G. M. SELBY & ASSOCIATES, INC.

SUNNY ISLES ARTIFICIAL REEF MODULE MONITORING PROGRAM

FIRST ANNUAL REPORT 1991/92

PREPARED FOR DADE COUNTY
DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT
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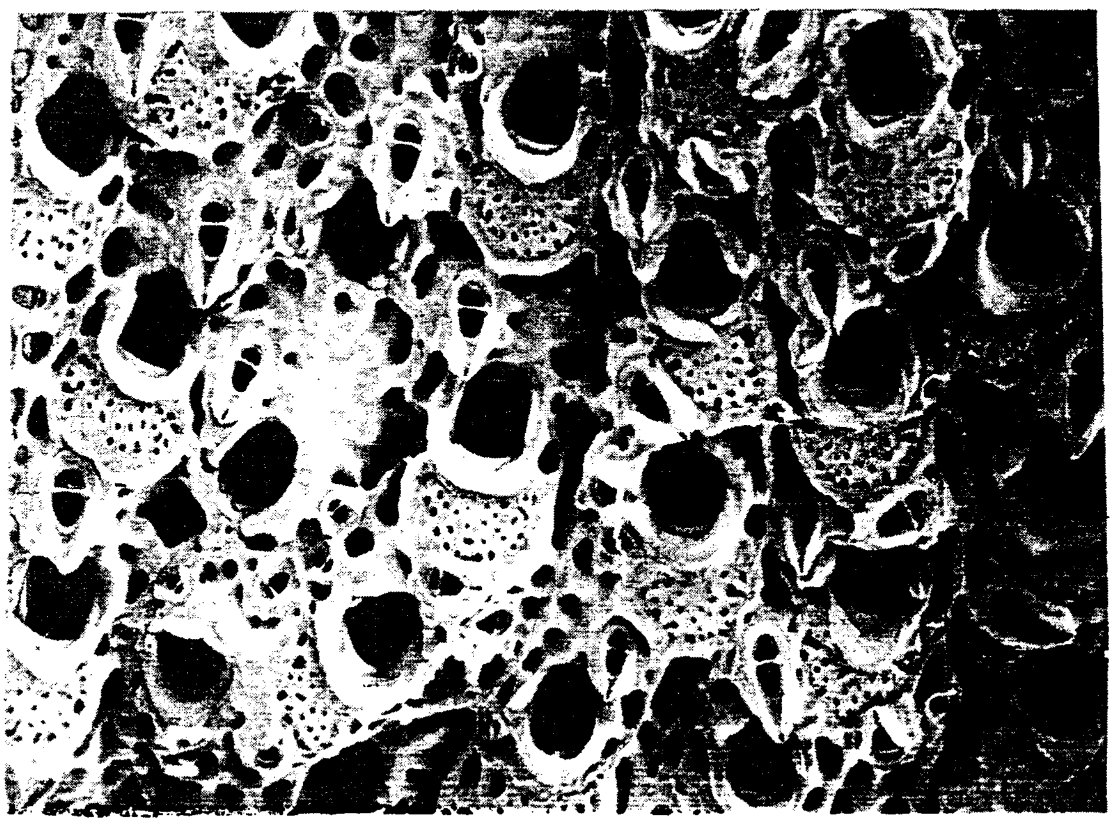

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;00 S. Dadeland Blvd., Suite 705, Miami, Florida 33156
: (305) 670-2216 Fax: (305) 670-3024

478 Ballard Drive, Suite 2, Melbourne, Florida 32935
Tel: (407) 253-0665 Fax: (407) 254-3118

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NOTE: FRONT COVER PHOTOGRAPH
Scanning electron microscope photograph of the Bryazoan parasmittina sp., commonly found on the artificial reef modules off Sunny Isles, Florida.

1. FISHES AND MOTILE INVERTEBRATES

Methods

Data Collection Methods

On 21 and 22 August 1992 total counts of fishes and motile invertebrates were made on 31 artificial reef modules of three different designs. Eleven rough surfaced dome - type modules (D18, 19, 20, 21, 22, 25, 30, 34, 43, 49, 50), ten shed-roof-type modules (M1, 2, 3, 4, 5, 6, 7, 8, 9, 10) and ten replacement modules (R2, 4, 7, 14, 15, 16, 17, 21, 22, 23) were sampled. Thirty-one reference or background sites were also sampled. Each module had a corresponding reference site located 10-15 m in a randomly selected direction from the module. If the selected direction and distance put the reference site within 10-15m of an adjacent module or over sand, the direction was shifted clockwise in 45 degree increments until no interference with sand habitat or other modules resulted. At each module (D, M, R) and control site (C), two divers simultaneously surveyed each site by approaching within 3 m. One diver videotaped while swimming around the site at the prescribed distance, while the other diver remained stationary and recorded fishes and motile invertebrates. After one complete revolution around the site, both divers moved closer and searched for animals in niches and caves in the site. Fish size was estimated by comparison to meter sticks with 20 cm tee bars attached (cm SL). As with the modules, control site sample areas were considered to be cylinders of 7-8m in diameter extending from the substrate to the surface. Control sites were also sampled in the same manner as the modules (see methods in the first report, Nov. 1991). Video and written records were later compared and combined to provide the final data set for each site.

The data sheets were designed to include the reference site data with the corresponding module data. The headings N-M and N-C refer to the number of fishes on the module, and the numbers at the reference (control) site, respectively. The designations SL-M and SL-C refer to the estimated standard length of fishes on the module and the estimated standard length of fishes on the reference site, respectively. The direction of the reference site from the module is indicated next to the heading N-C. Standard length is a basic ichthyological measurement which is defined as the distance from the tip of the snout to the end of the last vertebra, excluding the caudal or tail fin.

Statistical Methods

A. Standard Parametric Analyses of Study Sites.

One way analysis of variance (ANOVA) was performed on the four site types (D, M, R, and C, with samples sizes of 11, 10, 10, and 31, respectively) using both number of individuals per site and number of species per site as the data.
T-tests (independent samples) were performed on each combination of site types to determine which site types were significantly different in mean numbers of fishes and mean number of species per site type (with means based upon sample sizes of 11, 10, 10, and 31 respectively). In all cases, the spiny lobster (Panulirus argus) and the banded coral shrimp (Stenopus hispidus) were excluded from these tests. In order to determine whether there

was a correlation between a control site and its most proximate module, the following procedures were employed:

1. The controls were evaluated by One-way ANOVA subdivided into groups by module types.
2. The correlation matrix of all controls was compared to the correlation matrix of all modules using Mantel's normalized Z test (Rohlf, 1988). The Z score was tested by the Mantel's approximate t-test to determine whether there was a significant correlation between a control site and its nearest module.

B. Diversity Indices

Shannon-Weiner Diversity indexes (H, using logarithm to the base ten) were calculated for each site type based on both the number of species and the number of individuals per species). While evenness and dominance values will be readily employed in the future they are not given major importance in the report below, since it will take more time before such measures will permit effective evaluation of the community associations. The spiny lobster (Panulirus argus) and banded coral shrimp (Stenopus hispidus) were not included.

C. Multivariate Analyses of Sites and Taxa

The multivariate techniques used in the following analyses are Cluster Analysis, Principal Component Analyses (PCA), and Matrix Comparison (Gauch, 1982; Pielou, 1988). Cluster Analyses and Principal Component Analysis (PCA) were performed on the

correlation matrices of sites and taxa. The PCAs were performed using the matrices to generate eigenvalues and eigenvectors (scaled as square roots, SQRT LAMBDA, Pielou, 1984; Rohlf, 1988). PCA's were performed for both the rows and columns, i.e. the sites and the species, as the OTU's (outstanding taxonomic characteristics). In some instances, the cluster analyses are not included because they are very vague, i.e. the great number of taxa and sites makes interpretation very difficult.
The following conventions were followed:

1. Initial analyses, using all fish species, were done on controls and modules separately. This permitted comparison of community association in control environments in comparison to the treatments. This choice was justified by both ANOVA, and Mantel's tests, the results of which demonstrated no significant differences among the controls regardless of their associations with module types (see below, under Results).
2. In all cases, only fish species that actually occurred in the data sets were analyzed (i.e. species never found at any locations were excluded).
3. All analyses used Pearson product-moment correlation coefficients (r) for the similarity matrices. The same correlation matrices were used in Mantel's test comparing controls and modules, (see Methods, above) and in comparing between sampling periods.
4. In the scaled-down analyses of the fish species, the

control sites were analyzed together with the three module types. The data were standardized (as percent of total fishes per site) to eliminate the effect of unequal sample sizes (n=11, 10, 10, 31 for D, M, R, and C, respectively).

D. Comparisons Between May and August Samplings

One-way ANOVAs were used to test for differences in the mean number of individuals and the mean number of species at a site type (D, M, R, or C) between the May and August sampling periods. The similarity matrix (see #3, previous section) of each site type during the August sampling period was compared to the similarity matrix for that site type for the previous sampling by Mantel's Z.

RESULTS

Descriptive Results

The same patterns of module and reef fish association were noted during this sampling period, compared to the previous quarter. That is, grunts, snapper, surgeon fishes, butterfly fishes, and parrot fishes maintain a loose association with the modules whereas angel fishes, some groupers, soapfishes, jacknife fishes, damsel fishes, wrasses, and hamlets were tightly associated with the modules. In addition, larger individuals of all species generally leave the modules when disturbed by the divers during the close examination phase of the survey. The only exceptions to this general pattern was that of the nurse shark and moray eel. These fish when observed were always wedged alongside or underneath the modules and were generally reluctant to leave even when disturbed. Large invertebrates such as spiny lobster also retreated deeper into the modules when approached.

The differences we noted during our other trips between the fish fauna associated with the modules relative to the fish fauna associated with the surrounding hard bottom areas were essentially the same with few exceptions during the August survey. Reference areas typically had a number of bluehead wrasses and bicolor damselfishes with one or two harlequin basses, tobaccofish and/or sharpnose puffers. Occasionally there were larger species such as squirrelfish or scorpionfish but the size range of the typical reef flat inhabitants was small. Exceptions to this pattern were noted at reference sites for modules D20, D25, R15, and R22 where there were relatively large numbers of bluestripe grunts. As discussed below, these fish were in the area of several sets of modules and readily moved when approached by divers. We recorded them because they were in the reference area; however, our activities around the modules during the surveys undoubtedly displaced them from the immediate area of the modules. The same was true for the greater amberjack observed over module R22. These fish move over the modules and the surrounding reef in small schools but rarely stay for more than a few seconds.

Mixed schools of bluestripe grunts and white grunts with loosely associated gray snapper were often seen over reef areas surrounding the modules, always in association with relatively dense stands of soft corals and often between groups of modules. As noted on the data sheets, one mixed school was seen in the vicinity of modules M2, R22, and D25, another in the area of M5, M9, and M4, and a third in the region of R21, D7, and D49. A mixed school of bluestripe grunts and white grunts without gray snapper was seen between modules R15 and R16. It was difficult to determine if the observed schools were distinctly separate or if the same school was moving to new locations. In any case, there was a clear affinity of these schools to the artificial reefs as they tended to occupy the inter-module areas between closely grouped structures. This brings up another factor concerning the effect module spacing on the artificial reef as a whole. Closely spaced modules may be perceived by some species as a large single structure (refuge) rather than several small structures. In this respect, spacing of the modules may be as important, if not more important, than the shape of the modules.

