		
2.17	1	17	14	30	29	36	100	
1.89	0	14	12	26	25	33	80	100

STRIP 5 15 MAY 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	0	100						
2.70	0	9	100					
2.61	0	2	42	100				
2.49	0	1	24	67	100			
2.37	0	1	18	54	84	100		
2.17	0	1	16	50	50	44	100	
1.89	0	1	16	38	40	44	92	100

STRIP 5 30 JUN 1975

100							
51	100						
41	86	100					
34	75	88	100				
20	50	61	71	100			
28	23	20	38	54	100		
50	34	56	51	50	46	100	
4	2	40	35	21	3	51	100

STRIP 5 28 AUG 1975

100							
93	100						
20	19	100					
40	38	37	100				
1	1	18	59	100			
1	1	14	51	85	100		
0	1	16	56	95	91	100	
0	1	23	15	14	22	25	100

STRIP 5 27 NOV 1975

100							
68	100						
41	67	100					
29	50	79	100				
25	44	36	32	100			
17	31	27	24	78	100		
23	40	33	29	80	84	100	
3	2	2	2	23	16	21	100

STRIP 5 26 SEP 1975

100							
76	100						
70	93	100					
13	57	69	100				
0	48	61	87	100			
0	46	58	83	94	100		
0	50	46	67	80	87	100	
13	19	18	13	25	35	40	100

STRIP 5 15 JAN 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	70	100						
2.70	11	42	100					
2.61	11	42	100	100				
2.49	12	46	75	75	100			
2.37	10	29	60	60	56	100		
2.17	0	0	13	13	15	34	100	
1.89	11	1	12	12	1	63	41	100

STRIP 5 12 MAR 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	76	100						
2.70	13	38	1.00					
2.61	11	18	22	100				
2.49	0	8	9	72	100			
2.37	1	8	9	72	100	100		
2.17	1	8	10	78	93	93	100	
1.89	12	18	23	30	48	48	52	100

STRIP 5 19 MAY 1976

100							
71	100						
0	40	100					
0	0	1	100				
0	0	1	94	100			
1	1	1	84	90	100		
1	1	1	80	85	78	100	
20	17	1	0	16	14	38	100

STRIP 5 14 AUG 1976

100							
86	100						
86	100	100					
9	8	8	100				
2	2	2	66	100			
1	1	1	23	22	100		
1	1	1	19	18	89	100	
0	0	0	14	14	64	75	100

STRIP 6 15 MAY 1975

100							
0	?						
0		100					
0		5	100				
0		1	22	100			
0		0	17	84	100		
0		0	17	84	100	100	
0		0	15	80	87	87	100

STRIP 6 30 JUN 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	9	100						
2.70	3	51	100					
2.61	2	29	66	100				
2.49	1	28	22	34	100			
2.37	1	18	46	51	50	100		
2.17	1	17	43	48	47	95	100	
1.89	1	17	43	47	24	76	82	100

STRIP 6 28 AUG 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	66	100						
2.70	40	67	100					
2.61	33	57	89	100				
2.49	20	36	62	57	100			
2.37	20	37	31	29	56	100		
2.17	15	15	13	12	38	76	100	
1.89	0	1	1	1	31	70	96	100

STRIP 6 26 SEP 1975

100							
71	100						
33	37	100					
28	31	75	100				
10	11	29	50	100			
10	11	29	50	100	100		
10	10	27	47	96	96	100	
10	10	27	47	96	96	100	100

STRIP 6 15 JAN 1976

100							
78	100						
11	33	100					
1	22	89	100				
1	24	24	36	100			
1	21	21	32	89	100		
1	20	20	30	84	95	100	
1	22	22	34	71	63	70	100

STRIP 6 12 MAR 1976

			100				
			57	100			
			8	16	100		
			1	3	27	100	
			1	2	26	99	100

STRIP 7 30 JUN 1975

100							
67	100						
4	9	100					
0	1	18	100				
1	1	2	95	100			
1	2	2	38	41	100		
1	2	2	1	2	19	100	
1	1	2	1	1	18	92	100

STRIP 7 28 AUG 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	66	100						
2.70	40	66	100					
2.61	33	57	46	100				
2.49	49	80	58	76	100			
2.37	1	29	23	40	50	100		
2.17	22	20	17	31	37	31	100	
1.89	33	29	23	40	50	40	61	100

STRIP 7 26 SEP 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	93	100						
2.70	40	38	100					
2.61	14	13	50	100				
2.49	1	1	40	93	100			
2.37	1	1	15	15	16	100		
2.17	1	1	15	15	16	99	100	
1.89	1	1	14	14	15	92	92	100

STRIP 7 27 NOV 1975

100							
93	100						
33	35	100					
0	1	82	100				
1	1	82	99	100			
					?		
1	0	67	78	78		100	
1	0	67	78	78		100	100

STRIP 7 15 JAN 1976

100							
80	100						
53	61	100					
1	10	11	100				
0	8	8	70	100			
0	8	8	70	100	100		
0	8	8	70	87	87	100	
1	10	10	12	50	50	50	100

STRIP 7 19 MAY 1976

100							
82	100						
0	32	100					
0	0	10	100				
0	0	9	92	100			
0	0	9	92	100	100		
0	0	9	92	100	100	100	
0	0	22	76	69	70	70	100

STRIP 7 14 AUG 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	5	100						
2.70	1	41	100					
2.61	1	26	73	100				
2.49	1	26	73	100	100			
2.37	1	2	51	80	80	100		
2.17	1	2	1	15	15	40	100	
1.89	2	1	1	20	20	54	60	100

STRIP 8 26 SEP 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	85	100						
2.70	47	63	100					
2.61	15	14	63	100				
2.49	15	13	63	100	100			
2.37	15	13	63	100	100	100		
2.17	54	47	25	31	31	31	100	
1.89	15	13	21	25	26	26	46	100

STRIP 8 15 JAN 1976

100							
93	100						
59	63	100					
36	38	55	100				
1	1	24	70	100			
12	14	33	78	94	100		
15	17	40	40	29	40	100	
1	2	19	19	21	19	50	100

STRIP 8 12 MAR 1976

100							
100	100						
60	60	100					
1	1	38	100				
1	1	34	91	100			
1	1	32	87	96	100		
1	1	1	32	48	46	100	
1	1	1	1	1	1	46	100

STRIP 8 14 AUG 1976

			100				
			67	100			
			8	4	100		
			5	2	68	100	
			2	1	4	30	100

STRIP 9 26 SEP 1975

100							
50	100						
22	76	100					
34	29	32	100				
31	53	57	57	100			
18	44	47	35	86	100		
31	53	43	29	76	85	100	
40	36	1	23	1	1	21	100

STRIP 9 27 NOV 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	67	100						
2.70	17	38	100					
2.61	1	31	73	100				
2.49	2	18	61	86	100			
2.37	1	14	77	60	67	100		
2.17	1	14	77	60	67	100	100	
1.89	1	15	83	67	75	91	91	100

STRIP 9 15 JAN 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	80	100						
2.70	46	64	100					
2.61	13	26	34	100				
2.49	1	13	21	77	100			
2.37	1	13	21	77	100	100		
2.17	1	12	11	57	80	80	100	
1.89	11	21	19	67	75	75	94	100

STRIP 9 12 MAR 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	32	100						
2.70	36	54	100					
2.61	28	45	78	100				
2.49	9	24	31	45	100			
2.37	9	24	46	58	88	100		
2.17	9	31	40	53	91	91	100	
1.89	10	54	37	37	54	54	62	100

STRIP 9 19 MAY 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	66	100						
2.70	17	14	100					
2.61	1	1	89	100				
2.49	1	1	89	89	100			
2.37	1	1	22	21	32	100		
2.17	1	1	17	17	34	32	100	
1.89	2	2	18	18	35	47	68	100

STRIP 9 14 AUG 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04								
2.86								
2.70								
2.61				100				
2.49				67	100			
2.37				67	100	100		
2.17				8	16	16	100	
1.89				2	5	5	5	100

STRIP 10 26 SEP 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	46	100						
2.70	46	99	100					
2.61	57	41	41	100				
2.49	26	55	55	42	100			
2.37	26	55	55	41	100	100		
2.17	44	66	66	34	85	85	100	
1.89	19	15	15	2	2	2	21	100

STRIP 10 27 NOV 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	59	100						
2.70	16	56	100					
2.61	1	27	72	100				
2.49	1	14	55	75	100			
2.37	1	14	55	74	76	100		
2.17	1	13	47	60	61	80	100	
1.89	1	12	47	60	61	80	100	100

STRIP 10 15 JAN 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	67	100						
2.70	10	48	100					
2.61	1	11	14	100				
2.49	1	10	12	87	100			
2.37	1	11	13	80	94	100		
2.17	1	11	13	80	94	100	100	
1.89	10	19	23	75	89	94	94	100

STRIP 10 12 MAR 1976

100							
57	100						
26	75	100					
9	25	45	100				
8	18	38	67	100			
11	22	23	45	72	100		
9	18	25	55	65	72	100	
11	29	31	37	57	82	5[illegible]	100

STRIP 10 19 MAY 1976

100							
21	100						
1	12	100					
1	13	94	100				
0	10	76	70	100			
0	10	76	70	100	100		
0	9	73	67	96	96	100	
2	0	37	20	15	15	14	100

STRIP 10 14 AUG 1976

100							
99	100						
68	69	100					
68	68	99	100				
9	9	68	68	100			
3	3	41	41	50	100		
4	3	30	30	35	75	100	
2	2	29	29	34	74	99	100

STRIP 11 12 MAR 1976

100							
52	100						
57	58	100					
51	52	91	100				
34	35	41	50	100			
31	32	38	47	76	100		
25	26	32	40	67	88	100	
23	23	29	37	62	81	87	100

STRIP 11 19 MAY 19

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	93	100						
2.70	87	94	100					
2.61	47	57	54	100				
2.49	1	1	1	50	100			
2.37	1	0	1	45	80	100		
2.17	1	1	1	[illegible]	67	52	100	
1.89	25	22	20	[illegible]	3	2	5	100

STRIP 11 14 AUG 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	40	100						
2.70	17	79	100					
2.61	10	40	53	100				
2.49	0	28	39	78	100			
2.37	0	59	70	50	64	100		
2.17	9	19	30	47	42	38	100	
1.89	1	11	12	54	59	32	63	100

CONTROL 10 FEB 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	12	100						
2.70	16	35	100					
2.61	0	52	40	100				
2.49	0	38	50	53	100			
2.37	0	59	16	50	47	100		
2.17	0	14	37	44	27	25	100	
1.89	14	15	21	12	57	27	31	100

CONTROL 8 APR 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	25	100						
2.70	16	54	100					
2.61	0	67	45	100				
2.49	12	41	70	53	100			
2.37	0	56	46	72	52	100		
2.17	1	34	41	48	60	56	100	
1.89	8	15	25	21	55	47	52	100

CONTROL 15 MAY 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	21	100						
2.70	37	36	100					
2.61	45	54	38	100				
2.49	2	40	14	44	100			
2.37	2	47	23	39	62	100		
2.17	23	40	25	57	71	76	100	
1.89	15	10	19	22	53	39	53	100

CONTROL 30 JUN 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	57	101						
2.70	23	33	100					
2.61	1	15	75	100				
2.49	1	19	62	67	100			
2.37	1	1	1	1	14	100		
2.17	1	1	11	10	23	[illegible]	100	
1.89	1	0	1	0	16	47	63	100

CONTROL 28 AUG 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	43	100						
2.70	13	42	100					
2.61	9	39	61	100				
2.49	1	34	57	86	100			
2.37	0	8	44	53	64	100		
2.17	12	20	67	72	78	72	100	
1.89	1	9	53	61	66	84	76	100

CONTROL 27 NOV 1975

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	40	100						
2.70	18	47	100					
2.61	21	40	82	100				
2.49	11	41	82	80	100			
2.37	10	26	69	77	86	100		
2.17	9	22	64	43	61	58	100	
1.89	20	27	55	60	60	57	61	100

CONTROL 15 JAN 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	74	100						
2.70	28	70	100					
2.61	27	70	99	100				
2.49	1	11	26	25	100			
2.37	1	9	21	21	84	100		
2.17	1	9	21	21	84	91	100	
1.89	1	1	1	1	75	74	84	100

CONTROL 12 MAR 1976

LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	24	100						
2.70	10	71	100					
2.61	0	53	82	100				
2.49	1	44	69	86	100			
2.37	1	29	58	69	87	100		
2.17	0	20	52	48	69	74	100	
1.89	0	22	19	18	44	48	59	100