Specific habits in and around the modules were noted among the various reef fish species. Black margates commonly inhabited the upper internal space of the M-modules or sometimes the under space the modules and were never seen over open flats. Other relatively large fishes such as spotted goatfish in small schools were seen in association with the modules or feeding in sandy pockets between reef structure; gray snapper frequented the internal spaces of M-modules or were observed in mixed schools of bluestripe and white grunts. Porkfish had an association with the modules similar to that of the gray snapper, that is, freely moving between the modules but showing definite affinity for them as a refuge. Other relatively large sport fishes such as groupers, snappers (with the exception of gray snappers) and hogfish were usually solitary.

Such fishes were almost always seen in association with the modules and would often hid deep within the modular recesses when we approached to closely. Some graysby were seen out over the reef flat but they were always near a refuge to which they would dart when approached.

As pointed out in the last report, many of the modules harbor fish and invertebrate species that are ectoparasite cleaners and on a number of occasions we observed and videotaped various reef species being cleaned. It has been demonstrated that such behavior significantly contributes to the point diversity within a reef fish community (Slobodkin and Fishelson, 1974). The focal point (i.e., the cleaning station) is considered by the authors to be biologically based, that is, the cleaners are the resource that attract other species. They see this as distinct from a focal point that is physically based, such as a watering hole for large land mammals. In any area were relatively rare resources are available, one would expect increased point diversity. In this case, the modules attract the cleaners which in turn attract the cleanees. What is it about the modules that makes them attractive to cleaners? cleaning stations that we observed tend to be higher than the reef base. Possibly the modules provide the height off the reef base necessary for the ideal cleaning station. If height is a factor involved in attracting the cleaners then the M- modules would be expected to harbor more cleaners than the other two module types. Comparing occurrence and abundance of juvenile Spanish hogfish (strict ectoparasite pickers) among the modules give: D=27% occurrence, 4 individuals; R=40% occurrence, 4 individuals; M=50% occurrence, 13 individuals. Although other factors, such as habitat complexity, may be involved, the evidence does not controvert the hypothesis that height from the reef base is a factor influencing the suitability of a site as a cleaning station. Possibly the cleaner is better able to advertise from such a promontory.

Statistical Results

A. Raw Data and Parametric Comparisons by ANOVA and t-tests:
The raw data for controls are summarized in Tables F1.1 - F1.2 (background reference sites), and for module types in Tables F2.1-F2.4; note that the control sites are coded in relation to the module they were closest to in Table F1.1-1.2. Summary statistics for the four site types are given in Table F3.
The number of individuals varied from 13 to 121 among the three module types (D, M, and R),, and the number of species varied from 6 to 20. The highest average number of individuals (72.50) was found on the R modules, and the highest average number of species (15.10) was found on the M modules. The lowest average number of individuals (25.45) and the lowest average number of species (10.36) were found on the smallest module type: the D modules.
There were no significant differences among the means of the control sites by total individuals or species (One-way ANOVA for number of fishes: $F = 1.097$, df 2, 28, $p = 0.348$; and One-way ANOVA for number of species $F = 0.359$, df = 2, 28, $p = 0.701$).
The possibility that control sites were correlated with their nearest module was evaluated to determine whether the controls

could be treated as a single sampling group. The comparison of the correlation matrices of the control sites and the modules, based upon numbers of fishes, gave a highly random pattern (normalized Mantel Z statistic = 0.141, t = 1.145, p = 0.926). Therefore, the control sites were treated as one group in all subsequent analyses.

There were significant differences among the four study site types (D, M, and R modules plus the control sites, C) for both the number of fishes and the number of species (One way ANOVAS: F=30.49, and F=54.58, p<0.000, respectively; Table F4, Figure F1 and F2).

The control sites had a lower mean number of individuals than the M and R modules (t's= 6.205, 8.415, p <0.000, <0.000, df= 39, 39, respectively; Table F5). There was no significant difference in the mean number of individuals between the C sites and the D modules (t= 0.424, p= 0.674, df= 40). The C sites also had a significantly lower mean number of species than the D, M, and R modules (Independent t tests, t values = 5.354, 11.984, 11.366, p<0.000, p<0.000, <0.000, df = 40, 39, 39, respectively).

The D modules had a lower mean number of fishes than the M and R modules (t= -4.600, -7.950, p<0.000, <0.000, df= 19, 19, respectively) and a lower mean number of species than the M and R modules (t= -3.973, -3.661, p<0.000, =0.002, df= 19, 19). There was no difference in the mean number of fishes or mean number of species between the M and R modules (t= -0.497, 0.238, p= 0.625, 0.814, df= 18, 18; Table F5)

B. Diversity Indices

The Shannon-Weiner Diversity Indexes (H) were 1.2, 1.3 and 1.1 for the D, M, and R modules types respectively. The C control sites had a diversity index of 1.0 for comparison (Table F3).

C. Multivariate Analyses of Sites and Taxa

As noted in the METHODS, cluster analyses and PCA's of all taxa at the modules and control sites contained too much information to permit a meaningful interpretation; therefore these analyses are not included. Two methods of selecting the taxa to be included in "scaled-down" analyses were used. The first method was to select the most common species (i.e. those with n=15 or more from Table F6). Raw data were standardized (as percent; see METHODS) to remove the bias of unequal sample sizes (there were three times as many control sites as any one module type), and because some species are so abundant. Table F7 summarizes the standardized abundances of species in the four study site types.

The cluster analysis of the four study site types (controls, M, R and D Modules) reveals a separation of the controls as the most distinctive or different of the four (Figure F3). The M modules and the R modules are most similar in species composition in this clustering.

The three dimensional projection of the eigenvector matrix of study sites for the 26 most common fishes separates the Bluehead wrasse (THAb), the grunts (HAEs, HAEp), the Bicolor damselfish (POMp) and the ocean surgeon (ACAb) based upon their abundance and occurrence in all study site types (Tables F6 and F7; Figure F4).

Analysis of only the most abundant species overlooks the importance of less common and/or rare species in community assemblages. The second method of "scaling-down" for analysis was to select taxa, regardless of their abundance, which could be assigned to one of the six foraging guilds identified in the Third Quarterly Report (August 1992). This resulted in the selection of 19 species. As in the previous analysis, the data were standardized to remove the effect of sample size. The standardized data and species assignments to guilds are listed in Table F8.

The most abundant guild is Guild 3, demersal mesocarnivores (grunts, trumpetfish); Guild 4, macrocarnivores, is the least abundant (Table F8). The D modules are distinctive in having three-times as many herbivores (Guild 5, ocean surgeon, parrotfish) than either the M or R modules and the control sites. R modules are distinct from the M modules and control sites by the abundance of demersal mesocarnivores (Guild 3, grunts) and a lack planktivores (Guild 5, Chromis species; Table F8). A clustering of sites by guilds shows the D modules to be the least similar to the other sites (Figure F5). The most similar are the M modules and the control sites. A three- dimensional projection of the sites and taxa are shown in Figures F6 and F7, respectively.

D. Comparison Between May and August Samplings

The mean number of individuals (Fishes) and the mean number of species at each site type (D, M, R, and C) during the August sampling period were compared to the May sampling period by independent t-tests (Table F9). The mean number of fishes at the D modules were not significantly different (t=1.970, df= 20, p=0.070). However, the mean number of species at the D modules increased from 8.18 to 10.36 (t=2.22, df=20, p=0.038). In the M and R modules, the mean numbers were not significantly different from the previous sampling (M modules: t= 0.257, -0.162, df= 18, 18, p= 0.800, 0.870; R modules: t= 0.502, 1.434 df= 18, 18, p= 0.622, 0.169). The control sites also did not show a significant change in mean numbers from the May sample (t= 0.548, -0.412, df= 60, 60, p= 0.586, 0.683).

A comparison of the similarity matrices of the 31 modules showed no significant correlation between the distribution of the number of fishes and the species present at the modules in the May sampling and distribution of the number of fishes and species present during the August sampling (Mantel's Z=0.0957, t=0.905, p=0.8174; Figure F8). A similar comparison between control site matrices also showed no correlation between sampling periods (Mantel's Z=0.069, t=0.597, p=0.725; Figure F9). So while the mean number of fishes and species for each site type have not changed (with the exception of the mean number of fishes at the D modules), the species composition of any specific site has changed. The August sampling picked up a few species not encountered previously:

Brown chromis (Chromis multilineatus; 16 individuals found on 5 of 10 M modules)

Blackfin snapper (Lutjanus buccanella; 8 individuals found on 2 R modules)

Greater amberjack (Seriola dumerili; 8 individuals on 1 R modules and 8 individuals on the Control site associated with that R module (probably same school)).

Other species shifted in abundance: Chromis cyaneus (43 vs 18), Chromis insolatus (17 vs 4), Chromis scotti (27 vs 107), Acanthurus bahianus (83 vs 153).

Recommendations:

Future guild analyses would benefit if all species listed on the dive's team data sheet would be assigned a foraging guild code. The present guild analyses were not able to include some abundant species (such as Serranus tigrinus, Anisotremus virginicus and Chromis insolatus). Separate codes for habitat preference could further refine the analyses.

List of Tables for Fishes and Motile Invertebrates Study:

<u>List of Figures for Fishes and Motile Invertebrates Study.</u>

Figure F7. Projection of the first three principal components (axes are labeled) for the 6 foraging guilds.

Figure F8. Matrix plot for the modules of similarity matrices for the August and May sampling periods. Scales are based upon the Product- Moment Correlation Coefficients.

Figure F9. Matrix plot for the control sites of similarity matrices for the August and May sampling periods. Scales are based upon the Product- Moment Correlation Coefficients.

2. SESSILE INVERTEBRATES

Methods

Data Collection

The 4th quarterly inventory of artificial reef species by G. M. Selby & Associates took place during August 21 and 22, 1992, twelve months after installation of the modules, and two days before Hurricane Andrew. As in the case of the fishes and motile invertebrates, sessile invertebrates were surveyed on 31 artificial reefs. These included eleven rough Dome modules (#'s 18,19, 20, 21, 22, 25, 30, 34, 42, 43, and 50), ten sloped roof or M- modules (#'s 1-10 consecutively) and ten reef replacement or R-modules (#'s 2, 4, 7,14, 15, 16, 17, 21, 22, and 23). An additional 10 control sites, each 1.5 x 1.5 meters, were cleared of all flora and fauna in August, 1991 (="Barren Controls" #'s: 3, 8, 14, 19, 20, 21, 27, 30, 37, and 39). We continued to monitor these sites for natural reef substrate colonization.

Statistical Methods

A. Standard Parametric Analyses of Study Sites

One way analysis of variance (ANOVA) was performed on the four site types (D modules, M modules, R modules, and Barren Control sites,BC; samples sizes of 11, 10, 10, and 10, respectively) using both number of individuals per site and number of species per site as the data.

T-tests (independent samples) were performed on each combination of site types to determine which site types were significantly different in mean numbers of individuals and mean number of species of animals per site type (with means based upon sample sizes of 11, 10, 10, and 10 respectively).

B. Diversity Indices

Shannon-Weiner Diversity indices (H, using logarithm to the base ten) were calculated for each site type based on both the number of species and the number of individuals per species). While evenness and dominance values will be readily employed in the future they are not given major importance in the report below, since it will take more time before such measures will permit effective evaluation of the community associations.

C. Multivariate Analyses of Sites and Taxa

The mutlivariate techniques used in the following analyses are Cluster Analysis and Principal Component Analyses, PCA, (Gauch, 1982; Pielou, 1988). Cluster Analyses and Principal Component Analysis (PCA) were performed on the correlation matrices of sites and taxa. The PCAs were performed using the matrices to generate eigenvalues and eigenvectors (scaled as square roots, SQRT LAMBDA, Pielou, 1984; Rohlf, 1988). PCA's were performed for both the rows and columns, i.e. the sites and the species, as the OTU's (outstanding taxonomic characteristics).

In all analyses performed on the sessile invertebrates at barren controls (BC) and modules (D,R,M), the following conventions were followed:

1. All analyses used Pearson product-moment correlation coefficients (r) for the similarity matrices.
2. Scaled-down analysis of the most common invertebrate species (n>5) were used to give an overall picture. The raw data were not standarized since sample sized did not differ greatly.

RESULTS

Descriptive Results - Modules

The major colonizing organisms (sessile flora and fauna) after one year were encrusting algae, and cyanobacteria. Sheets of encrusting melobesioid and lithothamnioid algae have become quite prominent giving the modules an overall, patchy red and pink appearance. In a number of cases the red and pink patches were not strictly algal, and were supplemented by reddish, encrusting sponges and didemnid ascidians. These were enumerated whenever possible, but at the current stage of development, the red, encrusting invertebrates are too similar in appearance and in color to the plant material to make accurate distinctions. As in prior quarters, closer inspection of the rock surface (using a dissecting microscope) revealed a number of other red algal species including a fine meshwork of dichotomously branched calcareous red algae (Jania sp., possibly Jania pumila), small tufts of the red alga

Wrangelia argus and Laurencia sp. The photographs of modules taken this quarter have been supplemented with comparisons of the same modules photographed in November, 1991 to emphasize the overall change in appearance due to colonization by invertebrates and plants. Plates in the appendix emphasize the striking difference in appearance by showing paired comparisons of modules D-19, D-25, D-30, R-5, R-21, R-23, M-7, M-8, as well as control stations BC-3, BC-8, BC- 21 and BC-27 photographed nine months apart.

The most common invertebrates were barnacles of the genera Balanus sp. and Tetraclita sp. on the upper surfaces of the modules. The lateral surfaces of the modules, particularly the M and R types continued to exhibit most of the invertebrate macrofauna. Calcareous bryozoan colonies, the most conspicuous of which was Parasmittina sp., and juvenile file shells (Lima lima), were also quite common on these modules as they have been for the last two quarters. The R-modules consistently exhibited file shells, American oysters (Spondylus americanus) and rock urchins (Echinometra lucunter) as they did last quarter, in contrast to the second quarter. The blue sponge Callyspongia fallax is becoming increasingly common (see photo of D-25, D-49, R-15). The M modules continued to display clusters of orange tunicates, Stolonicus sabulosa, as well as larger, individual, black sea squirts (Ascidia nigra), especially on the shaded surfaces (see photo of M-1 & M-10). Colonies of the octocoral Telesto riisei were also prominent deep inside the large recesses of the M-modules 1, 2 (see photo) and 3 as last quarter, but were also found in M-7, 8 and 10 during the current survey (Table A). M-modules 4, 5, 6 and 9 were not colonized by Telesto at the end of the first year of monitoring. Module R-4 also has begun to be colonized by this octocoral (see photo). **Table A lists all invertebrates noted this quarter and notes which of them are highlighted in the photographs.**

During the third quarter survey, only 3 Dome modules exhibited any colonization by invertebrates. After 12 months, all Dome modules were colonized by at least some invertebrates. In most cases only 2-3 taxa per dome were found, with 1-2 individuals each. Most often it was the keyway that provided the preferred habitat. In five cases (D-18, 19, 21, 30 and 49) the keyway was occupied by the rough file shell, Lima lima. In D-25 a spiny oyster Spondylus americanus occupied the keyway, and in D-34 and 50 cleaner shrimp, Stenopus hispidus were found there. Interestingly, the cleaner shrimp were very common occupants of the keyway habitat in the first quarterly survey, but declined afterward, possibly due to competition with the prolific growth of filamentous algae and cyanobacteria in that restricted space. We noted that in the cases of D-20 and 25 the keyway was almost completely closed by this material.

The algae, bryozoans and ascidians on sides of the modules were the main source of the invertebrate diversity on M and R-modules, the upper surfaces of which were still dominated by filamentous algae and cyanobacteria. This trend continues from the previous quarter. The most common and obvious invertebrates noted during this study continues to be the large, tan, irregular, encrusting cheilostomate bryozoan colonies tentatively identified using scanning electron microscopy as Parasmittina sp. This organism was noted on the shaded surfaces of nearly every module, especially those with smooth sides. Thus it was found most common on the M-modules (see Table A) and least commonly on the Domes.

Descriptive Results - Barren Control (BC) Sites

At BC 30 and 37 there was little colonization because the sites were inundated by sand. On the latter site 16 Udotea sp. were found last quarter; this quarter we found only 4, with evidence of abrasion damage. However at other BC quadrats, a number of animals and plants not found on the modules were beginning to make their appearance last quarter, in parallel with the modules. Stations BC 8 and 19 had the highest diversity last quarter. At BC 8 there were 8 sponges among 4 taxa, plus 2 scleractinians. This quarter was essentially the same, with the addition of the calcareous chlorophyte Halimeda goreaui. At BC 19 last quarter there were 2 algal species, 10 sponges among 5 taxa and one gorgonian. This quarter the sponge and algal numbers were essentially the same, but 2 of the 3 gorgonians (all Eunicea fusca) were new to the quadrat. BC 3 clearly increased its diversity from 2 sponge taxa and one scleractinian last quarter, to 1 algal taxa, 2 sponge species, 1 gorgonian and 2 scleractinian. Other BC sites had not changed much from the previous quarter. It should be emphasized, however, that most of the of the taxa colonizing the BC stations are not the same as those found on the modules, with the exception of the sponge Holopsamma helwigi.

Statistical Results

A. Raw Data and Parametric Comparisons by ANOVA and t-tests for Sessile

The raw data for benthic sessile invertebrates at the modules and barren control sites are given in Table I1.1 thru I1.3. Summary statistics are found in Table I2. The number of individuals ranged from 1 to 31 among the three modules types (D, M, and R) and from 0 to 24 among the barren control sites. The highest average number of individuals (19.60) was found on the M modules. The number of species ranged from 1 to 10 on the modules and from 0 to 8 on the barren control sites. The highest average number of species (5.10) was found on the M modules. The lowest average number of individuals (4.27) and average number of species (2.36) were found on the D modules.

There were significant differences among the four site types (D, M, R, and BC) in mean number of individuals (F=10.088, df= 3, 37, p<0.000) and in the mean number of species (F= 3.790, df= 3, 37, p=0.0182; Table I3, Figure I1). The M modules had a higher average number of individuals than the D modules, R modules, and BC sites (t= -6.281, 3.392, 2.340, df= 19, 18, 18, p<0.000, =0.003, 0.031; Table I4). While there was no difference in the mean number of individuals on the R modules and the BC sites (t=-0.433, df=18, p=0.6702), the D modules had a lower mean than both the R modules and the BC sites (t=-2.910, -2.459, df=19, 19, p=0.009, 0.0237). The mean number of species on the D modules was lower than the M modules, R modules, and BC sites (t=-3.666, -3.1074,

-2.2525, df=19, 19, 19, p=0.0016, 0.0058, 0.0363). There was no significant difference in mean number of species between the M and R modules (t=0.888, df=18, p=0.3861) or the BC sites and the M and R modules (t=0.851, 0.1037, df=18,18, p=0.4056, 0.9186).

B. Diversity Indices

The diversity indices for the D, M, and R modules were 0.93, 0.82 and 0.91 respectively (Table I2). The barren control sites had a diversity index of 1.03.

C. Multivariate Analyses for Sessile Invertebrates

Cluster analysis and PCA were performed using 16 of the 36 invertebrate species. A species was included in the analysis if individuals occurred more than five times across any combination of D, M, R, and BC sites (see Table I6) with the exception of Dictyota bartayressi (n=20) and Wrangelia argus (n=20). Both of these species occurred twice as colonies, with each colony assigned a value of 10 individuals.

A clustering of the modules (Figure I2) demonstrates a clear separation of the M, R, and BC sites. The D modules cluster randomly in with the 3 other site types, indicating that the D modules share characteristics with all of the other sites without having a distinctive invertebrate fauna. In a clustering by species, 15 of the 16 species cluster into 3 major groups, with one species remaining by itself. The lone species, Stolonicus sabulosa, occurs on all four sites, and it is the only species which was most common on the D modules. The first great cluster is of species occurring only on the BC sites (Halimeda, Holopsamma, Udotea, and Niphates). The second great cluster of Melanostigma, Echinometra, Lima, and Didemnidae, represent species most common, but not restricted to, R modules. The third major cluster is of species either most abundant on (Parasmittina and Watersipora) or restricted to (Telesto) the M modules. A three-dimensional plot of the taxa is presented in Figure I4.

D. Comparison Between May and August Sampling

One-way ANOVA shows no change in the mean number of individuals and the mean number of species occurring on each site type during May and August sampling periods (Table I7).

Comparison of the Pearson r similarity matrices for the two sampling periods shows no correlation (Mantel's Z=0.482, t=9.965, p=1.00; Figure I5), indicating that the distribution of species abundances has changed. An examination of raw data reveals that the presence of common, characteristic species, such as Udotea, Telesto, Lima, remain stable on a module, although their abundances have changed. However, the less common species have shifted between site types and in their abundance in an apparently random manner to date.

List of Tables for Sessile Invertebrate Study

List of Figures for Sessile Invertebrate Study (axes are labeled) of the 16 most common species.

Figure I5. Matrix plot for the four study sites (D, M, R, and BC) of similarity matrices for the August and May sampling periods. Scales are based upon the Product-Moment Correlation Coefficients.

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APPENDIX A

LIST OF INVERTEBRATES AND KEY TO PHOTOGRAPHS

TABLE A

INVERTEBRATES ON SUNNY ISLES MODULES ONE YEAR POST-CONSTRUCTION

Invertebrate: Sunny Isles Modules August 21-22, 1992

Organisms with an asterisk are noted on station photographs by an arrow or flechette. The plate number following each station refers to the photographs in the appendix.