CONTROL 19 MAY 1976

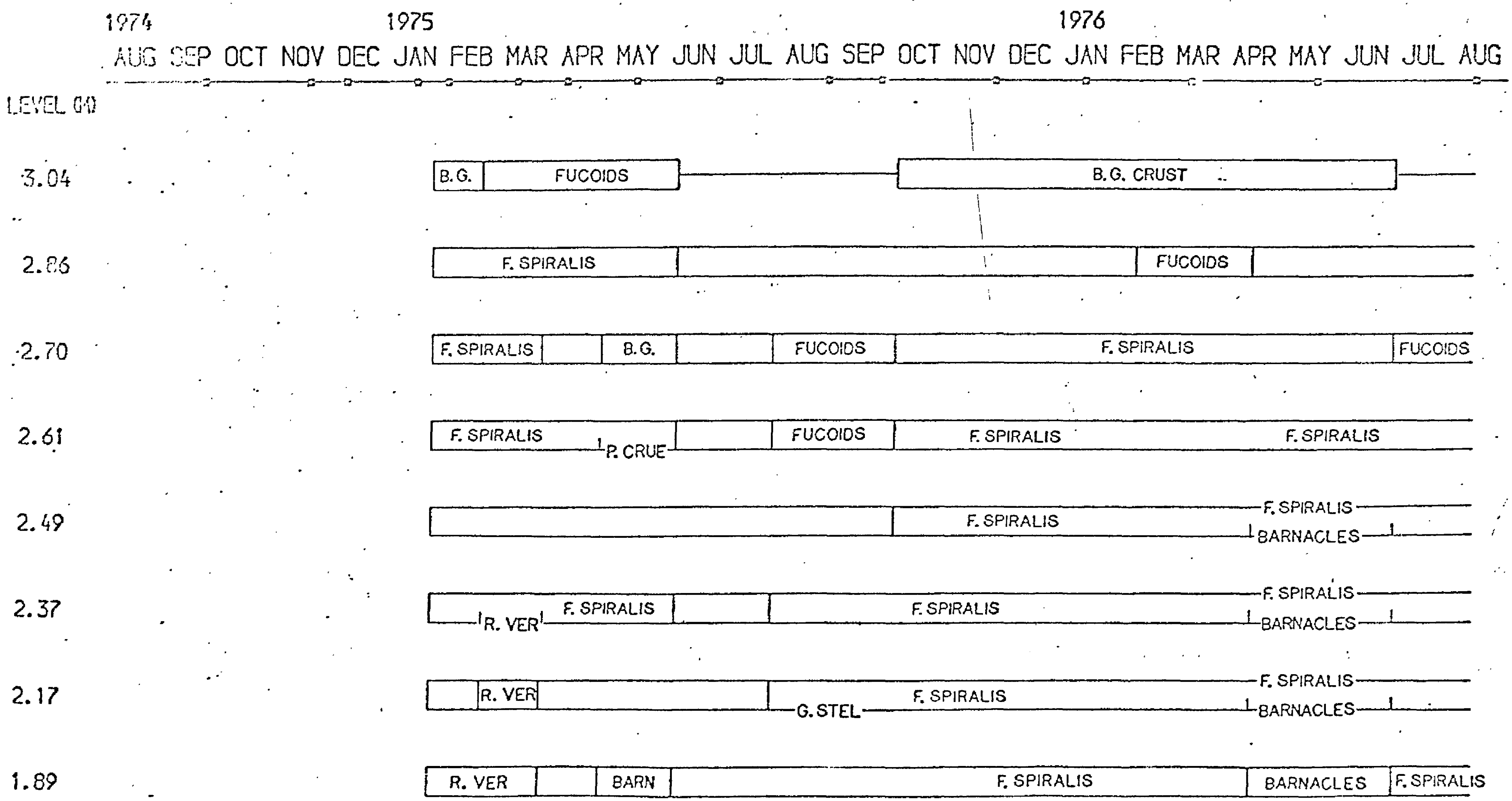
LEVEL (M)	3.04	2.86	2.70	2.61	2.49	2.37	2.17	1.89
3.04	100							
2.86	89	100						
2.70	61	71	100					
2.61	13	12	10	100				
2.49	0	1	1	75	100			
2.37	0	1	1	84	84	100		
2.17	0	1	1	57	67	69	100	
1.89	0	0	1	52	61	56	70	100

CONTROL 14 AUG 1976

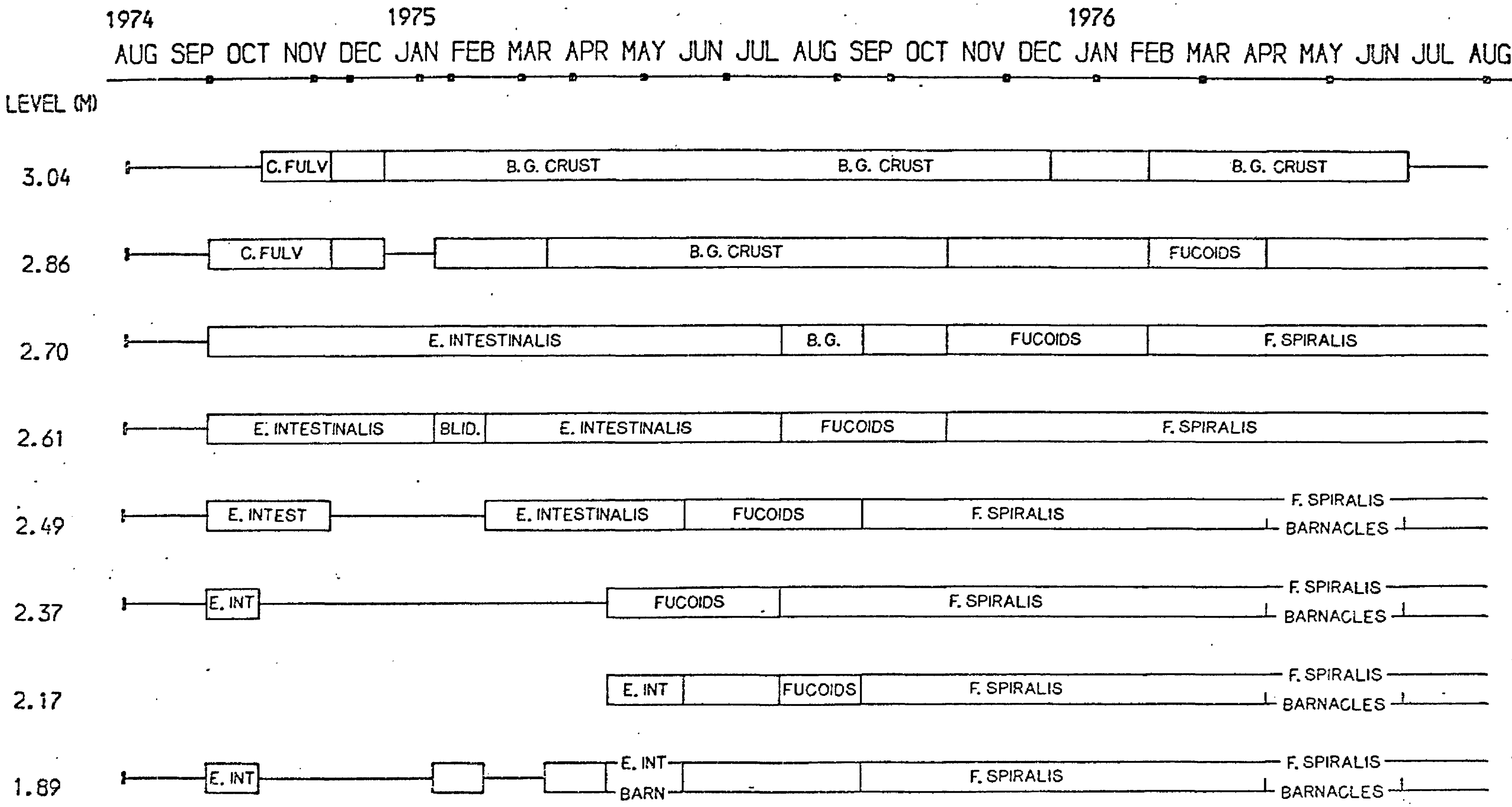
APPENDIX VII: Dominant species which covered more than 50% of the sampling quadrat in each strip. A single line indicates times when the total cover of all species was less than 50%. A block without a named species indicates times when the total cover was in excess of 50%, but no single species was dominant. The times of sampling are marked on each horizontal axis. The abbreviations used are:

B.G., B.G.CRUST	- crust of blue-green algae
F. SPIR	- *Fucus spiralis*
R. VER.	- *Ralfsia verrucosa*
FUCOIDS	- fucoid germlings
P. CRUE	- *Petrocelis cruenta*
G. STEL	- *Gigartina stellata*
BLID, BLID. CR, BLID. CRUST	- crustal form of *Blidingia*
C. FULVES, C. FULV	- *Capsosiphon fulvescens*
B. MIN	- *Blidingia minima*
E. INT, E. INTEST	- *Enteromorpha intestinalis*
U. PEN	- *Urospora penicilliformis*
U. PSE	- *Ulothrix pseudoflacca*
BARN, BARNACLES	- *Balanus balanoides*