Domes

D-18: Plate 2

- 2 Parasmittina sp. (Bryozoa)
- 2 Lima lima (file shells-in Keyway)
- 1 unidentified didemnid (Ascidia)

D-19: Plate 1

- 1 Holopsamma helwigi (Porifera)*
- 1 unid. didemnid (Ascidia)
- 2 Lima lima (in keyway)

D-20: Plate 2

- Unidentified poriferan*
- 2 Stenorhynchus seticornis (arrow crabs under base)
- 1 Watersipora sp. (Bryozoa)
- Keyway closed by filamentous algae growth

D-21: Plate 2

- 1 Stolonicus sabulosa
- 2 Spondylus americanus (bivalves)
- 2 Lima lima in keyway
- 1 Parasmittina sp. (Bryozoa)

D-22: Plate 3

Dictyota sp. unident. calcareous red alga
1 Stenopus hispidus
1 Ascidia nigra

D-25: Plate 4

1 Spondylus americanus in keyway- nearly closed by fil. algae
1 Callyspongia fallax*
1 unid. brown Porifera

D-30: Plate 5

2 Lima lima in keyway
2 Stolonicus sabulosa (Ascidia)

D-34: Plate 6

Dictyota sp.
1 unid. brown Porifera
1 Stenopus hispidus in keyway

D-43: Plate 6

1 Echinometra lucunter in keyway

D-49: Plate 7

1 Lima lima in keyway
1 Callyspongia fallax*
5 Stolonicus sabulosa (Ascidia)

D-50: Plate 7

2 unid. brown Porifera
1 Watersipora sp. (Bryozoa)
1 Stolonicus sabulosa
1 Lima lima
1 Stenopus hispidus

REEF REPLACEMENT MODULES
(when no location within the module is noted, the organisms are on the sides only)

R-2: Plate 8

Top:	Unid. brown Porifera
	1 Styella plicata (top of module)
side:	2 unid. didemnids
	1 Parasmittina sp.
	1 Stolonicus sabulosa
	2 Callyspongia fallax
	6 Lima lima
	2 Echinometra lucunter
	4 Melanostigma nigromaculatus (Sabellidae)

R-4: Plate 8

Top:	Millepora alcicornis
	Watersipora sp.
side:	1 Spodylus americanus
	6 Lima lima
	6 unid. didemnid ascidians
	2 Calyspongia fallax
Under:	1 Panulirus argus
Inside:	Telesto riisei*

R-7: Plate 10

Top:	filamentous algae only
	3 Lima lima
	1 Parasmittina
	1 Ascidia nigra
	1 Stenopus hispidus

R-14: PLate 10

5 Lima lima
1 Spondylus americanus
1 Parasmittina sp.

R-15: Plate 11

3 Lima lima
1 Callyspongia fallax*
1 Ascidia nigra
3 unid. serpulid polychaetes

R-16: Plate 11

Top: 2 Ascidia nigra
side: 1 Ascidia nigra
7 Lima lima*
1 Parasmittina sp.

R-17: Plate 12

2 Parasmittina sp.*
3 Lima lima
1 Stenopus hispidus

R-21: Plate 13

2 unid. blue Porifera
5 Lima lima
2 Melanostigma nigromaculatus
2 Stenopus hispidus
1 Echinometra lucunter (urchin)*
1 Eucidaris sp. (urchin)
2 Ascidia nigra

R-22: Plate 12

1 Melanostigma nigromaculata (sabellid polychaete)

2 Callyspongia fallax

2 Lima lima

R-23: Plate 14

3 unidentified blue Porifera

2 Echinometra lucunter

1 Stolonicus sabulosa

1 Parasmittina sp.

M-MODULES

(when no location within the module is noted, organisms occur on the sides only)

M-1: Plate 15

8 Callyspongia fallax

2 Ascidia nigra*

N Telesto riisei (Octocorallia inside module)

M-2: Plate 15

1 Callyspongia fallax

4 unid blue Porifera

3 Parasmittina sp.

1 Melanostigma nigromaculata

1 Ascidia nigra

N Telesto riisei (south half of module interior only)*

M-3: Plate 16

3 Callyspongia fallax

15 Parasmittina sp.

1 Watersipora sp.*

3 Telesto riisei (inside)

M-4: PLate 16

1 Callyspongia fallax

16 Parasmittina sp.* (up arrow)

5 Watersipora sp.

1 Ascidia nigra

1 unidentified didemnid ascidian* (down arrow)

1 Spondylus americanus* (flechette)

N unid. hydroids inside - no Telesto

M-5: Plate 17

2 Parasmittina sp.
2 Watersipora sp.*
1 Ascida nigra
1 unid ascidian
1 Spondylus americanus
2 Stenopus hispidus

M-6: Plate 17

2 unid. blue sponges
3 Spondylus americanus
8 Parasmittina sp.
no macrofauna inside

M-7: Plate 18

2 unid. blue Porifera
8 Parasmittina sp.
7 Watersipora sp.
3 Sponndylus americanus
2 Ascidia nigra
N Telesto riisei (one corner of interior only)

M-8: Plate 19

5 Parasmittina sp.
1 Watersipora sp.
1 Styella plicata
1 Stolonicus sabulosa
1 Eucidaris sp.* (urchin)
1 Stenorhynchus seticornis
2 Stenopus hispidus

2 Spondylus americanus
1 Lima lima
3 Telesto (inside)
N unid. hydroids (inside)

M-9: Plate 20

4 Watersipora sp.
4 Parasmittina sp.
3 Stenorhynchus seticornis
3 Spondylus americanus
3 Melanostigma nigromaculata
1 Styella plicata

M-10: Plate 20

1 Unid. orange Porifera
10 Parasmittina sp.
1 Watersipora sp.
2 Stenorhynchus seticornis* (arrow crab)
6 Ascidia nigra* (ascidian)
1 Diadema antillarum
1 Melanostigma nigromaculatus
N Telesto riisei (inside)

BARREN CONTROLS

BC-3: Plate 21

N Wrangelia argus (Rhodophyta)
1 Haliclona rubens (Porifera)
2 Niphates digitalis "
1 Briareum asbestinum (Octocorallia)
1 Dichoecoenia stokesi* (Scleractinia)
1 Siderastrea sp. juvenile "
2 Opisthognathus aurifrons (jawfish)

BC-8: Plate 22

2 Halimeda goreauii* (Chlorophyta)
1 Niphates digitalis
2 Callyspongia vaginalis
1 Haliclona rubens
3 Holposamma helwigi
1 Eusmilia fastigiata (Scleractinia)
1 Stephanocoenia michelini "

BC-14: Plate 23

1 Holopsamma helwigi
1 Ulosa reutzleri
1 Eusmilia fastigiata

BC-19

1 Halimeda goreauii*
N Dictyota sp.
2 Niphates digitalis (Porifera)
5 Holopsamma helwigi "
1 Haliclona rubens "
1 Spirastrella coccinea* "

3 Eunicea fusca (Octocorallia)

1 Briareum asbestinum* "

BC-20: plate 23

1 Halimeda goreauii

1 Unid. red Porifera

1 Holopsamama helwigi

BC-21: Plate 24

8 Udotea sp. (Chlorophyta)

N Wrangelia argus

1 Spirastrella coccinea (Porifera)

1 Niphates digitalis

1 Stephanocoenia michelini* (on loose rock)

BC-27: Plate 25

3 Udotea sp. (others present but in poor condition)

2 Halimeda goreauii

1 Aplysina sp. (Porifera)

2 Holopsamma helwigi "

1 Eunicea fusca (Octocorallia)

BC-30

1 unid. Porifera

BC-37: Plate 26

4 Udotea sp.

1 Verongia longissima (Porifera)

BC-39: Plate 26

11 Udotea sp.

3 Halimeda goreauii

3 Holopsamma helwigi

3 Stolonicus sabulosa

APPENDIX B

STATISTICAL PRESENTATION

TABLE F1.1 FISH AND MOTILE INVERTEBRATE DATA FOR CONTROL SITES

Species	Common Name	Module Code	D18	D19	D20	D21	D22	D25	D30	D34	D43	D49	D50	M1	M2	M3	M4	M5
Holocentrus rufus	Longspine squirrelfish	HOLr	0	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0
Epinephelus cruentatus	Graysby	EPIc	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0
Serranus tigrinus	Harlequin bass	SERt	3	1	0	0	1	0	0	1	0	2	0	0	0	1	2	1
Serranus tabacarius	Tobacco fish	SERt	1	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Hypoplecturs unicolor	Butter hamlet	HYPu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudupeneus maculatus	Spotted goatfish	PSEm	0	1	0	0	0	0	0	0	0	0	3	2	2	2	2	0
Ocyurus chrysurus	Yellowtail snapper	OCYc	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Anisotremus virginicus	Porkfish	ANIv	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Haemulon plumieri	White grunt	HAEp	0	0	5	0	0	0	0	1	0	0	0	0	0	0	2	0
Haemulon sciurus	Bluestriped grunt	HAEs	0	0	35	0	0	50	0	0	0	0	0	9	0	0	0	3
Chaetodon sedentarius	Reef butterflyfish	CHAs	0	0	0	0	0	2	0	0	2	0	0	1	2	0	2	2
Acanthurus bahianus	Ocean surgeon	ACAb	0	2	5	2	6	1	4	2	1	0	3	1	2	0	0	1
Pomacanthus arcuatus	Gray angelfish	POMa	0	0	2	0	0	0	0	0	2	1	0	0	0	0	0	1
Pomacanthus paru	French angelfish	POMp	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Holacanthus bermudensis	Blue angelfish	HOLb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holacanthus tricolor	Rock beauty	HOLt	0	0	0	2	0	0	0	1	0	2	0	0	0	0	0	0
Pomacentrus partitus	Bicolor damselfish	POMp	3	7	10	5	5	5	5	5	4	0	7	5	5	5	5	3
Halichoeres garnoti	Yellowhead wrasse	HALg	1	3	0	4	2	0	4	0	3	2	3	1	3	0	3	0
Lachnolaimus maximus	Hogfish	LACm	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thalassoma bifasciatum	Bluehead wrasse	THAb	0	5	0	3	3	0	5	2	0	3	5	3	0	4	3	0
Sparisoma viride	Stoplight parrotfish	SPAv	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparisoma aurofrenatum	Redband parrotfish	SPAa	0	2	3	0	0	1	0	0	0	0	2	0	0	0	0	2
Scorpaena plumieri	Spotted scorpionfish	SCOp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Monacanthus hispidus	Planehead fish	MONh	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
Balistes capriscus	Graytriggerfish	BALc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cantherhines pullus	Orangespotted filefish	CANp	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Canthigaster rostrata	Sharpnose puffer	CANr	2	0	0	0	2	2	3	0	0	0	0	2	0	0	3	0
Lactophrys triqueter	Smooth trunkfish	LACt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Seriola dumerili	Greater amberjack	SERd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL NUMBER OF FISHES	<COLUMN SUMS>		10	23	62	17	21	61	22	13	14	10	25	25	15	14	22	14

TABLE F1.2 FISH AND MOTILE INVERTEBRATE DATA FOR CONTROL SITES

Species	Common Name	Code	Module M6	M7	M8	M9	M10	R2	R4	R7	R14	R15	R16	R17	R21	R22	R23	TOTAL
Holocentrus rufus	Longspine squirrelfish	HOLr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Epinephelus cruentatus	Graysby	EPIc	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4
Serranus tigrinus	Harlequin bass	SERt	1	1	2	2	0	0	0	2	2	0	2	0	0	0	0	24
Serranus tabacarius	Tobacco fish	SERt	0	1	0	2	0	0	0	0	1	0	0	0	0	0	0	7
Hypoplecturs unicolor	Butter hamlet	HYPu	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Pseudupeneus maculatus	Spotted goatfish	PSEm	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	16
Ocyurus chrysurus	Yellowtail snapper	OCYc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Anisotremus virginicus	Porkfish	ANIv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Haemulon plumieri	White grunt	HAEp	0	0	0	0	0	0	0	2	0	7	0	0	0	0	0	17
Haemulon sciurus	Bluestriped grunt	HAEs	0	0	0	0	0	0	0	0	0	10	0	0	0	50	0	157
Chaetodon sedentarius	Reef butterflyfish	CHAs	0	0	0	0	0	0	0	0	0	2	2	0	2	0	0	17
Acanthurus bahianus	Ocean surgeon	ACAb	0	2	0	0	0	1	6	1	2	1	6	3	2	0	1	55
Pomacanthus arcuatus	Gray angelfish	POMa	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	8
Pomacanthus paru	French angelfish	POMp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Holacanthus bermudensis	Blue angelfish	HOLb	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1
Holacanthus tricolor	Rock beauty	HOLt	0	0	0	0	1	0	0	0	0	0	3	1	0	0	1	11
Pomacentrus partitus	Bicolor damselfish	POMp	5	3	17	3	5	10	7	5	5	5	7	5	7	7	4	174
Halichoeres garnoti	Yellowhead wrasse	HALg	0	0	4	0	6	3	2	2	2	0	2	2	0	4	0	56
Lachnolaimus maximus	Hogfish	LACm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Thalassoma bifasciatum	Bluehead wrasse	THAb	0	3	0	5	3	2	0	5	5	0	7	0	5	5	4	80
Sparisoma viride	Stoplight parrotfish	SPAv	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	2
Sparisoma aurofrenatum	Redband parrotfish	SPAa	0	0	0	2	1	7	0	0	0	1	1	0	0	0	1	23
Scorpaena plumieri	Spotted scorpionfish	SCOp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Monacanthus hispidus	Planehead fish	MONh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4
Balistes capriscus	Graytriggerfish	BALc	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	3
Cantherhines pullus	Orangespotted filefish	CANp	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	4
Canthigaster rostrata	Sharpnose puffer	CANr	3	2	3	2	1	3	0	1	2	1	0	2	0	2	5	41
Lactophrys triqueter	Smooth trunkfish	LACt	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Seriola dumerili	Greater amberjack	SERd	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	8
TOTAL NUMBER OF FISHES	<COLUMN SUMS>		10	12	27	17	17	28	16	19	21	30	31	13	16	78	19	0 722 722

TABLE F2.1 FISH AND MOTILE INVERTEBRATE DATA FOR MODULES

Species	Common Name	Code	D18	D19	D20	D21	D22	D25	D30	D34	D43	D49	D50	M1	M2	M3	M4	M5
			Module															
Ginglymostoma cirratum	Nurse shark	GINc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urolophus jamaicensis	Yellow stingray	UROj	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnothorax funebris	Green moray	GYMf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Synodus intermedius	Sand diver	SYNi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aulostomus maculatus	Trumpetfish	AULm	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0
Holocentrus rufus	Longspine squirrelfish	HOLr	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Priacanthus arenatus	Bigeye	PRIa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rypticus maculatus	Whitespotted soapfish	RYPm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Epinephelus cruentatus	Graysby	EPIc	1	1	0	0	0	0	1	0	0	0	0	1	0	1	1	0
Epinephelus morio	Red grouper	EPIm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycteroperca microlepis	Gag	MYCm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycteroperca bonaci	Black grouper	MYCb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranus tigrinus	Harlequin bass	SERt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranus tabacarius	Tobacco fish	SERt	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypoplecturs unicolor	Butter hamlet	HYPu	0	0	0	1	0	0	0	1	1	0	0	0	0	1	1	1
Pseudupeneus maculatus	Spotted goatfish	PSEm	0	0	0	0	2	2	0	0	3	0	2	3	3	2	3	1
Seriola zonata	Banded rudderfish	SERz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caranx ruber	Bar jack	CARr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ocyurus chrysurus	Yellowtail snapper	OCYc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lutjanus analis	Mutton snapper	LUTa	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Lutjanus griseus	Gray snapper	LUTg	0	0	0	0	0	4	0	0	0	0	0	0	13	0	35	15
Lutjanus synagris	Lane snapper	LUTs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diplodus holbrooki	Spottail pinfish	DIPh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anisotremus surinamensis	Black margate	ANIs	0	0	0	0	0	0	0	0	0	0	0	0	3	4	6	0
Anisotremus virginicus	Porkfish	ANIv	0	0	4	0	0	0	0	0	0	0	0	20	1	2	3	2
Haemulon plumieri	White grunt	HAEp	0	10	0	2	5	0	0	2	0	0	0	20	20	5	10	0
Haemulon sciurus	Bluestriped grunt	HAEs	0	0	0	0	0	0	0	0	0	0	0	35	20	0	0	0
Equetus lanceolatus	Jacknife fish	EQUl	1	0	1	0	0	0	0	0	0	2	0	0	0	0	2	0
Equetus acuminatus	High-hat	EQUa	0	0	2	0	3	0	0	0	1	0	0	0	0	0	1	1
Chaetodon ocellatus	Spotfin butterflyfish	CHAo	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Chaetodon sedentarius	Reef butterflyfish	CHAs	2	2	2	3	0	0	2	0	2	0	0	0	0	0	2	0
Acanthurus bahianus	Ocean surgeon	ACAb	8	6	0	5	5	2	2	0	3	0	3	2	5	3	5	0
Acanthurus coeruleus	Blue tang	ACAc	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Acanthurus randalli	Gulf surgeonfish	ACAr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaetodipterus faber	Spadefish	CHAf	0	0	0	0	0	0	1	0	0	0	0	0	0	0	7	0
Pomacanthus arcuatus	Gray angelfish	POMa	2	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
Pomacanthus paru	French angelfish	POMp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holacanthus bermudensis	Blue angelfish	HOLb	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Holacanthus ciliaris	Queen angelfish	HOLc	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
Holacanthus tricolor	Rock beauty	HOLt	2	3	0	1	2	1	2	0	1	1	0	3	1	0	0	1
Abudefduf saxatilis	Sergeant major	ABUs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromis cyaneus	Blue chromis	CHRc	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chromis insolatus	Sunshinefish	CHRi	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Chromis scotti	Purple reeffish	CHRs	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	5
Pomacentrus leucostictus	Beaugregory	POMl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentrus partitus	Bicolor damselfish	POMp	7	0	0	2	0	0	4	2	0	0	0	0	3	3	3	0

TABLE F2.2 FISH AND MOTILE INVERTEBRATE DATA FOR MODULES

Species	Common Name	Code	D18	D19	D20	D21	D22	D25	D30	D34	D43	D49	D50	M1	M2	M3	M4	M5
			Module															
Bodianus rufus	Spanish hogfish	BODr	0	1	1	0	0	0	2	0	2	0	0	0	3	3	0	0
Halichoeres garnoti	Yellowhead wrasse	HALg	1	2	0	0	2	0	3	0	3	0	2	1	0	0	0	0
Lachnolaimus maximus	Hogfish	LACm	1	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0
Thalassoma bifasciatum	Bluehead wrasse	THAb	10	0	0	2	7	0	0	5	10	10	4	20	5	10	10	8
Sparisoma viride	Stoplight parrotfish	SPAv	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	0
Sparisoma aurofrenatum	Redband parrotfish	SPAa	2	3	2	6	2	2	7	2	3	0	2	3	4	5	10	3
Echeneis neucratoides	Whitefin sharksucker	ECHn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scorpaena bergi	Goosehead scorpionfish	SCOb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scorpaena plumieri	Spotted scorpionfish	SCOp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monacanthus hispidus	Planehead fish	MONh	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Balistes capriscus	Graytriggerfish	BALc	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Balistes betula	Queen triggerfish	BALb	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Cantherhines pullus	Orangespotted filefish	CANp	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Diodon holacanthus	Balloonfish	DIOh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canthigaster rostrata	Sharpnose puffer	CANr	2	2	0	1	3	2	2	0	2	2	0	3	3	0	3	5
Lactophrys quadricornis	Scrawled cowfish	LACq	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lactophrys triqueter	Smooth trunkfish	LACt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycteroperca phenax	Scamp	MYCp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentrus variabius	Cocoa damselfish	POMv	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0
Echeneis naucrates	Whitefin sharksucker	ECHn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spoerhoides spengleri	Bandtail puffer	SPOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scarus croicensis	Striped parrotfish	SCAc	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Haemulon flavolineatum	French grunt	HAEf	1	0	2	1	0	2	0	0	1	0	0	6	0	1	0	0
Chromis multilineatus	Brown chromis	CHRm	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	7
Bodianus pulchellus	Spotfin hogfish	BODp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lutjanus buccanella	Blackfin snapper	LUTb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Seriola dumerili	Greater amberjack	SERd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaetodon capistratus	Four-eye butterflyfish	CHAc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panulirus argus	Spiny lobster	PANa	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	0
Stenopus hispidus	Banded coral shrimp	STEh	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
arrow crab	arrow crab	crab	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2
TOTAL NUMBER OF FISHES	<COLUMN SUMS>		44	33	17	27	34	19	27	13	32	17	17	121	86	47	104	49

TABLE F2.3 FISH AND MOTILE INVERTEBRATE DATA FOR MODULES

Species	Common Name	Code	Module M6	M7	M8	M9	M10	R2	R4	R7	R14	R15	R16	R17	R21	R22	R23	TOTAL
Ginglymostoma cirratum	Nurse shark	GINc	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2
Urolophus jamaicensis	Yellow stingray	UROj	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gymnothorax funebris	Green moray	GYMf	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Synodus intermedius	Sand diver	SYNi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aulostomus maculatus	Trumpetfish	AULm	0	1	0	1	0	0	0	1	0	0	1	0	0	1	0	8
Holocentrus rufus	Longspine squirrelfish	HOLr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Priacanthus arenatus	Bigeye	PRIa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rypticus maculatus	Whitespotted soapfish	RYPm	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Epinephelus cruentatus	Graysby	EPIc	1	1	0	0	0	0	1	0	0	1	1	0	0	0	0	11
Epinephelus morio	Red grouper	EPIm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycteroperca microlepis	Gag	MYCm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mycteroperca bonaci	Black grouper	MYCb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranus tigrinus	Harlequin bass	SERt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serranus tabacarius	Tobacco fish	SERt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Hypoplecturs unicolor	Butter hamlet	HYPu	0	0	1	0	1	0	0	0	1	1	1	1	1	1	1	15
Pseudupeneus maculatus	Spotted goatfish	PSEm	0	3	0	6	2	3	0	0	0	1	3	1	3	0	0	43
Seriola zonata	Banded rudderfish	SERz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Caranx ruber	Bar jack	CARr	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2
Ocyurus chrysurus	Yellowtail snapper	OCYc	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Lutjanus analis	Mutton snapper	LUTa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Lutjanus griseus	Gray snapper	LUTg	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	73
Lutjanus synagris	Lane snapper	LUTs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Diplodus holbrooki	Spottail pinfish	DIPh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anisotremus surinamensis	Black margate	ANIs	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	17
Anisotremus virginicus	Porkfish	ANIv	1	2	1	2	2	0	1	5	15	0	0	5	0	0	0	66
Haemulon plumieri	White grunt	HAEp	0	0	10	0	0	25	20	15	20	15	15	15	0	0	6	215
Haemulon sciurus	Bluestriped grunt	HAEs	3	0	0	0	0	0	0	15	25	10	10	0	0	0	0	118
Equetus lanceolatus	Jacknife fish	EQUl	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	8
Equetus acuminatus	High-hat	EQUa	0	2	1	0	0	0	0	1	0	0	1	0	0	2	0	15
Chaetodon ocellatus	Spotfin butterflyfish	CHAo	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	4
Chaetodon sedentarius	Reef butterflyfish	CHAs	2	2	0	0	2	2	2	0	0	0	0	0	0	2	0	27
Acanthurus bahianus	Ocean surgeon	ACAb	0	0	15	0	4	0	0	5	2	5	4	7	0	0	7	98
Acanthurus coeruleus	Blue tang	ACAc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Acanthurus randalli	Gulf surgeonfish	ACAr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chaetodipterus faber	Spadefish	CHAf	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	15
Pomacanthus arcuatus	Gray angelfish	POMa	0	1	1	0	0	1	0	0	1	1	0	0	0	0	0	11
Pomacanthus paru	French angelfish	POMp	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	3
Holacanthus bermudensis	Blue angelfish	HOLb	1	0	1	0	0	0	2	0	0	0	0	0	0	0	0	5
Holacanthus ciliaris	Queen angelfish	HOLc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Holacanthus tricolor	Rock beauty	HOLt	0	0	0	0	1	0	0	2	2	2	0	2	2	0	0	29
Abudefduf saxatilis	Sergeant major	ABUs	1	0	0	0	0	0	0	0	0	0	0	0	1	0	2	4
Chromis cyaneus	Blue chromis	CHRc	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	18
Chromis insolatus	Sunshinefish	CHRi	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	4
Chromis scotti	Purple reeffish	CHRs	30	0	0	0	12	0	20	10	0	0	0	15	0	0	10	107
Pomacentrus leucostictus	Beaugregory	POMl	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pomacentrus partitus	Bicolor damselfish	POMp	3	5	3	0	0	5	5	5	3	0	0	4	10	5	3	75