Contents

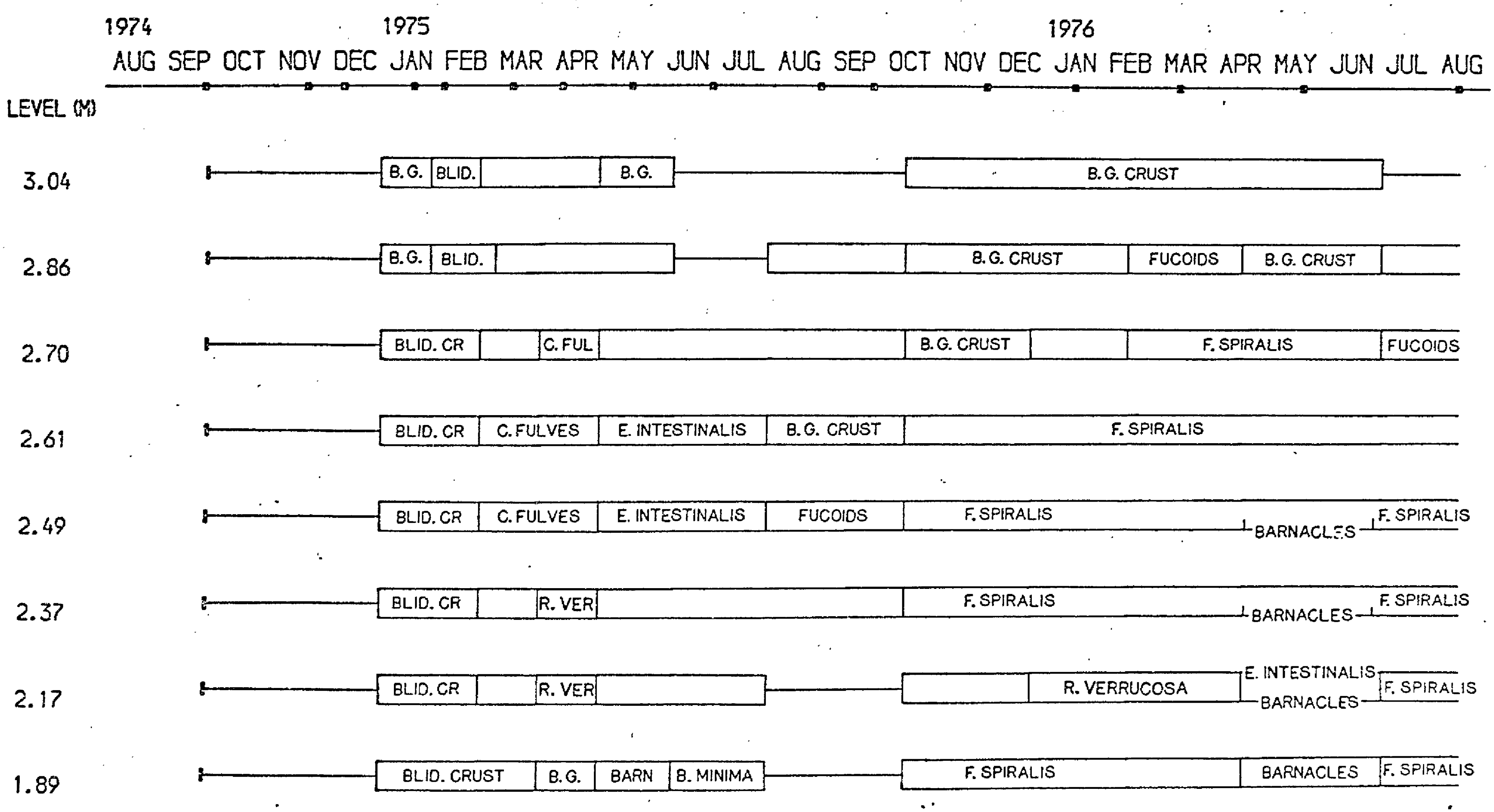


CONTROL STRIP

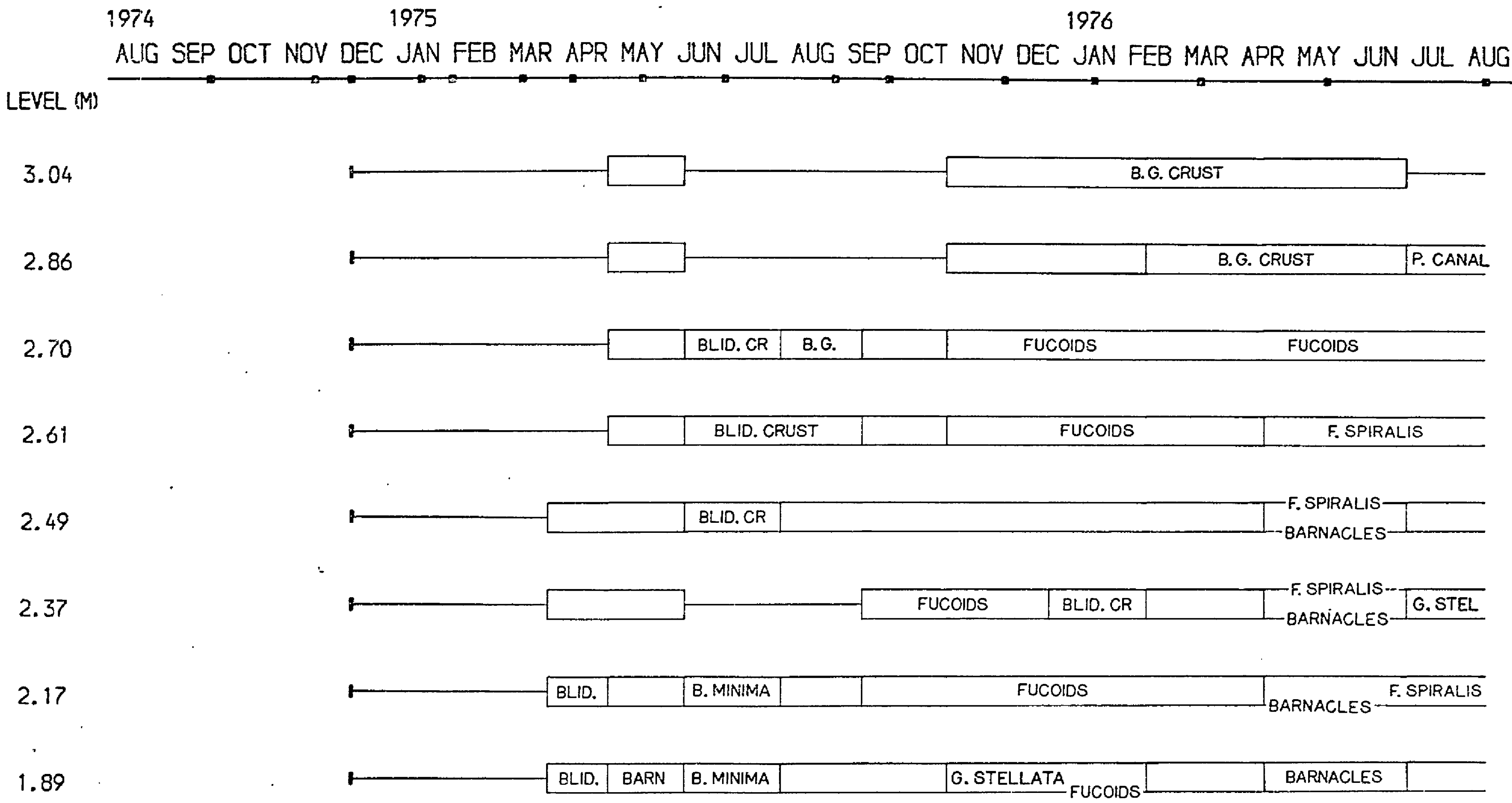


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
C. FULV
B.G. CRUST
B.G. CRUST
B.G. CRUST
2.86
C. FULV
B.G. CRUST
FUCOIDS
2.70
E. INTESTINALIS
B.G.
FUCOIDS
F. SPIRALIS
2.61
E. INTESTINALIS
BLID.
E. INTESTINALIS
FUCOIDS
F. SPIRALIS
2.49
E. INTEST
E. INTESTINALIS
FUCOIDS
F. SPIRALIS
F. SPIRALIS
BARNACLES
2.37
E. INT
FUCOIDS
F. SPIRALIS
F. SPIRALIS
BARNACLES
2.17
E. INT
FUCOIDS
F. SPIRALIS
F. SPIRALIS
BARNACLES
1.89
E. INT
E. INT
BARN
F. SPIRALIS
F. SPIRALIS
BARNACLES

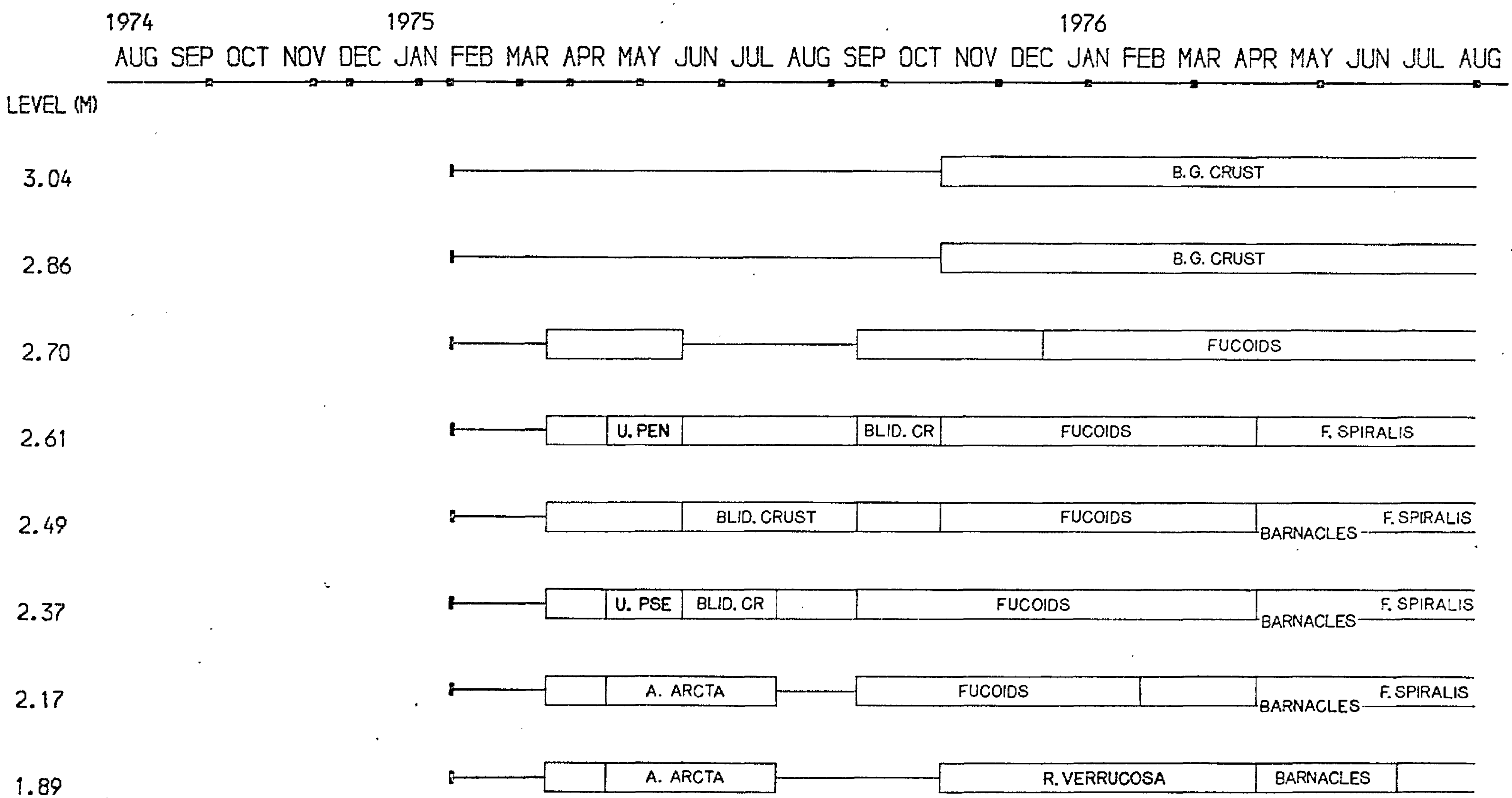
STRIP 1


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
B.G.
BLID.
B.G.
B.G. CRUST
2.86
B.G.
BLID.
B.G. CRUST
FUCOIDS
B.G. CRUST
2.70
BLID. CR
C. FUL
B.G. CRUST
F. SPIRALIS
FUCOIDS
2.61
BLID. CR
C. FULVES
E. INTESTINALIS
B.G. CRUST
F. SPIRALIS
2.49
BLID. CR
C. FULVES
E. INTESTINALIS
FUCOIDS
F. SPIRALIS
BARNACLES
F. SPIRALIS
2.37
BLID. CR
R. VER
F. SPIRALIS
BARNACLES
F. SPIRALIS
2.17
BLID. CR
R. VER
R. VERRUCOSA
E. INTESTINALIS
BARNACLES
F. SPIRALIS
1.89
BLID. CRUST
B.G.
BARN
B. MINIMA
F. SPIRALIS
BARNACLES
F. SPIRALIS

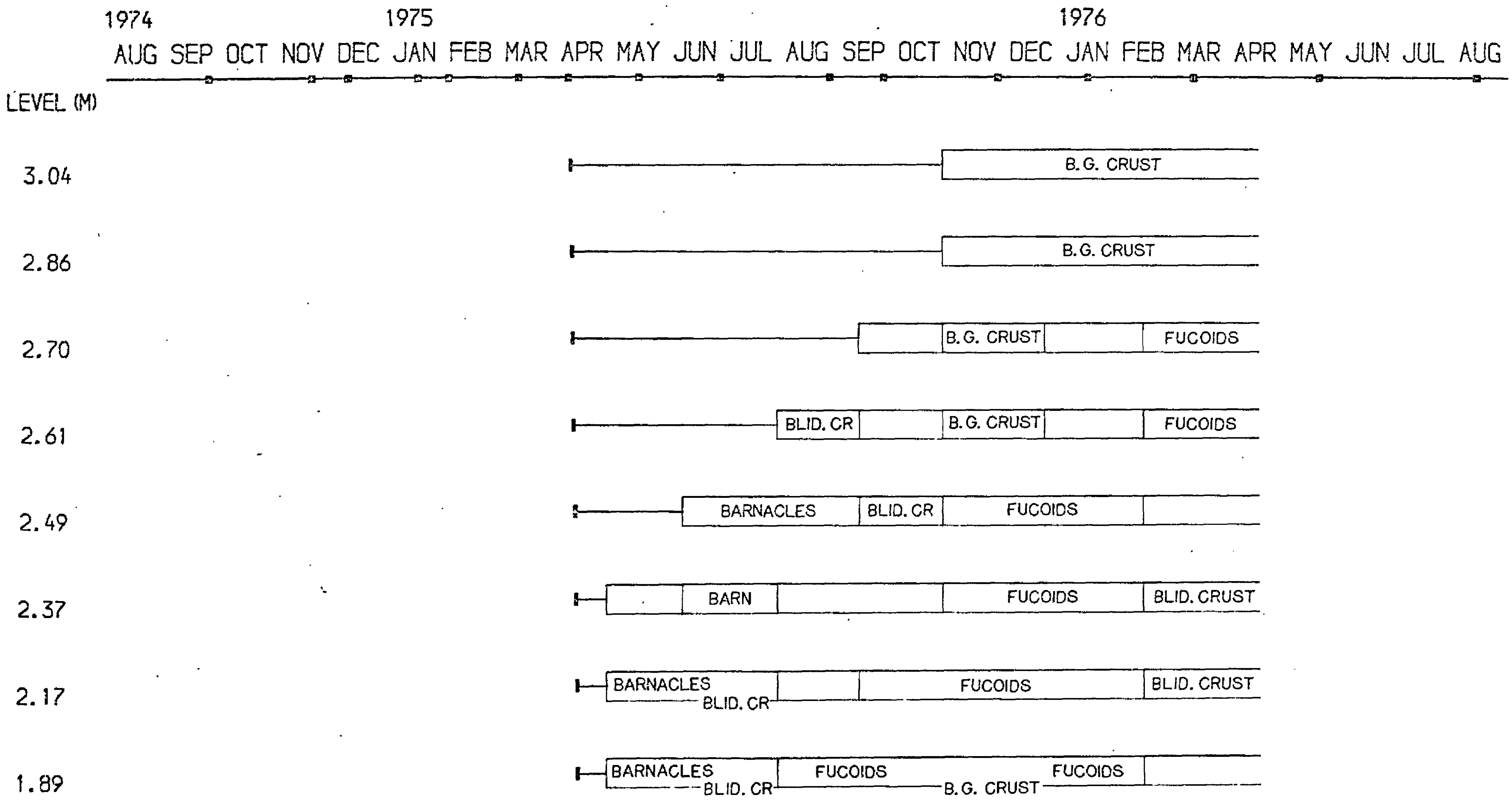
STRIP 2


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
B.G. CRUST
B.G. CRUST
P. CANAL
BLID. CR
B.G.
FUCOIDS
FUCOIDS
BLID. CRUST
FUCOIDS
F. SPIRALIS
BLID. CR
F. SPIRALIS
BARNACLES
FUCOIDS
BLID. CR
F. SPIRALIS
BARNACLES
G. STEL
BLID.
B. MINIMA
FUCOIDS
BARNACLES
F. SPIRALIS
BLID.
BARN
B. MINIMA
G. STELLATA
FUCOIDS
BARNACLES