TABLE F2.4 FISH AND MOTILE INVERTEBRATE DATA FOR MODULES

Species	Common Name	Code	Module M6	M7	M8	M9	M10	R2	R4	R7	R14	R15	R16	R17	R21	R22	R23	TOTAL
Bodianus rufus	Spanish hogfish	BODr	5	5	0	0	3	0	0	1	0	2	1	1	0	0	3	33
Halichoeres garnoti	Yellowhead wrasse	HALg	0	1	0	0	3	0	0	2	0	2	0	0	4	1	0	27
Lachnolaimus maximus	Hogfish	LACm	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	5
Thalassoma bifasciatum	Bluehead wrasse	THAb	0	20	5	7	0	15	20	20	15	10	10	19	32	15	20	309
Sparisoma viride	Stoplight parrotfish	SPAv	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	6
Sparisoma aurofrenatum	Redband parrotfish	SPAa	5	6	6	1	5	4	3	0	4	4	4	4	4	4	3	113
Echeneis neucratoides	Whitefin sharksucker	ECHn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scorpaena bergi	Goosehead scorpionfish	SCOb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scorpaena plumieri	Spotted scorpionfish	SCOp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Monacanthus hispidus	Planehead fish	MONh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Balistes capriscus	Graytriggerfish	BALc	0	0	1	0	0	1	0	1	1	0	0	0	0	4	0	10
Balistes betula	Queen triggerfish	BALb	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2
Cantherhines pullus	Orangespotted filefish	CANp	0	1	1	0	0	0	0	0	0	2	1	0	0	0	0	7
Diodon holacanthus	Balloonfish	DIOh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Canthigaster rostrata	Sharpnose puffer	CANr	0	3	3	3	2	2	3	3	3	2	0	3	3	3	1	64
Lactophrys quadricornis	Scrawled cowfish	LACq	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lactophrys triqueter	Smooth trunkfish	LACt	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1
Mycteroperca phenax	Scamp	MYCp	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Pomacentrus variabius	Cocoa damselfish	POMv	0	0	0	0	0	0	0	0	0	0	2	0	0	1	1	7
Echeneis naucrates	Whitefin sharksucker	ECHn	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spoerhoides spengleri	Bandtail puffer	SPOS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scarus croicensis	Striped parrotfish	SCAc	1	0	0	0	1	0	0	0	0	0	2	0	1	0	1	7
Haemulon flavolineatum	French grunt	HAEf	0	10	0	0	0	1	1	2	2	3	2	1	3	2	1	42
Chromis multilineatus	Brown chromis	CHRm	2	0	0	4	1	0	2	3	0	0	0	0	0	0	0	21
Bodianus pulchellus	Spotfin hogfish	BODp	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1
Lutjanus buccanella	Blackfin snapper	LUTb	0	0	0	0	0	0	0	0	5	0	3	0	0	0	0	8
Seriola dumerili	Greater amberjack	SERd	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	8
Chaetodon capistratus	Four-eye butterflyfish	CHAc	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	2
Panulirus argus	Spiny lobster	PANa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
Stenopus hispidus	Banded coral shrimp	STEh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
arrow crab	arrow crab	crab	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	6
TOTAL NUMBER OF FISHES	(COLUMN SUMS)		60	66	56	26	58	61	80	97	101	61	69	81	64	49	62	

TABLE F3. Summary statistics of fish data for the four study site types (D, M, R, and C)

MODULE	N	Diversity Index H	Total # fish	Range	Total # species	Range	Most common species	
D	11	1.2	280	13 to 44	35	6 to 15	Thallasoma bifasciatum n=48 Acanthurus bahianus n=34 Sparisoma aurofrenatum n=31 Haemulon plumieri n=19	Bluehead wrasse Ocean surgeon Redband parrotfish White grunt
M	10	1.3	673	26 to 121	46	9 to 18	Thalassoma bifasciatum n=85 Lutjanus griseus n=68 Haemulon plumieri n=65 Haemulon sciurius n=58	Bluehead wrasse Gray snapper White grunt Bluestriped grunt
R	10	1.1	720	49 to 101	40	11 to 20	Thalassoma bifasciatum n=176 Haemulon plumieri n=131 Haemulon sciurius n=60 Chromis scotti n=55	Bluehead wrasse White grunt Bluestriped grunt Purple reeffish
C	31	1.0	722	10 to 78	29	4 to 9	Pomacentrus partitus n=174 Thallasoma bifasciatum n=80 Halichoeres garnoti n=56 Acanthurus bahianus n=55	Bicolor damselfish Bluehead wrasse Yellowhead wrasse Ocean surgeon

Module	N	$\bar{X}$ of fish per module	s.e.	$\bar{X}$ species per module	s.e.
D	11	25.45	2.91	10.36	0.81
M	10	67.30	9.01	15.10	0.88
R	10	72.50	5.33	14.80	0.90
C	31	23.29	2.85	6.77	0.28

TABLE F4. One-way Analysis of Variance for the four study site types (D, M, R, and C) for fish data.

Number of fishes:

Source	df	Sum of Squares	Mean Squares	F-value	p
Between	3	28895.1	9631.69	30.49	<0.000
Within	58	18319.7	315.86		

The calculated F-value indicates that there are significant differences among the means of the populations (p<0.000).

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Number of species:

Source	df	Sum of Squares	Mean Squares	F-value	p
Between	3	814.39	271.46	54.58	<0.000
Within	58	288.47	4.97		

The calculated F-value indicates that there are significant differences among the means of the populations (p<0.000).

Table F5. Results of t-tests (independent samples, separate variance) comparing mean number of fishes and mean number of species in the four study sites (D, M, R, and C).

Mean Number of Fishes:

Sites	df	t	p
D vs M	19	-4.600	<0.000
D vs R	19	-7.950	<0.000
M vs R	18	-0.497	0.625
D vs C	40	0.424	0.674
M vs C	39	6.205	<0.000
R vs C	39	8.415	<0.000

Mean Number of Species:

Sites	df	t	p
D vs M	19	-3.973	<0.000
D vs R	19	-3.661	0.002
M vs R	18	0.238	0.814
D vs C	40	5.354	<0.000
M vs C	39	11.984	<0.000
R vs C	39	11.366	<0.000

TABLE F6.\ SUMMARY OF FISH AND MOTILE INVERTEBRATE DATA FOR MODULES

Species	Common Name	D N=11	M N=10	R N=10	C N=31	TOTAL
Ginglymostoma cirratum	Nurse shark	0	1	1	0	2
Gymnothorax funebris	Green moray	0	0	1	0	1
Aulostomus maculatus	Trumpetfish	2	3	3	0	8
Holocentrus rufus	Longspine squirrelfish	1	0	0	3	4
Rypticus maculatus	Whitespotted soapfish	0	1	0	0	1
Epinephelus cruentatus	Graysby	3	5	3	4	15
Serranus tigrinus	Harlequin bass	0	0	0	24	24
Serranus tabacarius	Tobacco fish	2	0	0	7	9
Hypoplectus unicolor	Butter hamlet	3	5	7	1	16
Pseudupeneus maculatus	Spotted goatfish	9	23	11	16	59
Caranx ruber	Bar jack	0	2	0	0	2
Ocyurus chrysurus	Yellowtail snapper	0	1	0	1	2
Lutjanus analis	Mutton snapper	1	0	0	0	1
Lutjanus griseus	Gray snapper	4	68	1	0	73
Anisotremus surinamensis	Black margate	0	17	0	0	17
Anisotremus virginicus	Porkfish	4	36	26	1	67
Haemulon plumieri	White grunt	19	65	131	17	232
Haemulon sciurus	Bluestriped grunt	0	58	60	157	275
Equetus lanceolatus	Jacknife fish	4	2	2	0	8
Equetus acuminatus	High-hat	6	5	4	0	15
Chaetodon ocellatus	Spotfin butterflyfish	1	1	2	0	4
Chaetodon sedentarius	Reef butterflyfish	13	8	6	17	44
Acanthurus bahianus	Ocean surgeon	34	34	30	55	153
Acanthurus coeruleus	Blue tang	0	1	0	0	1
Chaetodipterus faber	Spadefish	1	7	7	0	15
Pomacanthus arcuatus	Gray angelfish	6	2	3	8	19
Pomacanthus paru	French angelfish	0	1	2	1	4
Holacanthus bermudensis	Blue angelfish	0	3	2	1	6
Holacanthus ciliaris	Queen angelfish	0	2	0	0	2
Holacanthus tricolor	Rock beauty	13	6	10	11	40
Abudefduf saxatilis	Sergeant major	0	1	3	0	4
Chromis cyaneus	Blue chromis	3	15	0	0	18
Chromis insolatus	Sunshinefish	1	0	3	0	4
Chromis scotti	Purple reeffish	0	52	55	0	107
Pomacentrus partitus	Bicolor damselfish	15	20	40	174	249
Bodianus rufus	Spanish hogfish	6	19	8	0	33
Halichoeres garnoti	Yellowhead wrasse	13	5	9	56	83
Lachnolaimus maximus	Hogfish	3	1	1	1	6
Thalassoma bifasciatum	Bluehead wrasse	48	85	176	80	389
Sparisoma viride	Stoplight parrotfish	2	2	2	2	8
Sparisoma aurofrenatum	Redband parrotfish	31	48	34	23	136
Scorpaena plumieri	Spotted scorpionfish	0	0	0	1	1
Monacanthus hispidus	Planehead fish	1	0	0	4	5
Balistes capriscus	Graytriggerfish	2	1	7	3	13
Balistes betula	Queen triggerfish	1	1	0	0	2

TABLE F6.2 SUMMARY OF FISH AND MOTILE INVERTEBRATE DATA FOR MODULES

Species	Common Name	D N=11	M N=10	R N=10	C N=31	TOTAL
Cantherhines pullus	Orangespotted filefish	2	2	3	4	11
Canthigaster rostrata	Sharpnose puffer	16	25	23	41	105
Lactophrys triqueter	Smooth trunkfish	0	0	1	0	1
Mycteroperca phenax	Scamp	0	1	0	0	1
Pomacentrus variabius	Cocoa damselfish	2	1	4	0	7
Scarus croicensis	Striped parrotfish	1	2	4	0	7
Haemulon flavolineatum	French grunt	7	17	18	0	42
Chromis multilineatus	Brown chromis	0	16	0	0	16
Bodianus pulchellus	Spotfin hogfish	0	1	0	0	1
Lutjanus buccanella	Balckfin snapper	0	0	8	0	8
Seriola dumerili	Greater amberjack	0	0	8	8	16
Chaetodon capistratus	Four-eye butterflyfish	0	1	1	0	2
Panulirus argus	Spiny lobster	0	4	0	0	4
Stenopus hispidus	Banded coral shrimp	2	2	0	0	4
arrow crab	arrow crab	0	6	0	0	6
TOTAL NUMBER OF FISHES excluding invertebrates	(COLUMN SUMS)	280	673	720	721	2394

TABLE F7 Standardized occurrence of 26 most common species on D, M, R, and C sites.

Species	Common Name	Code	D	M	R	C
Epinephelus cruentatus	Graysby	EPIc	1.18	0.78	0.44	0.57
Serranus tigrinus	Harlequin bass	SERt	0	0	0	3.46
Hypoplectus unicolor	Butter hamlet	HYPu	1.18	0.78	1.04	0.14
Pseudupeneus maculatus	Spotted goatfish	PSEm	3.54	3.58	1.64	2.30
Lutjanus griseus	Gray snapper	LUTg	1.57	10.6	0.14	0
Anisotremus surinamensis	Black margate	ANIs	0	2.65	0	0
Anisotremus virginicus	Porkfish	ANIv	1.57	5.61	3.88	0.14
Haemulon plumieri	White grunt	HAEp	7.48	10.1	19.5	2.45
Haemulon sciurus	Bluestriped grunt	HAEs	0	9.04	8.95	22.6
Equetus acuminatus	High-hat	EQUa	2.36	0.78	0.59	0
Chaetodon sedentarius	Reef butterflyfish	CHAs	5.11	1.24	0.89	2.45
Acanthurus bahianus	Ocean surgeon	ACAb	13.3	5.30	4.47	7.93
Chaetodipterus faber	Spadefish	CHAf	0.39	1.09	1.04	0
Pomacanthus arcuatus	Gray angelfish	POMa	2.36	0.31	0.44	1.15
Holacanthus tricolor	Rock beauty	HOLt	5.11	0.93	1.49	1.58
Chromis cyaneus	Blue chromis	CHRc	1.18	2.34	0	0
Chromis scotti	Purple reeffish	CHRs	0	8.11	8.20	0
Pomacentrus partitus	Bicolor damselfish	POMp	5.90	3.12	5.97	25.1
Bodianus rufus	Spanish hogfish	BODr	2.36	2.96	1.19	0
Halichoeres garnoti	Yellowhead wrasse	HALg	5.11	0.78	1.34	8.08
Thalassoma bifasciatum	Bluehead wrasse	THAb	18.8	13.2	26.2	11.5
Sparisoma aurofrenatum	Redband parrotfish	SPAa	12.2	7.48	5.07	3.31
Canthigaster rostrata	Sharpnose puffer	CANr	6.29	3.90	3.43	5.91
Haemulon flavolineatum	French grunt	HAEf	2.75	2.65	2.68	0
Chromis multilineatus	Brown chromis	CHRm	0	2.49	0	0
Seriola dumerili	Greater amberjack	SERd	0	0	1.19	1.15

Table F8. Standardized occurrence of 19 species selected for guild analysis.

Guild	D	M	R	C
1	3.8	4.1	0.9	0.0
2	23.7	9.8	30.1	13.7
3	17.9	38.9	51.3	34.5
4	0.0	0.9	2.1	1.6
5	11.5	23.6	0.0	34.5
6	42.9	22.8	15.5	15.8

Guild 1 Midwater microcarnivores: juvenile BODr,STEh
Guild 2 Demersal microcarnivores: CHAs, POMa, CANr, BALc
Guild 3 Demersal mesocarnivores: AULm, HAEp, HAEs, HAEf
Guild 4 Macrocarnivores: GINc, CARr, SERd
Guild 5 Planktivores: CHRc, CHRs, POMp
Guild 6 Herbivores: ACAb, SPAv, SPAa

Table F9. Results of t-tests (independent samples, separate variance) comparing mean number of fishes and mean number of species in the four study sites (D, M, R, and C) in May and August.

Mean Number of Fishes:

Sites	df	t	p
D modules	20	1.916	0.070
M modules	18	0.257	0.800
R modules	18	0.502	0.622
C sites	60	0.548	0.586

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Mean Number of Species:

Sites	df	t	p
D modules	20	2.22	0.038
M modules	18	-0.162	0.870
R modules	18	1.434	0.169
C sites	60	-0.412	0.683

FIGURE F1 Number of species and number of individuals at three module types.

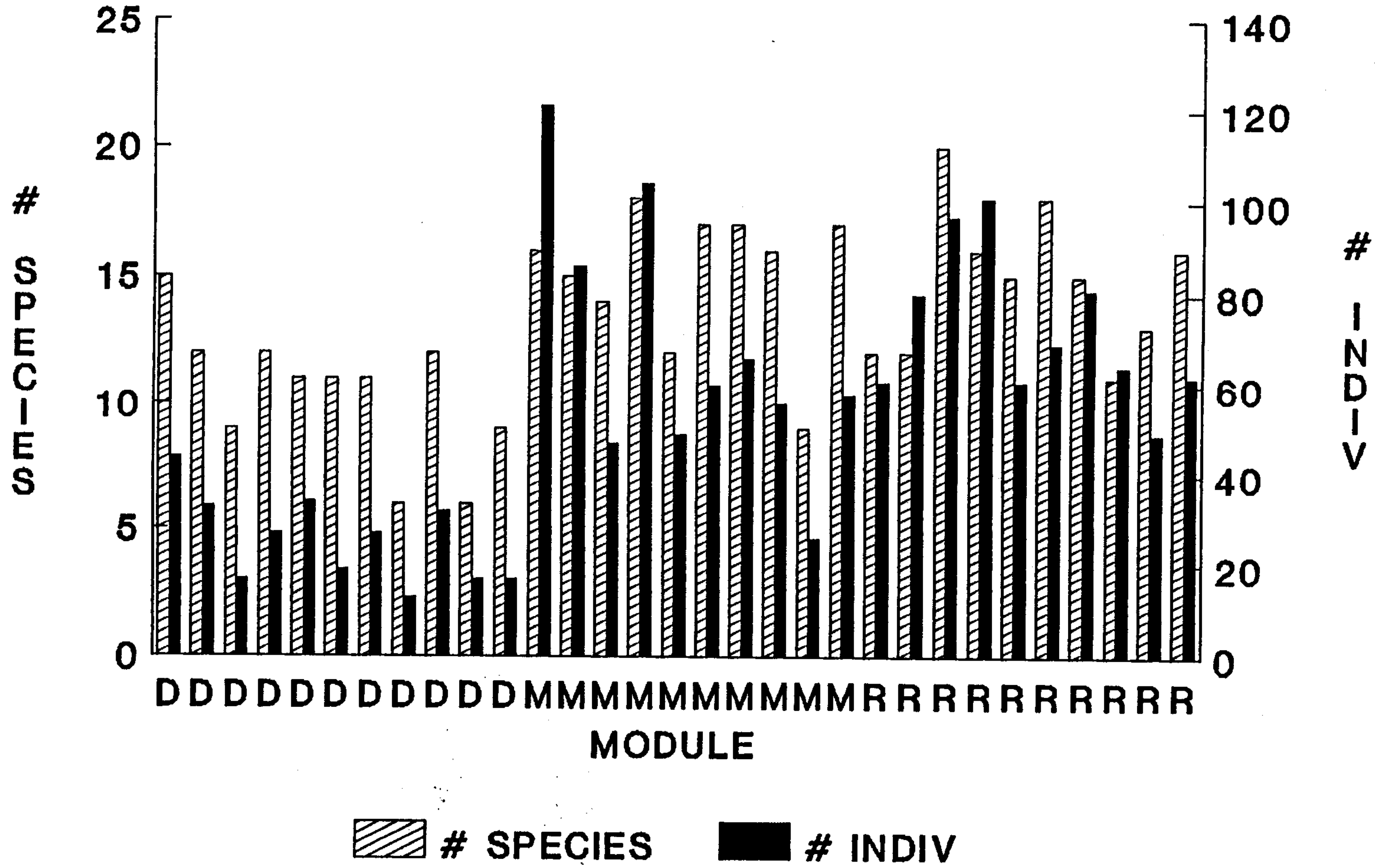
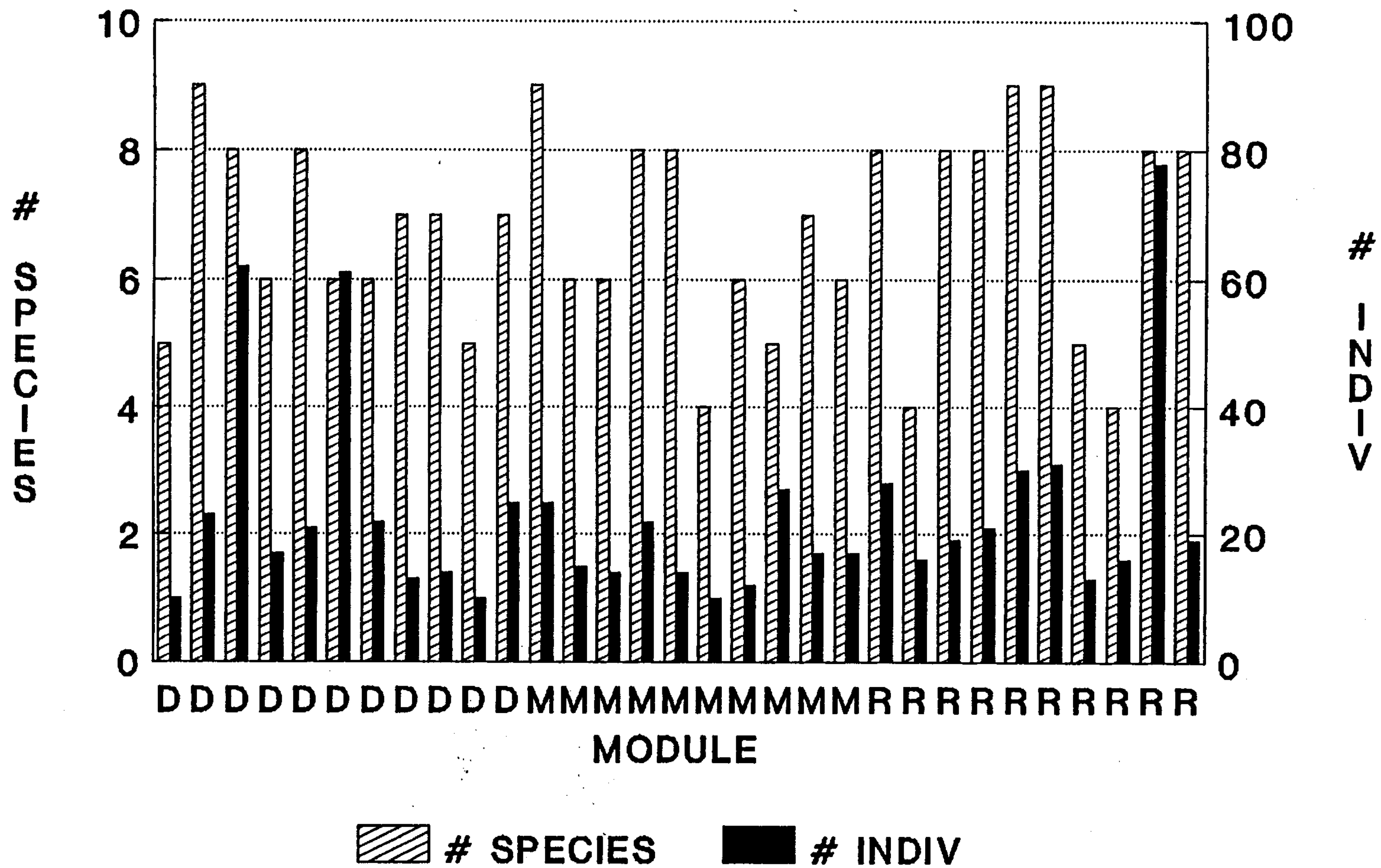


FIGURE F2 Number of species and number of individuals at three reference sites.