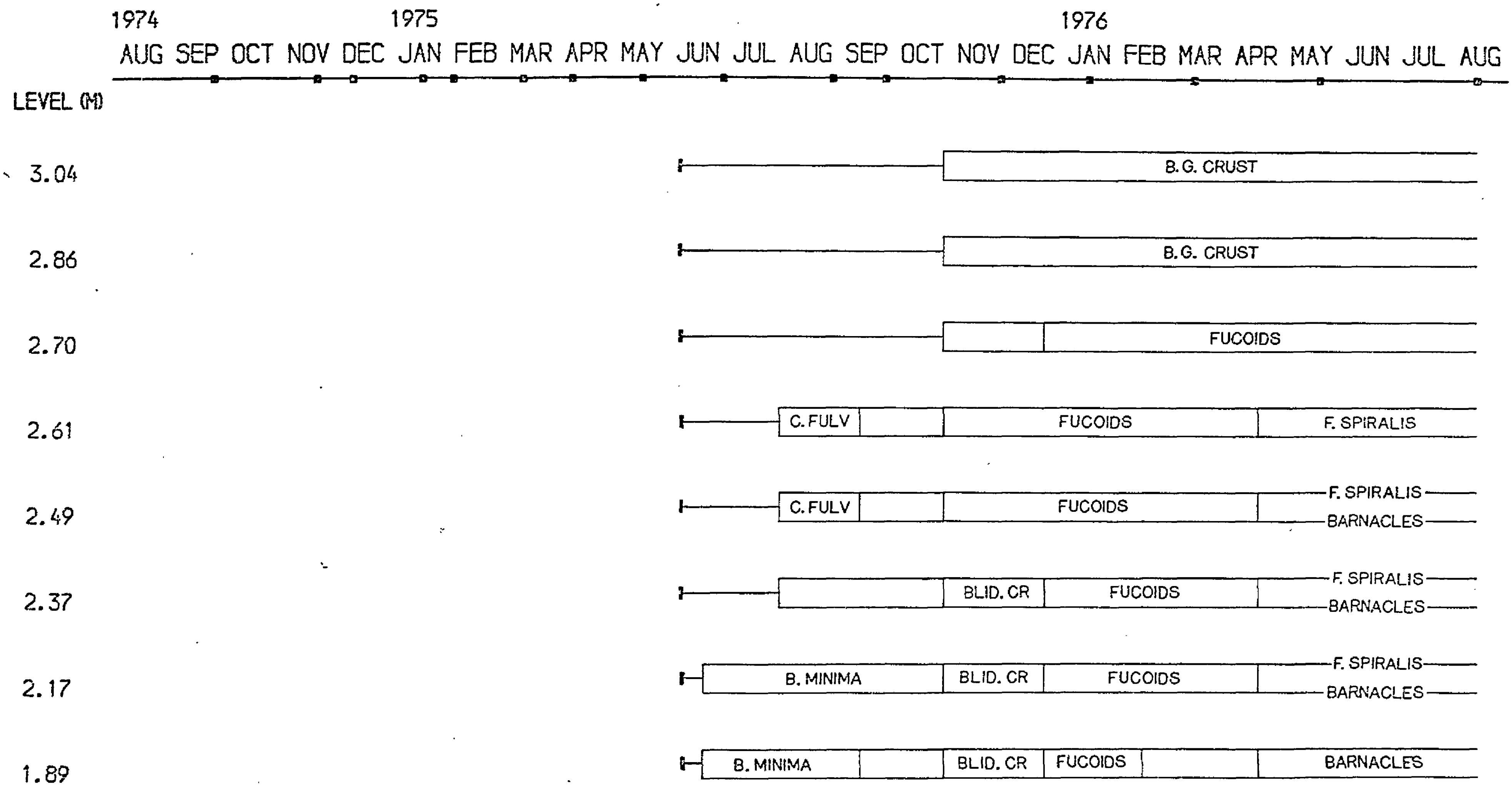
STRIP 4


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
B.G. CRUST
B.G. CRUST
FUCOIDS
U. PEN
BLID. CR
FUCOIDS
F. SPIRALIS
BLID. CRUST
FUCOIDS
BARNACLES
F. SPIRALIS
U. PSE
BLID. CR
FUCOIDS
BARNACLES
F. SPIRALIS
A. ARCTA
FUCOIDS
BARNACLES
F. SPIRALIS
A. ARCTA
R. VERRUCOSA
BARNACLES

STRIP 5

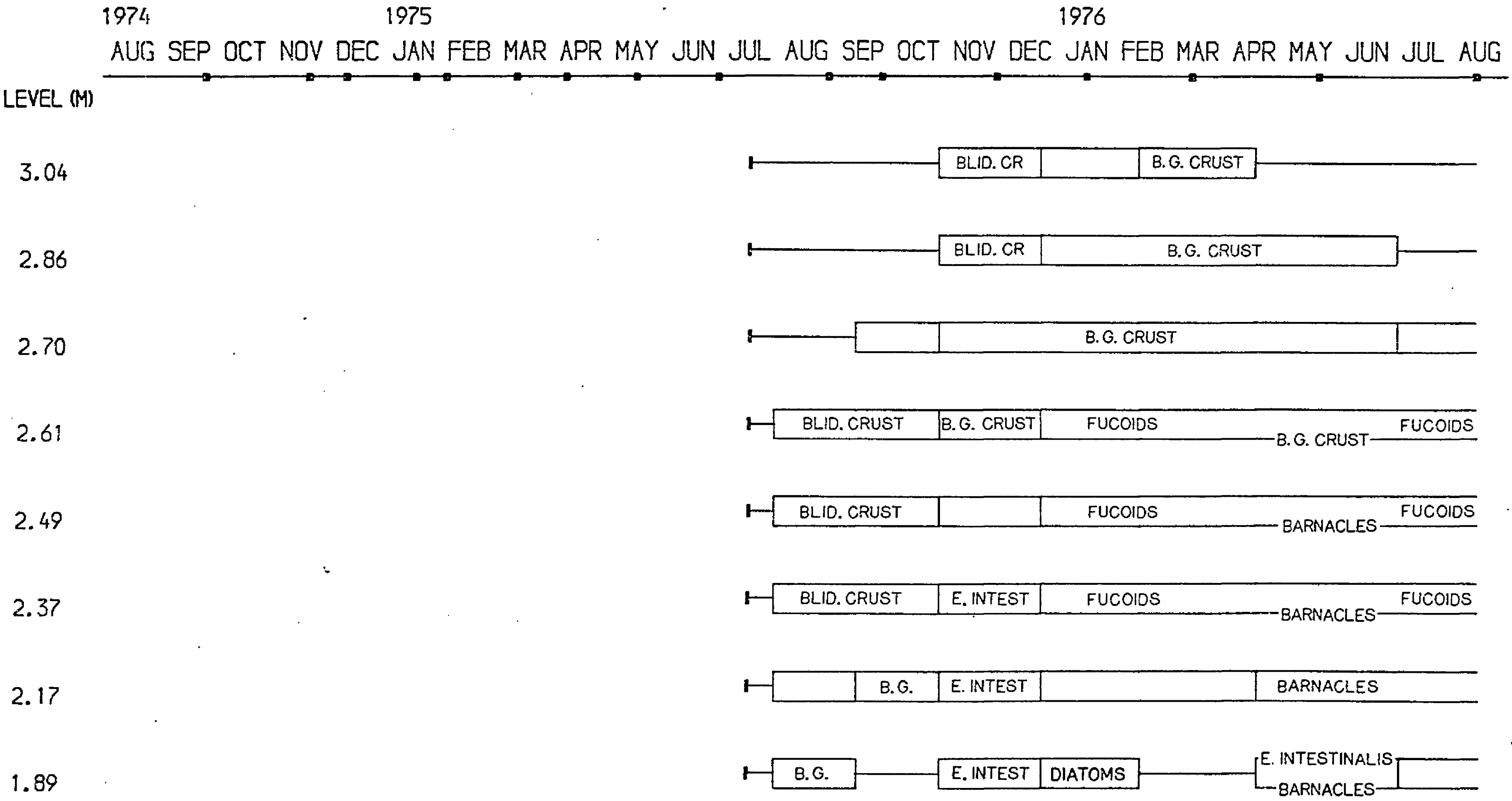

1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
B.G. CRUST
2.86
B.G. CRUST
2.70
B.G. CRUST
FUCOIDS
2.61
BLID. CR
B.G. CRUST
FUCOIDS
2.49
BARNACLES
BLID. CR
FUCOIDS
2.37
BARN
FUCOIDS
BLID. CRUST
2.17
BARNACLES
BLID. CR
FUCOIDS
BLID. CRUST
1.89
BARNACLES
BLID. CR
FUCOIDS
B.G. CRUST
FUCOIDS

STRIP 6



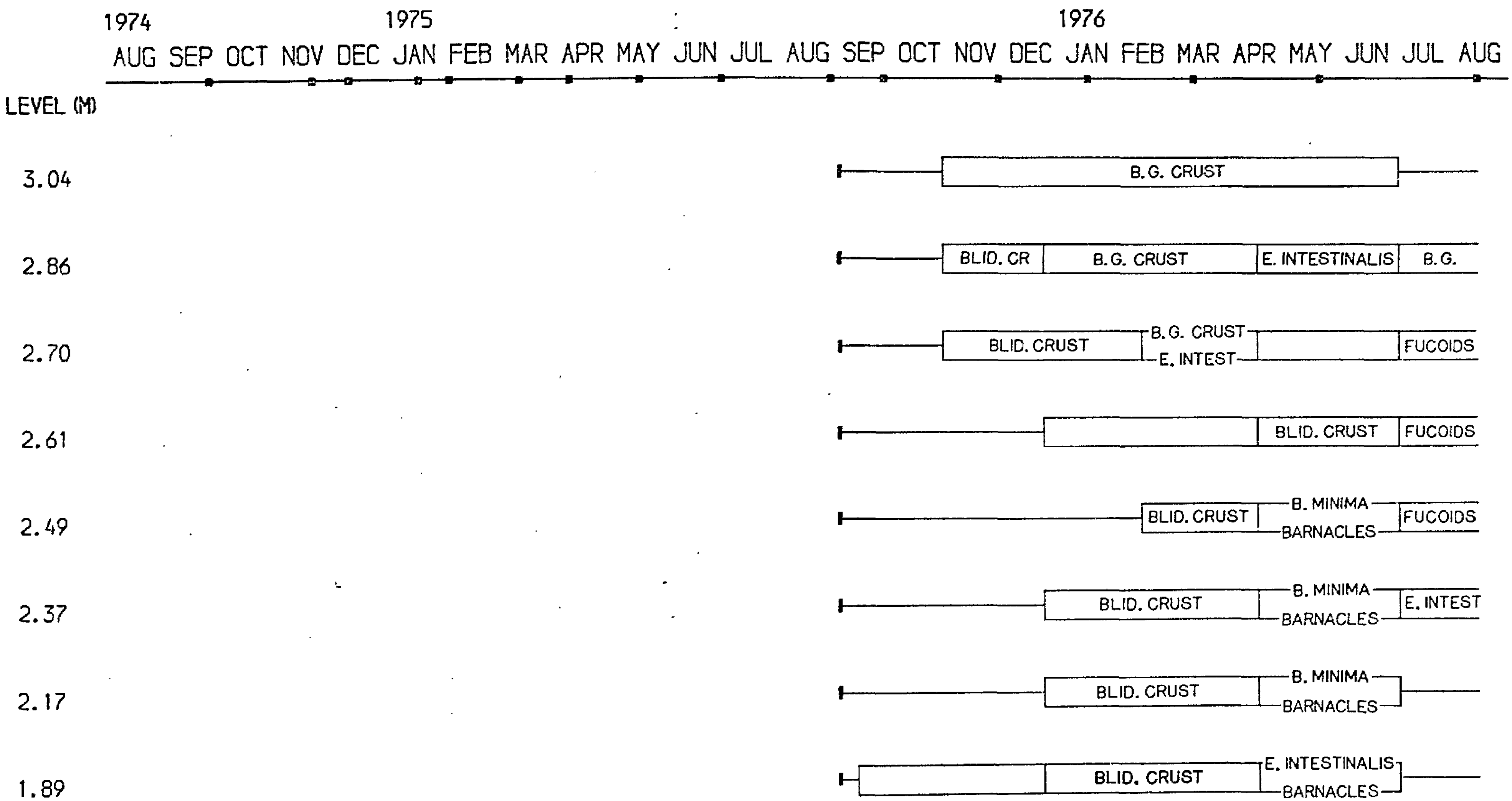
1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
B.G. CRUST
2.86
B.G. CRUST
2.70
FUCOIDS
2.61
C. FULV
FUCOIDS
F. SPIRALIS
2.49
C. FULV
FUCOIDS
F. SPIRALIS
BARNACLES
2.37
BLID. CR
FUCOIDS
F. SPIRALIS
BARNACLES
2.17
B. MINIMA
BLID. CR
FUCOIDS
F. SPIRALIS
BARNACLES
1.89
B. MINIMA
BLID. CR
FUCOIDS
BARNACLES

STRIP 7

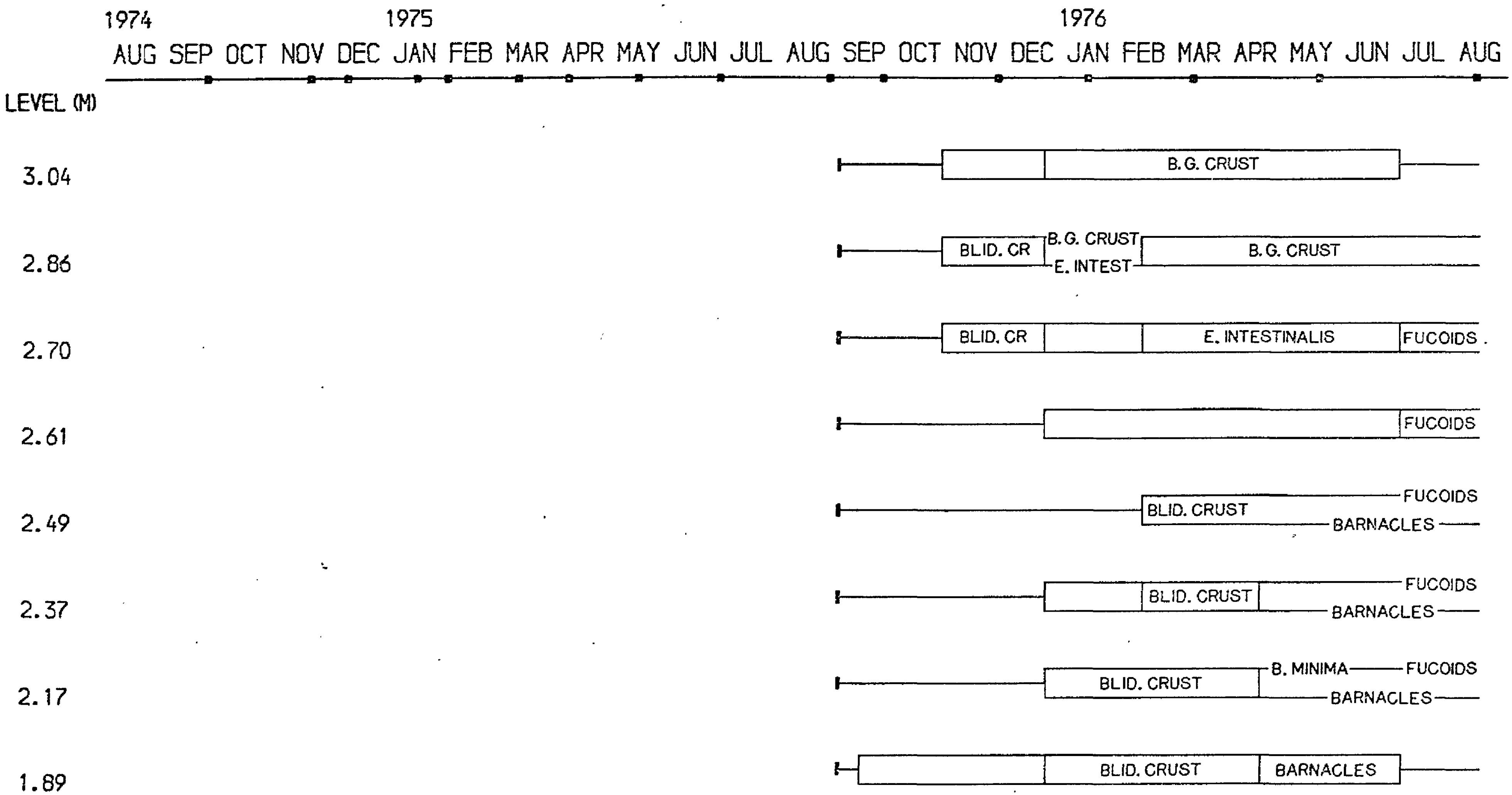


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
BLID. CR
B.G. CRUST
BLID. CR
B.G. CRUST
B.G. CRUST
BLID. CRUST
B.G. CRUST
FUCOIDS
B.G. CRUST
FUCOIDS
BLID. CRUST
FUCOIDS
BARNACLES
FUCOIDS
BLID. CRUST
E. INTEST
FUCOIDS
BARNACLES
FUCOIDS
B.G.
E. INTEST
BARNACLES
B.G.
E. INTEST
DIATOMS
E. INTESTINALIS
BARNACLES

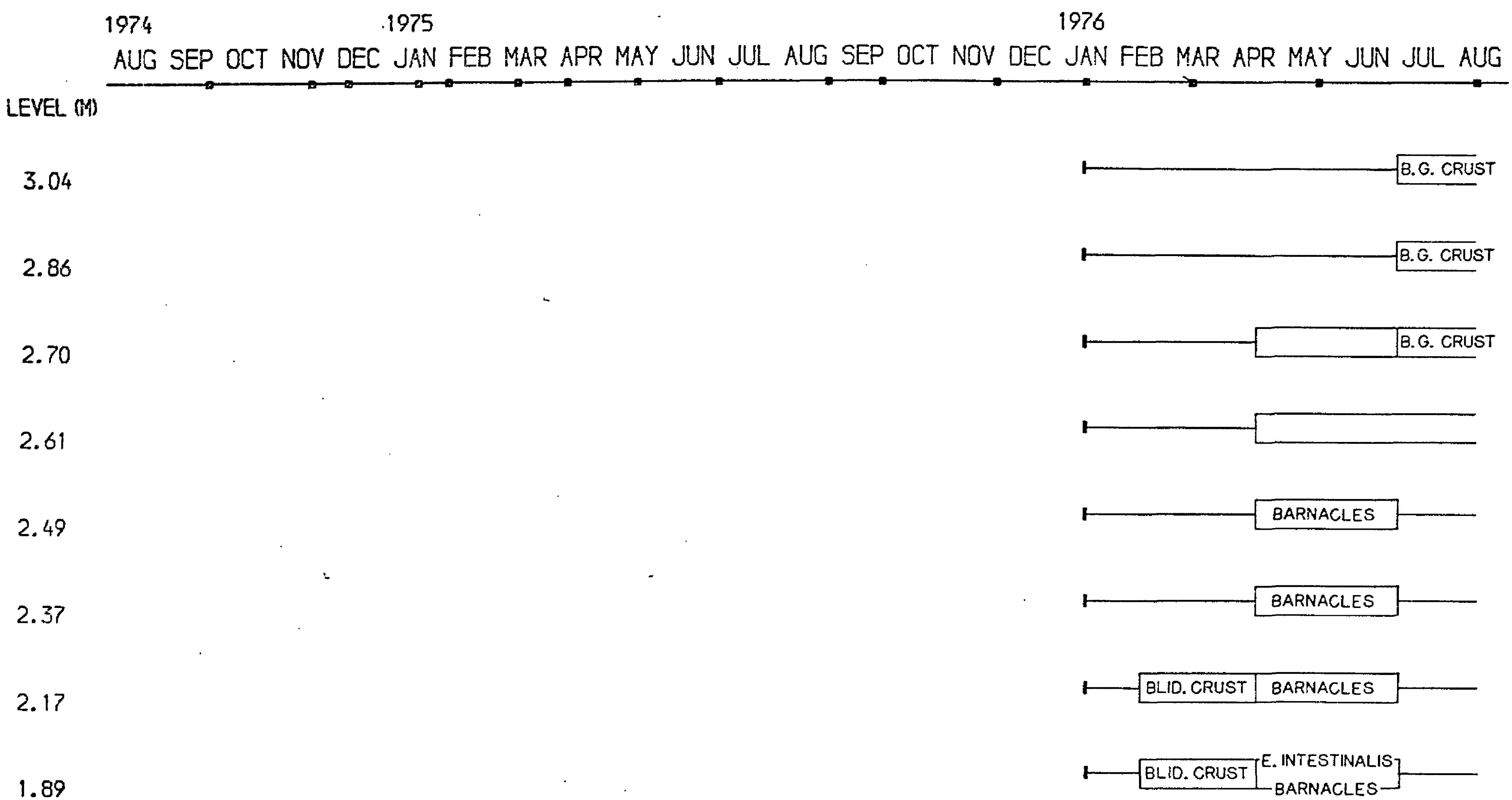
STRIP 8


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
B.G. CRUST
BLID. CR
B.G. CRUST
E. INTESTINALIS
B.G.
BLID. CRUST
B.G. CRUST
E. INTEST
FUCOIDS
BLID. CRUST
FUCOIDS
BLID. CRUST
B. MINIMA
BARNACLES
FUCOIDS
BLID. CRUST
B. MINIMA
BARNACLES
E. INTEST
BLID. CRUST
B. MINIMA
BARNACLES
BLID. CRUST
E. INTESTINALIS
BARNACLES

STRIP 9


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
B.G. CRUST
BLID. CR
B.G. CRUST
E. INTEST
B.G. CRUST
BLID. CR
E. INTESTINALIS
FUCOIDS
FUCOIDS
BLID. CRUST
FUCOIDS
BARNACLES
BLID. CRUST
FUCOIDS
BARNACLES
BLID. CRUST
B. MINIMA
FUCOIDS
BARNACLES
BLID. CRUST
BARNACLES

STRIP 10


1974
1975
1976
AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG
LEVEL (M)
3.04
2.86
2.70
2.61
2.49
2.37
2.17
1.89
B.G. CRUST
B.G. CRUST
B.G. CRUST
BARNACLES
BARNACLES
BLID. CRUST
BARNACLES
BLID. CRUST
E. INTESTINALIS
BARNACLES

STRIP 11

APPENDIX VIII: Matrices of the similarities between samples from the same level on a cleared strip and on the control.

Similarities are presented as percentage values and show the times at which populations in cleared strips came to resemble those in the control. The matrices are shown for strips 1-11; strips 1 - 7 returned to normal within the period of field observations.

*) low similarities resulting from separating fucoid germlings and *Fucus spiralis* in calculations.

STRIP: 11

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04									2	33	54
2.86									1	44	46
2.70									1	27	34
2.61									1	12	11
2.49									2	39	1
2.37									1	40	24
2.17									1	44	1
1.89									2	52	1

Comparison of STRIP 1 with control.

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04	43	11	36	14	45	23	100	67	100	89	100
2.86	12	14	1	12	15	33	24*	40*	91	57	100
2.70	11	1	0	1	13	50	93	76	94	63	93
2.61	13	1	0	10	25	77	69	89	100	91	100
2.49	1	0	1	11	1	44	78	89	82	100	92
2.37	0	0	18	31	12	1	64	95	90	90	99
2.17	–	–	–	40	41	11	82	61	92	88	82
1.89	0	1	21	39	52	15	91	73	94	76	78

STRIP: 2

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04	9	19	46	14	6	66	71	63	72	89	100
2.86	12	-	2	14	1	17	36*	17*	70	50	100
2.70	0	1	1	1	27	2	25*	21*	63	73	74
2.61	0	1	0	10	1	11	67	80	71	91	96
2.49	0	1	0	10	1	44	72	70	78	90	91
2.37	0	27	39	27	12	1	61	81	58	93	96
2.17	0	13	16	25	23	1	14	10	30	43	82
1.89	0	0	19	39	18	1	63	64	67	80	72

STRIP: 4

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04	12	18	20	15	2	2	62	75	59	82	66
2.86	15	18	1	13	1	25	29	21	60	25*	43
2.70	17	1	2	40	24	15	12	10	75	24*	62
2.61	22	1	0	12	38	1	8	12	75	76	76
2.49	0	0	0	22	1	20	17	12	12	84	64
2.37	0	0	1	32	3	2	16	23	21	89	39
2.17	20	1	16	48	21	1	19	32	25	74	80
1.89	1	1	16	47	15	0	29	20	27	61	84

STRIP: 5

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr.	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04			16	25	-	2	92	88	59	78	60
2.86			1	2	1	1	32	12	72	20*	65
2.70			1	1	21	19	18	8	82	22*	62
2.61			0	10	1	1	9	12	82	81	80
2.49			0	10	1	14	10	12	14	84	85
2.37			1	18	10	2	8	20	10	89	71
2.17			1	41.	12	1	11	10	22	76	66
1.89			1	38	17	2	1	12	1	66	0

STRIP: 6

LEVEL (m)	1975 10 Feb.	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04				1	-	2	93	63	62		
2.86				2	-	8	34	15	57		
2.70				1	0	1	14	14	70		
2.61				16	0	1	9	14	59		
2.49				31	1	1	9	10	25		
2.37				25	11	2	9	10	20		
2.17				32	22	1	11	8	28		
1.89				31	25	0	9	10	21		

STRIP: 7

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04						2	93	77	59	78	54
2.86						1	32	16	47	21*	54
2.70						26	13	9	75	19*	56
2.61						1	9	1	71	80	67
2.49						1	1	1	12	78	61
2.37						2	2	-	10	83	57
2.17						1	2	0	10	71	52
1.89						1	12	1	1	60	70

STRIP: 8

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04						2	12	50	67	19	75
2.86						1	11	16	53	27	67
2.70						1	13	9	24	21	80
2.61						0	8	1	70	9	10
2.49						1	1	1	1	35	9
2.37						1	0	1	1	37	15
2.17						-	12	0	13	52	23
1.89						1	1	1	1	64	40

STRIP: 9

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04							59	63	59	78	85
2.86							9	14	46	k7	55
2.70							11	11	21	21	66
2.61							22	1	43	8	10
2.49							1	1	14	31	26
2.37							1	12	12	33	25
2.17							1	0	11	41	17
1.89							1	1	1	49	29

STRIP: 10

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04							47	62	53	78	39
2.86							11	13	42	17	57
2.70							13	11	13	16	56
2.61							12	1	27	8	10
2.49							1	1	13	31	9
2.37							1	14	11	48	8
2.17							1	0	11	33	18
1.89							1	1	1	73	16

APPENDIX IX: Matrices of similarities between the 8 levels on the control when fucoid germlings are considered as Fucus spiralis in the calculations. The similarities are presented as percentage values.

3.04m	100							
2.86	40	100						
2.70	18	82	100					
2.61	10	40	56	100				
2.49	0	28	41	78	100			
2.37	0	58	73	50	64	100		
2.17	9	19	32	47	42	38	100	
1.89	1	11	13	54	59	32	63	100

10 February 1975

100							
19	100						
34	63	100					
50	40	50	100				
24	38	36	47	100			
19	44	42	41	62	100		
44	38	47	61	71	75	100	
29	10	18	23	53	39	53	100

30 June 1975

100							
57	100						
23	33	100					
1	15	75	100				
1	19	62	67	100			
1	14	59	73	50	100		
1	12	63	57	56	63	100	
1	17	43	37	61	47	63	100

28 August 1975

100							
89	100						
61	71	100					
13	24	57	100				
0	12	48	75	100			
0	11	44	84	84	100		
0	16	59	60	70	72	100	
0	13	50	52	61	56	74	100

14 August 1976

APPENDIX X : Culture medium

To 1 l of pasteurized seawater were added:

60ml of Solution A, which contained:

50 ml 0.4% $NaNO_3$ in distilled water

2 ml of each of the following

1.47 g/l $MnSO_4 \cdot 4H_2O$

0.0023 g/l - $CuSO_4 \cdot 5H_2O$

0.064 g/l - $CoCl \cdot 6H_2O$

0.23 g/l - $Na_2MoO_4 \cdot 2H_2O$

0.005 g/l - $LiCl \cdot H_2O$

2 ml of Solution B, which contained:

4.98 g/l $ZnSO_4 \cdot 7H_2O$

15 ml of Solution C, which contained:

2.6 g/l tretrasodium salt of EDTA

0.12 g/l - $FeSO_4 \cdot 7H_2O$

1.5 ml of Solution D, which contained:

15 g/l - $Na_2HPO_4 \cdot 12H_2O$

Each stock solution was autoclaved separated and stored in a refrigerator until use. The solutions were added to the pasteurized seawater using sterile techniques.

APPENDIX XI : Species colonizing glass slides placed on the shore for one week in 1975 and 1976.

Glass slides were left on the shore for the week following the date given in each table. Counts for the number of Blidingia minima, Enteromorpha sp., Ulothrix/Urospora sp., Ralfsia sp., and the creeping brown filaments are given in separate tables with the mean, standard deviation (S.D.), and the values in plants/mm^2 these represent. Counts were all made at a magnification of x400 unless otherwise specified. Plants not found in microscope fields but observed on the slide are noted as 'present'.

The last table summarizes the data for the distributions on slides of species with low abundances. Presence is noted by a '+', and plant densities are given when abundances were high enough to obtain counts.

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DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
6 April 1976	2.49m	A	open	1	4,3,3,4,2,4,3,3,1,4	3.1	(0.99)	19.5
				2	2,7,4,4,6,3,2,3,1,4	3.6	(1.84)	22.6
			covered	1	2,1,2,2,4,3,0,0,2,2	1.8	(1.23)	11.3
5 May 1976	2.36m	A	open	1	none found			
				2	none found			
		B	open	1	none found			
				2 (X100)	1,0,0,1,0,0,0,2,4,0	0.8		0.3
	2.49m	B	open	1	4,11,6,7,14,9,5,5,6,4	7.44	(3.28)	46.8
				2	5,3,3,3,2,2,6,0,4	3.11	(1.76)	19.6
		C	open	1	1,1,3,2,1,0,1,2,1,0,2,1,3,2	1.43	(0.97)	9.0
		C	covered	1	4,6,8,7,1,3,3,3,4	4.33	(2.24)	35.0
2 June 1976	2.86	A	open	1 (X100)	8,5,8,11,7,14,10,3,13,3	8.20	(4.94)	3.6
				2 (X100)	6,8,10,11,10,7,6,14,7,14	9.30	(3.02)	3.7
		B	open	1 (X100)	0,0,1,0,1,1,1,1,1,1	0.6		0.24
				2 (X100)	1,0,0,0,0,2,1,1,0,0	0.5		0.20
	2.49	B	open	1	18,15,15,10,17,10,12,16,14,10	13.7	(3.02)	86.2
				2	8,10,14,12,12,12,9,7,15,9,14	11.1	(2.66)	69.8
		C	covered	1	13,11,14,9,9,15,11,10,10	11.3	(2.18)	71.3
		C	open	1	1,4,1,3,2,2,2,2,1,2,2,4,3	2.23	(1.01)	14.0
				2	4,0,1,0,5,2,4,1,4,2,2	2,27	(1.74)	14.3
				3	2,4,5,2,3,3,2,5,0,3	2.90	(1.52)	18.2
				4	2,4,4,3,3,4,4,5,0,5	3.40	(1.51)	21.4

Blidingia minima

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN (S.D.)	DENSITY MM^2
2 June 1976	2.49m	D	covered	1	1,4,2,2,4,4,8,4,4,3	3.6 (1.90)	22.6
				2	3,6,2,6,3,3,4,3,6,1	3.7 (1.77)	23.3
				3	2,6,3,3,3,5,3,3,5,5	3.8 (1.32)	23.9
				4	4,7,3,7,5,6,10,7,5,4	5.8 (2.04)	36.5
5 July 1976	2.86m	A	open	1	6,3,3,3,4,8,6,1,4,4	4.2 (1.99)	26.4
	2.49m	B	covered	1	12,13,12,10,14,12,8,10,8	11.0 (2.12)	69.2
		C	covered	1	3,10,10,4,4,2,4,3,2,3	4.5 (2.99)	28.3
				2	4,4,7,5,3,7,9,5,7,8,6	5.9 (1.87)	37.2
6 Nov. 1976	2.49m	C	open	1	1,3,2,0,2,1,1,0,0,3,0,0	1.1	6.8
				2	0,0,0,1,0,0,1,4,0,0,0	0,6	3.4
				3	4,3,2,2,0,2,1,1,3,2	2.0 (1.15)	12.6
		C	covered	1	3,8,7,5,3,2,4,3,10,4	4.9 (2.60)	30.8
				2	5,3,5,4,6,2,5,9,3,5	4.7 (1.95)	29.6
				3	5,4,8,5,8,4,6,5,7,4	5.6 (1.58)	35.2
4 March 1977	2.49m	C	open	1	2,3,4,0,8,2,1,0,1,2,0,0,3,3,5,2,2,1,4,2	2.3 (1.97)	14.2
				2	2,1,0,2,2,1,1,1,3,4,1,1,2,3,2,0,0,1,1,1	1.5 (1.05)	9.1
				3	0,1,2,1,3,1,3,1,0,0,2,1,2,1,0,0,2,1,0,0	1.0 (1.03)	6.3

Blidingia minima

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
6 April 1976	2.49m	A	open	1	2,2,4,4,0,4,7,10,13,8	5.40	(4.03)	34.0
				2	0,2,3,5,7,4,0,0,0,3	2.40	(2.46)	18.2
			covered	1	0,0,0,0,3,0,0,0,0,0	0.3		1.9
5 May 1976	2.86m	A	open	1	none found			
				2	none found			
		B	open	1	none found			
				2	none found			
	2.49m	B	open	1	3,10,11,5,3,3,5,5,4	5.4	(3.00)	34.2
				2	3,3,4,0,0,6,5,0,1	2.4	(2.30)	15.4
		C	open	1	0,0,0,0,0,0,1,0,0,1,0,0,0,0,	0.14		0.9
		C	covered	1	0,0,2,0,4,0,2,1,1	1.1	(1.36)	7.0
2 June 1976	2.86	A	open	1 (X100)	3,0,3,0,4,3,0,0,1,0	1.3		0.5
				2 (X100)	0,4,0,0,3,0,6,0,1,0	1.4		0.6
		B	open	1	none found			
				2	none found			
	2.49	B	open	1 (X100)	3,4,2,0,1,2,3,	2.3	(1.49)	0.9
				2 (X100)	4,1,4,0,2,0,0,1,0	1.3	(1.66)	0.5
		C	covered	1 (X100)	5,10,4,3,8,2,7,3,5,8	5.5	(2.64)	2.2
		C	open	1	present			< 0.04
				2	present			< 0.04
				3	present			< 0.04
				4	present			< 0.04

Enteromorpha sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN (S.D.)	DENSITY MM^2
2 June	2.49m	D	covered	1	2,2,3,1,6,2,2,3,3,1	2.50 (1.43)	15.7
				2	3,3,2,5,3,2,3,2,3,6	3.2 (1.32)	20.1
				3	6,3,3,2,1,1,0,4,7,4	3.1 (2.23)	19.5
				4	3,4,1,3,4,7,2,4,1,3	3.2 (1.75)	20.1
5 July 1976	2.86m	A	open	1	none found		
	2.49m	B	covered	1	8,8,3,6,8,4,5,7,7,7 =	6.3 (1.77)	39.6
		C	covered	1	29,33,33,27,35,26,28	30.1 (3.48)	189.3
				2	26,29,20,21,25,27,21	24.1 (3.48)	151.6
6 Nov. 1976	2.49m	C	open	1 (X100)	0,2,0,0,0,0,0,0,1,1	0.4	0.16
				2 (X100)	0,0,0,0,1,0,0,0,0,0	0.1	0.04
				3 (X100)	0,1,1,0,0,0,0,0,0,1	0.3	0.12
		C	covered	1 (X100)	2,2,3,3,1,4,0,0,0,4	1.9 (1.60)	0.8
				2 (X100)	4,5,5,1,3,4,2,8,3,0	3.5 (2.27)	1.4
				3 (X100)	3,4,3,5,2,5,3,4,4,6	3.9 (1.20)	1.5
4 March 1977	2.49m	C	open	1	none found		
				2	none found		
				3	present		< 0.04

Enteromorpha sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE		COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
6 April 1976	2.49m	A	open	1		9,6,7,7,5,10,2,7,8,9	7.0	(2.31)	44.0
				2		10,10,10,5,8,9,1,9,7,9	7.8	(2.86)	49.0
			covered	1		2,7,6,6,2,4,4,3,2,3	3.9	(1.85)	24.5
5 May 1976	2.86m	A	open	1		present			< 0.04
				2		present			< 0.04
		B	open	1		present			< 0.04
				2	(X100)	0,0,0,1,0,0,0,0,0,0	0.1		0.04
	2.49m	B	open	1		3,6,8,11,8,7,3,2,4	5.8	(2.99)	36.3
				2		2,2,3,1,2,0,0,5,6	2.3	(2.06)	14.7
		C	open	1		0,0,0,0,0,0,0,0,3,2,1,0,1	0.54		3.1
		C	covered	1		0,1,0,0,1,0,0,1,0	0.33		2.1
2 June 1976	2.86	A	open	1	(X100)	0,1,3,5,0,1,1,1,1,0	1.3	(1.57)	0.5
				2	(X100)	4,1,3,0,0,0,1,0,1,0	1.0	(1.41)	0.4
		B	open	1	(X100)	1,0,0,0,0,0,0,0,1,0	0.2		0.08
				2	(X100)	3,0,0,1,1,0,0,1,1	0.8		0.3
	2.49	B	open	1		7,3,7,2,2,2,7,2,5,3	4.0	(2.26)	25.2
				2		4,4,1,2,2,3,1,3,6,3,4	3.0	(1.48)	18.9
		C	covered	1		4,5,4,7,3,6,4,2,0	4.0	(2.18)	25.2
		C	open	1		1,0,1,0,1,0,0,0,0,0,0,1,1	0.38		2.4
				2		1,0,0,0,1,0,0,1,0,0,0,	0.27		1.7
				3		1,1,1,1,0,1,0,0,0,1	0.60		3.8
				4		0,0,0,1,0,1,1,0,1,0	0.40		2.5

Ulothrix/Urospora sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN (S.D.)	DENSITY MM^2
2 June 1976	2.49m	D	covered	1	2,3,3,3,1,2,3,4,1,0	2.2 (1.23)	13.8
				2	1,3,3,5,4,3,2,2,2,3,4	2.8 (1.14)	17.6
				3	3,1,2,1,2,2,3,2,3,1	2.0 (0.82)	12.6
				4	4,4,3,3,4,4,1,3,4,2	3.2 (1.03)	20.1
5 July 1976	2.86m	A	open	1 (X100)	6,7,5,6,4,8,5,4,5,4	5.4 (1.35)	2.1
	2.49m	B	covered	1 (X100)	11,7,4,15,6,6,12,8,14,6	8.9 (3.81)	3.5
		C	covered	1 (X100)	7,3,10,8,3,14,5,11,4,9	7.4 (3.69)	2.9
				2 (X100)	7,6,9,9,4,8,4,12,7,7	7.3 (2.41)	2.9
6 Nov. 1976	2.49m	C	open	1 (X100)	1,1,0,0,0,0,0,0,0,0	0.2	0.08
				2 (X100)	1,0,0,0,0,0,2,0,0,0	0.3	0.12
				3 (X100)	0,2,1,0,0,0,0,0,0,0	0.3	0.12
		C	covered	1 (X100)	0,0,0,3,0,2,0,1,0,0	0.6	0.2
				2 (X100)	0,6,2,0,1,1,0,0,0,4	1.4	0.6
				3 (X100)	2,0,1,1,1,0,1,2,3,0	1.1	0.4
4 March 1977	2.49m	C	open	1	present		< 0.04
				2 (X100)	0,0,0,1,0,0,2,0,0,0	0.3	0.12
				3	present		< 0.04

<u>Ulothrix/Urospora sp.</u>

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN (S.D.)	DENSITY/MM²
6 April 1976	2.49m	A	open	1	none found		
				2	0,0,0,0,1,0,0,0,1,0		1.26
			covered	1	3,0,2,0,0,0,0,0,0		3.1
5 May 1976	2.86m	A	open	1	none found		
				2	none found		
		B	open	1	none found		
				2	none found		
	2.49m	B	open	1	none found		
				2	none found		
		C	open	1	none found		
			covered	1	0,0,0,1,0,0,0,0,0,0		0.7
2 June 1976	2.86m	A	open	1	none found		
				2	none found		
		B	open	1	none found		
				2	none found		
	2.49m	C	covered	1	(x100) 0,4,3,0,3,2,0,1,2,2	1.67 (1.50)	0.7
			open	1	none found		
				2	none found		
				3	none found		
				4	none found		

Ralfsia sp

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE		COUNTS/ FIELD	MEAN	(S.D.)	DENSITY/MM^2
2 June 1976	2.49m	D	covered	1	(x100)	10,11,4,1,5,3,3,4,1,7	4.9	(3.45)	1.93
				2	(x100)	1,3,1,6,3,4,3,4,3,1	2.9	(1.60)	1.1
				3	(x100)	4,7,4,4,6,1,7,8,4,9	5.4	(2.41)	2.1
				4	(x100)	1,4,2,1,5,6,4,1,2,1	2.7	(1.89)	1.1
5 July 1976	2.86m	A	open	1		none found			
	2.46m	B	covered	1		present			
		C	covered	1		present	no counts possible		
				2		present	Enteromorpha sp. too dense		
6 Nov 1976	2.49m	C	open	1		none found			
				2		none found			
				3		none found			
			Covered	1		1,0,0,0,2,1,1,1,1,0			4.4
				2		1,0,1,0,1,1,5,0,0,0			5.7
				3		4,2,2,0,1,5,1,3,0,2	2.0	(1.63)	12.6
4 March 1976	2.49m	C	open	1		none found			
				2		none found			
				3		none found			

Ralfsia sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
6 April 1976	2.49m	A	open	1	none found			
				2	0,0,0,0,0,0,0,1,0,0	0.1		0.6
			covered	1	present			
5 May 1976	2.86m	A	open	1	none found			
				2	none found			
		B	open	1	none found			
				2	none found			
	2.49m	B	open	1	none found			
				2	none found			
		C	open	1	present			
		C	covered	1	2,1,2,1,3,0,0,0,1	1.11	(1.05)	7
2 June 1976	2.86	A	open	1	none found found			
				2	none found			
		B	open	1	none found			
				2	none found			
	2.49	B	open	1	none found			
				2	none found			
		C	covered	1 (x100)	0,3,1,0,0,0,1,3,2,1	1.10	(1.20)	7
		C	open	1	none found			
				2	none found			
				3	none found			
				4	none found			

Brown, creeping, filamentous algae

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE		COUNTS/FIELD	MEAN (S.D.)	DENSITY MM^2
2 June 1976	2.49m	D	covered	1	(X100)	0,1,2,1,0,2,1,2,1,1	1.10 (0.74)	0.4
				2	(X100)	1,0,0,1,0,1,3,2,0,0	0.80 (1.03)	0.3
				3	(X100)	5,7,1,0,1,2,2,3,1,1	2.30 (2.16)	0.9
				4	(X100)	1,2,2,2,4,1,1,2,0,0	1.50 (1.18)	0.6
5 July 1976	2.86m	A	open	1		none found		
	2.49m	B	covered	1		present)	no counts possible	
		C	covered	1		present)	Enteromorpha sp. too dense	
				2		present)		
6 Nov. 1976	2.49m	C	open	1		None found		
				2		none found		
				3	(X100)	1,0,3,1,1,2,0,0,0,1	0.9 (0.99)	0.4
		C	covered	1		1,3,1,0,3,1,1,4,2,5	2.10 (1.60)	13.2
				2		7,2,3,1,1,2,1,3,1,2	2.30 (1.83)	14.5
				3		1,0,1,5,5,2,3,3,3,3	2.60 (1.65)	16.4
4 March 1977	2.49m	C	open	1		none found		
				2		none found		
				3		none found		

Brown, creeping, filamentous algae

APPENDIX VIII: Matrices of the similarities between samples from the same level on a cleared strip and on the control.

Similarities are presented as percentage values and show the times at which populations in cleared strips came to resemble those in the control. The matrices are shown for strips 1-11; strips 1 - 7 returned to normal within the period of field observations.

*) low similarities resulting from separating fucoid germlings and Fucus spiralis in calculations.

STRIP: 11

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04									2	33	54
2.86									1	44	46
2.70									1	27	34
2.61									1	12	11
2.49									2	39	1
2.37									1	40	24
2.17									1	44	1
1.89									2	52	1

Comparison of STRIP 1 with control.

LEVEL (m)	1975 10 Feb.	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04	43	11	36	14	45	23	100	67	100	89	100
2.86	12	14	1	12	15	33	24*	40*	91	57	100
2.70	11	1	0	1	13	50	93	76	94	63	93
2.61	13	1	0	10	25	77	69	89	100	91	100
2.49	1	0	1	11	1	44	78	89	82	100	92
2.37	0	0	18	31	12	1	64	95	90	90	99
2.17	-	-	-	40	41	11	82	61	92	88	82
1.89	0	1	21	39	52	15	91	73	94	76	78

STRIP: 2

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04	9	19	46	14	6	66	71	63	72	89	100
2.86	12	–	2	14	1	17	36*	17*	70	50	100
2.70	0	1	1	1	27	2	25*	21*	63	73	74
2.61	0	1	0	10	1	11	67	80	71	91	96
2.49	0	1	0	10	1	44	72	70	78	90	91
2.37	0	27	39	27	12	1	61	81	58	93	96
2.17	0	13	16	25	23	1	14	10	30	43	82
1.89	0	0	19	39	18	1	63	64	67	80	72

STRIP: 4

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04	12	18	20	15	2	2	62	75	59	82	66
2.86	15	18	1	13	1	25	29	21	60	25*	43
2.70	17	1	2	40	24	15	12	10	75	24*	62
2.61	22	1	0	12	38	1	8	12	75	76	76
2.49	0	0	0	22	1	20	17	12	12	84	64
2.37	0	0	1	32	3	2	16	23	21	89	39
2.17	20	1	16	48	21	1	19	32	25	74	80
1.89	1	1	16	47	15	0	29	20	27	61	84

STRIP: 5

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04			16	25	-	2	92	88	59	78	60
2.86			1	2	1	1	32	12	72	20*	65
2.70			1	1	21	19	18	8	82	22*	62
2.61			0	10	1	1	9	12	82	81	80
2.49			0	10	1	14	10	12	14	84	85
2.37			1	18	10	2	8	20	10	89	71
2.17			1	41.	12	1	11	10	22	76	66
1.89			1	38	17	2	1	12	1	66	0

STRIP: 6

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04				1	-	2	93	63	62		
2.86				2	-	8	34	15	57		
2.70				1	0	1	14	14	70		
2.61				16	0	1	9	14	59		
2.49				31	1	1	9	10	25		
2.37				25	11	2	9	10	20		
2.17				32	22	1	11	8	28		
1.89				31	25	0	9	10	21		

STRIP: 7

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04						2	93	77	59	78	54
2.86						1	32	16	47	21*	54
2.70						26	13	9	75	19*	56
2.61						1	9	1	71	80	67
2.49						1	1	1	12	78	61
2.37						2	2	-	10	83	57
2.17						1	2	0	10	71	52
1.89						1	12	1	1	60	70

STRIP: 8

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04						2	12	50	67	19	75
2.86						1	11	16	53	27	67
2.70						1	13	9	24	21	80
2.61						0	8	1	70	9	10
2.49						1	1	1	1	35	9
2.37						1	0	1	1	37	15
2.17						-	12	0	13	52	23
1.89						1	1	1	1	64	40

STRIP: 9

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04							59	63	59	78	85
2.86							9	14	46	k7	55
2.70							11	11	21	21	66
2.61							22	1	43	8	10
2.49							1	1	14	31	26
2.37							1	12	12	33	25
2.17							1	0	11	41	17
1.89							1	1	1	49	29

STRIP: 10

LEVEL (m)	1975 10 Feb	10 Mar	8 Apr	15 May	30 June	28 Aug	27 Nov	1976 15 Jan	12 Mar	19 May	14 Aug
3.04							47	62	53	78	39
2.86							11	13	42	17	57
2.70							13	11	13	16	56
2.61							12	1	27	8	10
2.49							1	1	13	31	9
2.37							1	14	11	48	8
2.17							1	0	11	33	18
1.89							1	1	1	73	16

APPENDIX IX: Matrices of similarities between the 8 levels on the control when fucoid germlings are considered as <u>Fucus spiralis</u> in the calculations. The similarities are presented as percentage values.

3.04m	100							
2.86	40	100						
2.70	18	82	100					
2.61	10	40	56	100				
2.49	0	28	41	78	100			
2.37	0	58	73	50	64	100		
2.17	9	19	32	47	42	38	100	
1.89	1	11	13	54	59	32	63	100

10 February 1975

100							
19	100						
34	63	100					
50	40	50	100				
24	38	36	47	100			
19	44	42	41	62	100		
44	38	47	61	71	75	100	
29	10	18	23	53	39	53	100

30 June 1975

100							
57	100						
23	33	100					
1	15	75	100				
1	19	62	67	100			
1	14	59	73	50	100		
1	12	63	57	56	63	100	
1	17	43	37	61	47	63	100

28 August 1975

100							
89	100						
61	71	100					
13	24	57	100				
0	12	48	75	100			
0	11	44	84	84	100		
0	16	59	60	70	72	100	
0	13	50	52	61	56	74	100

14 August 1976

APPENDIX X : Culture medium

To 1 l of pasteurized seawater were added:

60ml of Solution A, which contained:

50 ml 0.4% $NaNO_3$ in distilled water

2 ml of each of the following

1.47 g/l $MnSO_4 \cdot 4H_2O$

0.0023 g/l - $CuSO_4 \cdot 5H_2O$

0.064 g/l - $CoCl \cdot 6H_2O$

0.23 g/l - $Na_2MoO_4 \cdot 2H_2O$

0.005 g/l - $LiCl \cdot H_2O$

2 ml of Solution B, which contained:

4.98 g/l $ZnSO_4 \cdot 7H_2O$

15 ml of Solution C, which contained:

2.6 g/l tretrasodium salt of EDTA

0.12 g/l - $FeSO_4 \cdot 7H_2O$

1.5 ml of Solution D, which contained:

15 g/l - $Na_2HPO_4 \cdot 12H_2O$

Each stock solution was autoclaved separated and stored in a refrigerator until use. The solutions were added to the pasteurized seawater using sterile techniques.

APPENDIX XI : Species colonizing glass slides placed on the shore for one week in 1975 and 1976.

Glass slides were left on the shore for the week following the date given in each table. Counts for the number of *Blidingia minima*, *Enteromorpha* sp., *Ulothrix*/*Urospora* sp., *Ralfsia* sp., and the creeping brown filaments are given in separate tables with the mean, standard deviation (S.D.), and the values in plants/mm^2 these represent. Counts were all made at a magnification of x400 unless otherwise specified. Plants not found in microscope fields but observed on the slide are noted as 'present'.

The last table summarizes the data for the distributions on slides of species with low abundances. Presence is noted by a '+', and plant densities are given when abundances were high enough to obtain counts.

Contents	Page

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY / MM^2
6 April 1976	2.49m	A	open	1	4,3,3,4,2,4,3,3,1,4	3.1	(0.99)	19.5
				2	2,7,4,4,6,3,2,3,1,4	3.6	(1.84)	22.6
			covered	1	2,1,2,2,4,3,0,0,2,2	1.8	(1.23)	11.3
5 May 1976	2.36m	A	open	1	none found			
				2	none found			
		B	open	1	none found			
				2 (X100)	1,0,0,1,0,0,0,2,4,0	0.8		0.3
	2.49m	B	open	1	4,11,6,7,14,9,5,5,6,4	7.44	(3.28)	46.8
				2	5,3,3,3,2,2,6,0,4	3.11	(1.76)	19.6
		C	open	1	1,1,3,2,1,0,1,2,1,0,2,1,3,2	1.43	(0.97)	9.0
		C	covered	1	4,6,8,7,1,3,3,3,4	5.57		35.0
2 June 1976	2.86	A	open	1 (X100)	8,5,8,11,7,14,10,3,13,3	9.20	(4.94)	3.6
				2 (X100)	6,8,10,11,10,7,6,14,7,14	9.30	(3.02)	3.7
		B	open	1 (X100)	0,0,1,0,1,1,1,1,1,1	0.6		0.24
				2 (X100)	1,0,0,0,0,2,1,1,0,0	0.5		0.20
	2.49	B	open	1	18,15,15,10,17,10,12,16,14,10	13.7	(3.02)	86.2
				2	8,10,14,12,12,12,9,7,15,9,14	11.1	(2.66)	69.8
		C	covered	1	13,11,14,9,9,15,11,10,10	11.3	(2.18)	71.3
		C	open	1	1,4,1,3,2,2,2,2,1,2,2,4,3	2.23	(1.01)	14.0
				2	4,0,1,0,5,2,4,1,4,2,2	2,27	(1.74)	14.3
				3	2,4,5,2,3,3,2,5,0,3	2.90	(1.52)	18.2
				4	2,4,4,3,3,4,4,5,0,5	3.40	(1.51)	21.4

Blidingia minima

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN (S.D.)	DENSITY MM^2
2 June 1976	2.49m	D	covered	1	1,4,2,2,4,4,8,4,4,3	3.6 (1.90)	22.6
				2	3,6,2,6,3,3,4,3,6,1	3.7 (1.77)	23.3
				3	2,6,3,3,3,5,3,3,5,5	3.8 (1.32)	23.9
				4	4,7,3,7,5,6,10,7,5,4	5.8 (2.04)	36.5
5 July 1976	2.86m	A	open	1	6,3,3,3,4,8,6,1,4,4	4.2 (1.99)	26.4
	2.49m	B	covered	1	12,13,12,10,14,12,8,10,8	11.0 (2.12)	69.2
		C	covered	1	3,10,10,4,4,2,4,3,2,3	4.5 (2.99)	28.3
				2	4,4,7,5,3,7,9,5,7,8,6	5.9 (1.87)	37.2
6 Nov. 1976	2.49m	C	open	1	1,3,2,0,2,1,1,0,0,3,0,0	1.1	6.8
				2	0,0,0,1,0,0,1,4,0,0,0	0,6	3.4
				3	4,3,2,2,0,2,1,1,3,2	2.0 (1.15)	12.6
		C	covered	1	3,8,7,5,3,2,4,3,10,4	4.9 (2.60)	30.8
				2	5,3,5,4,6,2,5,9,3,5	4.7 (1.95)	29.6
				3	5,4,8,5,8,4,6,5,7,4	5.6 (1.58)	35.2
4 March 1977	2.49m	C	open	1	2,3,4,0,8,2,1,0,1,2,0,0,3,3,5,2,2,1,4,2	2.3 (1.97)	14.2
				2	2,1,0,2,2,1,1,1,3,4,1,1,2,3,2,0,0,1,1,1	1.5 (1.05)	9.1
				3	0,1,2,1,3,1,3,1,0,0,2,1,2,1,0,0,2,1,0,0	1.0 (1.03)	6.3

Blidingia minima

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
6 April 1976	2.49m	A	open	1	2,2,4,4,0,4,7,10,13,8	5.40	(4.03)	34.0
				2	0,2,3,5,7,4,0,0,0,3	2.40	(2.46)	18.2
			covered	1	0,0,0,0,3,0,0,0,0,0	0.3		1.9
5 May 1976	2.86m	A	open	1	none found			
				2	none found			
		B	open	1	none found			
				2	none found			
	2.49m	B	open	1	3,10,11,5,3,3,5,5,4	5.4	(3.00)	34.2
				2	3,3,4,0,0,6,5,0,1	2.4	(2.30)	15.4
		C	open	1	0,0,0,0,0,0,1,0,0,1,0,0,0,0,	0.14		0.9
		C	covered	1	0,0,2,0,4,0,2,1,1	1.1	(1.36)	7.0
2 June 1976	2.86	A	open	1 (X100)	3,0,3,0,4,3,0,0,1,0	1.3		0.5
				2 (X100)	0,4,0,0,3,0,6,0,1,0	1.4		0.6
		B	open	1	none found			
				2	none found			
	2.49	B	open	1 (X100)	3,4,2,0,1,2,3,	2.3	(1.49)	0.9
				2 (X100)	4,1,4,0,2,0,0,1,0	1.3	(1.66)	0.5
		C	covered	1 (X100)	5,10,4,3,8,2,7,3,5,8	5.5	(2.64)	2.2
		C	open	1	present			< 0.04
				2	present			< 0.04
				3	present			< 0.04
				4	present			< 0.04

Enteromorpha sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN (S.D.)	DENSITY MM^2
2 June 1976	2.49m	D	covered	1	2,2,3,1,6,2,2,3,3,1	2.50 (1.43)	15.7
				2	3,3,2,5,3,2,3,2,3,6	3.2 (1.32)	20.1
				3	6,3,3,2,1,1,0,4,7,4	3.1 (2.23)	19.5
				4	3,4,1,3,4,7,2,4,1,3	3.2 (1.75)	20.1
5 July 1976	2.86m	A	open	1	none found		
	2.49m	B	covered	1	8,8,3,6,8,4,5,7,7,7 =	6.3 (1.77)	39.6
		C	covered	1	29,33,33,27,35,26,28	30.1 (3.48)	189.3
				2	26,29,20,21,25,27,21	24.1 (3.48)	151.6
6 Nov. 1976	2.49m	C	open	1 (X100)	0,2,0,0,0,0,0,0,1,1	0.4	0.16
				2 (X100)	0,0,0,0,1,0,0,0,0,0	0.1	0.04
				3 (X100)	0,1,1,0,0,0,0,0,0,1	0.3	0.12
		C	covered	1 (X100)	2,2,3,3,1,4,0,0,0,4	1.9 (1.60)	0.8
				2 (X100)	4,5,5,1,3,4,2,8,3,0	3.5 (2.27)	1.4
				3 (X100)	3,4,3,5,2,5,3,4,4,6	3.9 (1.20)	1.5
4 March 1977	2.49m	C	open	1	none found		
				2	none found		
				3	present		< 0.04

Enteromorpha sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
6 April 1976	2.49m	A	open	1	9,6,7,7,5,10,2,7,8,9	7.0	(2.31)	44.0
				2	10,10,10,5,8,9,1,9,7,9	7.8	(2.86)	49.0
			covered	1	2,7,6,6,2,4,4,3,2,3	3.9	(1.85)	24.5
5 May 1976	2.86m	A	open	1	present			< 0.04
				2	present.			< 0.04
		B	open	1	present			< 0.04
				2 (X100)	0,0,0,1,0,0,0,0,0,0	0.1		0.04
	2.49m	B	open	1	3,6,8,11,8,7,3,2,4	5.8	(2.99)	36.3
				2	2,2,3,1,2,0,0,5,6	2.3	(2.06)	14.7
		C	open	1	0,0,0,0,0,0,0,0,3,2,1,0,1	0.54		3.1
		C	covered	1	0,1,0,0,1,0,0,1,0	0.33		2.1
2 June 1976	2.86	A	open	1 (X100)	0,1,3,5,0,1,1,1,1,0	1.3	(1.57)	0.5
				2 (X100)	4,1,3,0,0,0,1,0,1,0	1.0	(1.41)	0.4
		B	open	1 (X100)	1,0,0,0,0,0,0,0,1,0	0.2		0.08
				2 (X100)	3,0,0,1,1,0,0,1,1	0.8		0.3
	2.49	B	open	1	7,3,7,2,2,2,7,2,5,3	4.0	(2.26)	25.2
				2	4,4,1,2,2,3,1,3,6,3,4	3.0	(1.48)	18.9
		C	covered	1	4,5,4,7,3,6,4,2,0	4.0	(2.18)	25.2
		C	open	1	1,0,1,0,1,0,0,0,0,0,0,1,1	0.38		2.4
				2	1,0,0,0,1,0,0,1,0,0,0,	0.27		1.7
				3	1,1,1,1,0,1,0,0,0,1	0.60		3.8
				4	0,0,0,1,0,1,1,0,1,0	0.40		2.5

Ulothrix/Urospora sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
2 June 1976	2.49m	D	covered	1	2,3,3,3,1,2,3,4,1,0	2.2	(1.23)	13.8
				2	1,3,3,5,4,3,2,2,2,3,4	2.8	(1.14)	17.6
				3	3,1,2,1,2,2,3,2,3,1	2.0	(0.82)	12.6
				4	4,4,3,3,4,4,1,3,4,2	3.2	(1.03)	20.1
5 July 1976	2.86m	A	open	1 (X100)	6,7,5,6,4,8,5,4,5,4	5.4	(1.35)	2.1
	2.49m	B	covered	1 (X100)	11,7,4,15,6,6,12,8,14,6	8.9	(3.81)	3.5
		C	covered	1 (X100)	7,3,10,8,3,14,5,11,4,9	7.4	(3.69)	2.9
				2 (X100)	7,6,9,9,4,8,4,12,7,7	7.3	(2.41)	2.9
6 Nov. 1976	2.49m	C	open	1 (X100)	1,1,0,0,0,0,0,0,0,0	0.2		0.08
				2 (X100)	1,0,0,0,0,0,2,0,0,0	0.3		0.12
				3 (X100)	0,2,1,0,0,0,0,0,0,0	0.3		0.12
		C	covered	1 (X100)	0,0,0,3,0,2,0,1,0,0	0.6		0.2
				2 (X100)	0,6,2,0,1,1,0,0,0,4	1.4		0.6
				3 (X100)	2,0,1,1,1,0,1,2,3,0	1.1		0.4
4 March 1977	2.49m	C	open	1	present			< 0.04
				2 (X100)	0,0,0,1,0,0,2,0,0,0	0.3		0.12
				3	present			< 0.04

Ulothrix/Urospora sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN (S.D.)	DENSITY/MM^2
6 April 1976	2.49m	A	open	1	none found		
				2	0,0,0,0,1,0,0,0,1,0		1.26
			covered	1	3,0,2,0,0,0,0,0,0		3.1
5 May 1976	2.86m	A	open	1	none found		
				2	none found		
		B	open	1	none found		
				2	none found		
	2.49m	B	open	1	none found		
				2	none found		
		C	open	1	none found		
			covered	1	0,0,0,1,0,0,0,0,0,0		0.7
2 June 1976	2.86m	A	open	1	none found		
				2	none found		
		B	open	1	none found		
				2	none found		
	2.49m	C	covered	1	(x100) 0,4,3,0,3,2,0,1,2,2	1.67 (1.50)	0.7
			open	1	none found		
				2	none found		
				3	none found		
				4	none found		

Ralfsia sp

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE		COUNTS/ FIELD	MEAN	(S.D.)	DENSITY/MM^2
2 June 1976	2.49m	D	covered	1	(x100)	10,11,4,1,5,3,3,4,1,7	4.9	(3.45)	1.93
				2	(x100)	1,3,1,6,3,4,3,4,3,1	2.9	(1.60)	1.1
				3	(x100)	4,7,4,4,6,1,7,8,4,9	5.4	(2.41)	2.1
				4	(x100)	1,4,2,1,5,6,4,1,2,1	2.7	(1.89)	1.1
5 July 1976	2.86m	A	open	1		none found			
	2.46m	B	covered	1		present			
		C	covered	1		present	no counts possible		
				2		present	Enteromorpha sp. too dense		
6 Nov 1976	2.49m	C	open	1		none found			
				2		none found			
				3		none found			
			Covered	1		1,0,0,0,2,1,1,1,1,0			4.4
				2		1,0,1,0,1,1,5,0,0,0			5.7
				3		4,2,2,0,1,5,1,3,0,2	2.0	(1.63)	12.6
4 March 1976	2.49m	C	open	1		none found			
				2		none found			
				3		none found			

Ralfsia sp.

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	COUNTS/FIELD	MEAN	(S.D.)	DENSITY MM^2
6 April 1976	2.49m	A	open	1	none found			
				2	0,0,0,0,0,0,0,1,0,0	0.1		0.6
			covered	1	present			
5 May 1976	2.86m	A	open	1	none found			
				2	none found			
		B	open	1	none found			
				2	none found			
	2.49m	B	open	1	none found			
				2	none found			
		C	open	1	present			
		C	covered	1	2,1,2,1,3,0,0,0,1	1.11	(1.05)	7
2 June 1976	2.86	A	open	1	none found			
				2	none found			
		B	open	1	none found			
				2	none found			
	2.49	B	open	1	none found			
				2	none found			
		C	covered	1 (x100)	0,3,1,0,0,0,1,3,2,1	1.10	(1.20)	7
		C	open	1	none found			
				2	none found			
				3	none found			
				4	none found			

Brown, creeping, filamentous algae

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE		COUNTS/FIELD	MEAN (S.D.)	DENSITY MM^2
2 June 1976	2.49m	D	covered	1	(X100)	0,1,2,1,0,2,1,2,1,1	1.10 (0.74)	0.4
				2	(X100)	1,0,0,1,0,1,3,2,0,0	0.80 (1.03)	0.3
				3	(X100)	5,7,1,0,1,2,2,3,1,1	2.30 (2.16)	0.9
				4	(X100)	1,2,2,2,4,1,1,2,0,0	1.50 (1.18)	0.6
5 July 1976	2.86m	A	open	1		none found		
	2.49m	B	covered	1		present)	no counts possible	
		C	covered	1		present)	Enteromorpha sp. too dense	
				2		present)		
6 Nov. 1976	2.49m	C	open	1		None found		
				2		none found		
				3	(X100)	1,0,3,1,1,2,0,0,0,1	0.9 (0.99)	0.4
		C	covered	1		1,3,1,0,3,1,1,4,2,5	2.10 (1.60)	13.2
				2		7,2,3,1,1,2,1,3,1,2	2.30 (1.83)	14.5
				3		1,0,1,5,5,2,3,3,3,3	2.60 (1.65)	16.4
4 March 1977	2.49m	C	open	1		none found		
				2		none found		
				3		none found		

Brown, creeping, filamentous algae

DATE	LEVEL	LOCATION	EXPOSURE	SLIDE	Blue-green algae	Prasiola stipitata	Monostroma oxyspermum	Capsosiphon fulvescens	Cladophora rupestris	Litosiphon filiformis	Ectocarpus sp.	Fucoid germlings	Porphyra sp.	Red cr (Gigartina or Petrocelis)
6 April 1976	2.49m	A	open	1										
				2										
			covered	1						+	0.12/mm^2			
5 May 1976	2.86m	A	open	1										
				2										
		B	open	1	1.57/mm^2									
				2	0.16/mm^2									
	2.49m	B	open	1			0.63/mm^2							
				2			2.30/mm^2							
		C	open	1										
				2										
		C	covered	1					0.21/mm^2					
2 June 1976	2.86m	A	open	1	+			+						
				2				0.20/mm^2						
		B	open	1	+									
				2										
	2.49m	B	open	1										
				2										
		C	covered	1				+	+		0.43/mm^2			
		C	open	1				+						
				3				+						
				4				+						
2 June 1976	2.49m	D	covered	1							0.08/mm^2			
				2							0.04/mm^2			
				3							0.20/mm^2			
				4							0.12/mm^2			
5 July 1976	2.86m	A	open	1		+	+							
	2.49m	B	covered	1				+				+		
		C	covered	1								0		
				2								+		
6 Nov. 1976	2.49m	C	open	1										
				2										
				3										
		C	covered	1							+			
				2							+			
				3							+			
4 March 1977	2.49	C	open	1	0.42/mm^2									
				2	1.57/mm^2									
				3	2.20/mm^2									

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CODE LIST FOR SPECIES NAMES

100 - Audouinella sp.
201 - Spongomorpha arcta
402 - Blidingia marginata
403 - Blidingia minima
701 - Capsosiphon fulvescens
903 - Chaetomorpha melagonium
1301 - Cladophora albida
1314 - " rupestris
1315 - " sericea
1401 - Codiolum gregarium
1402 - Codiolum petrocelidis
1804 - Enteromorpha flexuosa
1805 - " intestinalis
1807 - " linza
1808 - " prolifera
2205 - Monostroma oxyspermum
2501 - Percursaria percursa
2802 - Prasiola stipitata
3001 - Pseudendoclonium submarinum
3303) 3305) - Rhizoclonium riparium
3401 - Rosenvingiella polyrhiza
4001 - Ulothrix conscociata
4002 - " flacca
4003 - " pseudoflacca
4101 - Ulva lactuca
4201 - Ulvella lens
430. - Urospora penicilliformis
4401 - Prasinocladus marinus
5001 - Ascophyllum nodosum
7500 - Ectocarpus sp.
7602 - Elachista fucicola
8000 - fucoid germlings
8004 - Fucus spiralis
8100 - Giffordia/Pilayella sp.
8501 - Halothrix lumbricalis
9201 - creeping brown filaments
9901 - Litosiphon filiformis
10901 - Pelvetia canaliculata
11805 - Ralfsia verrucosa
12505 - Sphacelaria fusca
13003 - Stictyosiphon tortilis
16321 - Ceramium shuttleworthianum
20003 - Gigartina stellata
21702 - Hildenbrandia rubra
24101 - Petrocelis cruenta
25303 - Porphyra linearis
25306 - " umbilicalis
26202 - Audouinella purpurea
27800 - Blue-green algal crust
29800 - Rivularia sp.
40000 - Blidingia crust
40100) 40200) - unidentified green crusts
41000 - Lichina sp.
50000 - Balanus balanoides
51000 - Halichondria panicea
52000 - Hymeniacidon perlevis
55000 - Mytilidae
60000 - Verrucaria sp.