IGURE F3 MOST COMMON FISH SPECIES

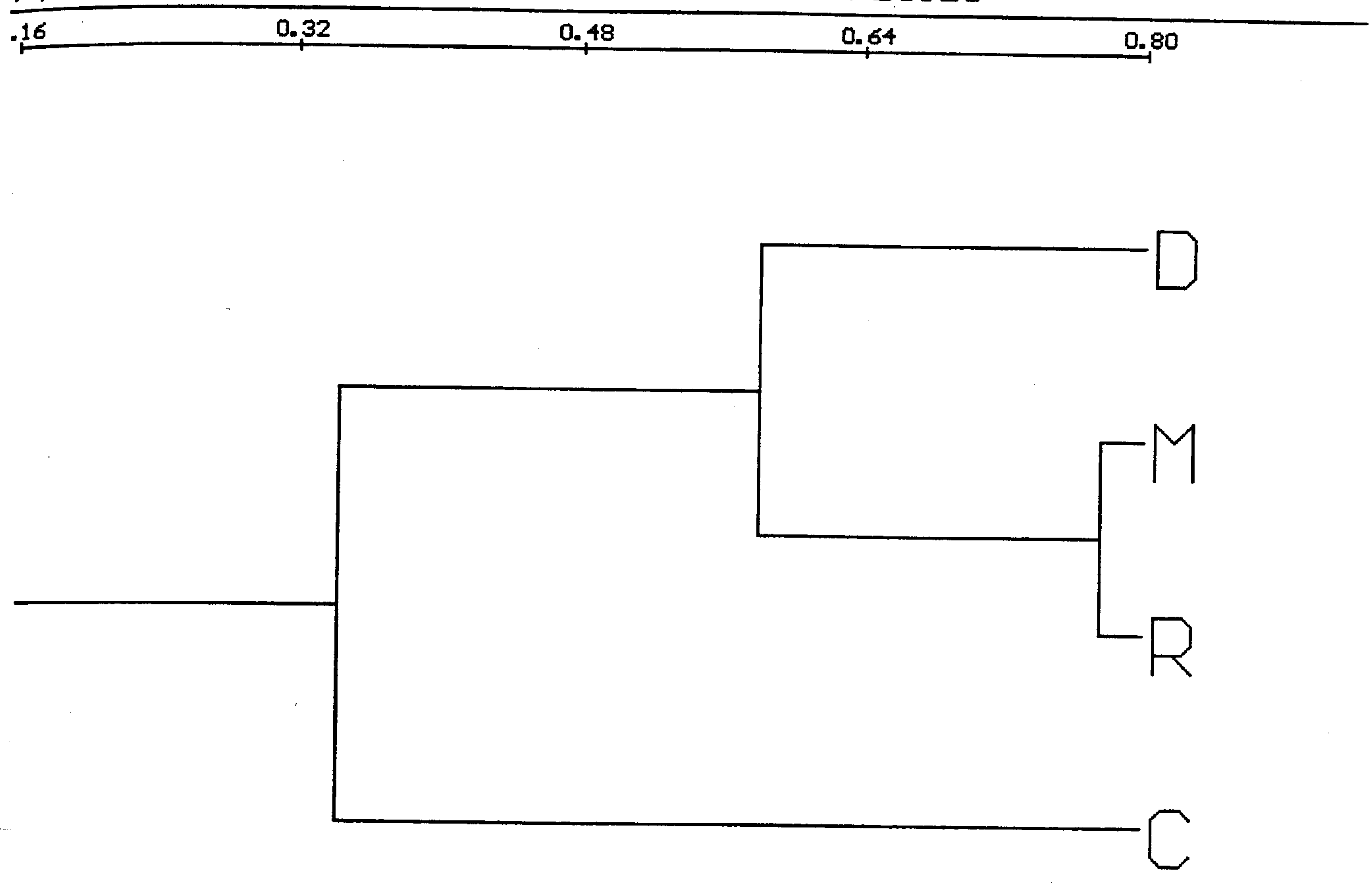
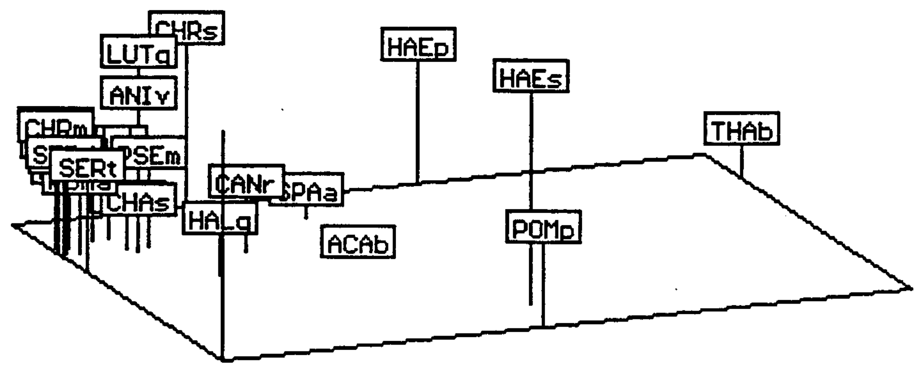


FIGURE F4 MOST COMMON FISH SPECIES



22 b= 20 r=99.0

FIGURE F5 GUILD ANALYSIS OF FISHES

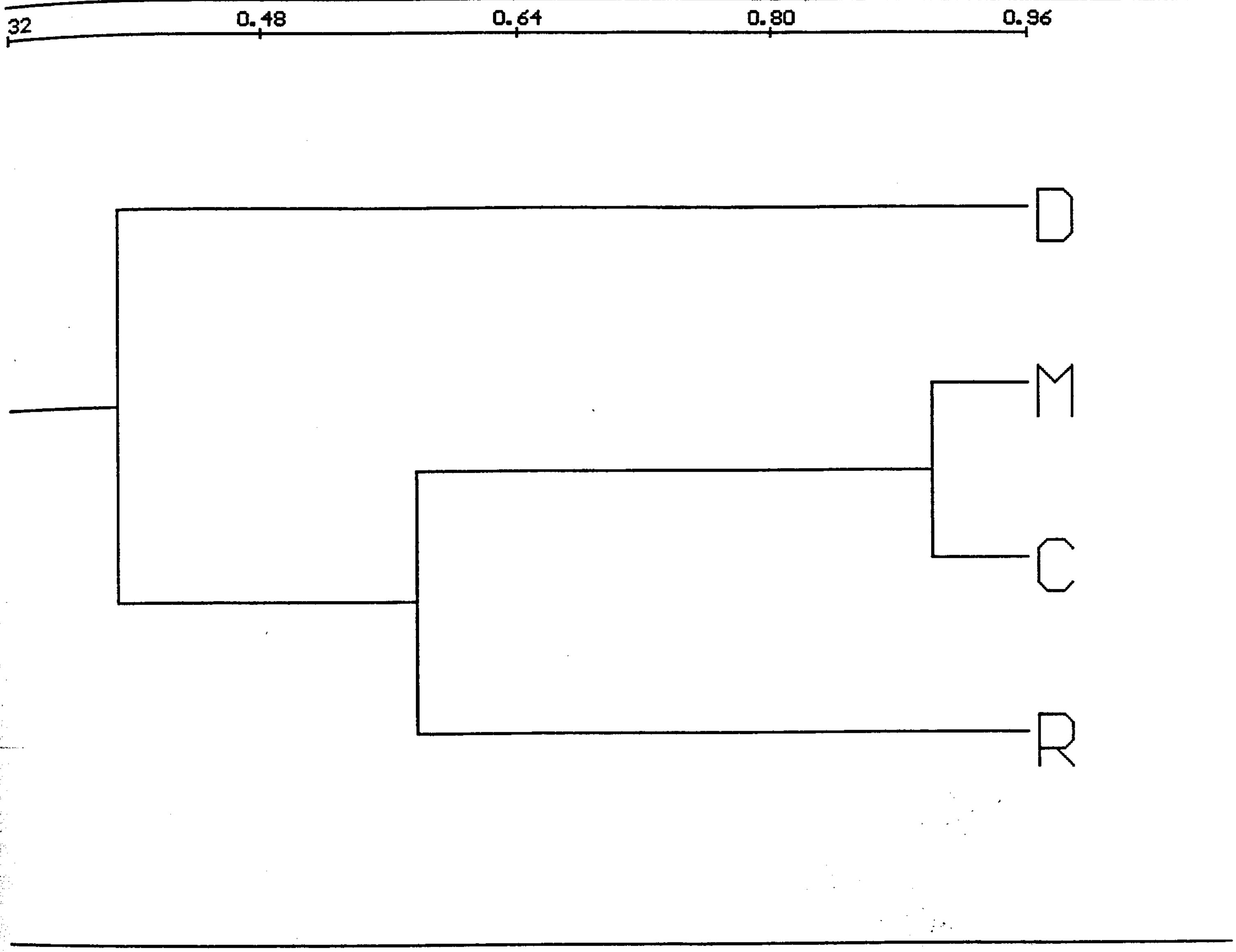
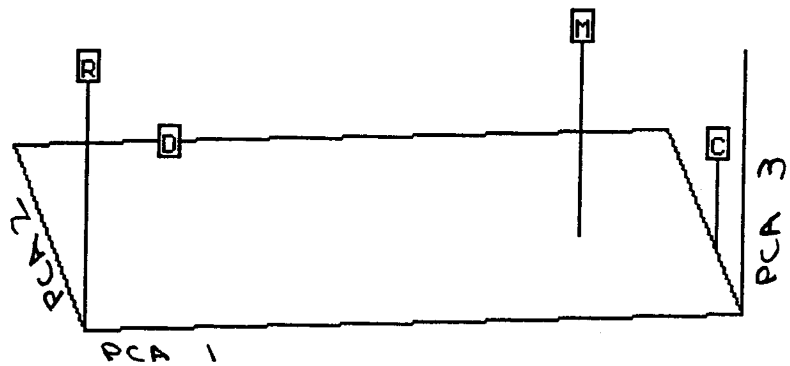
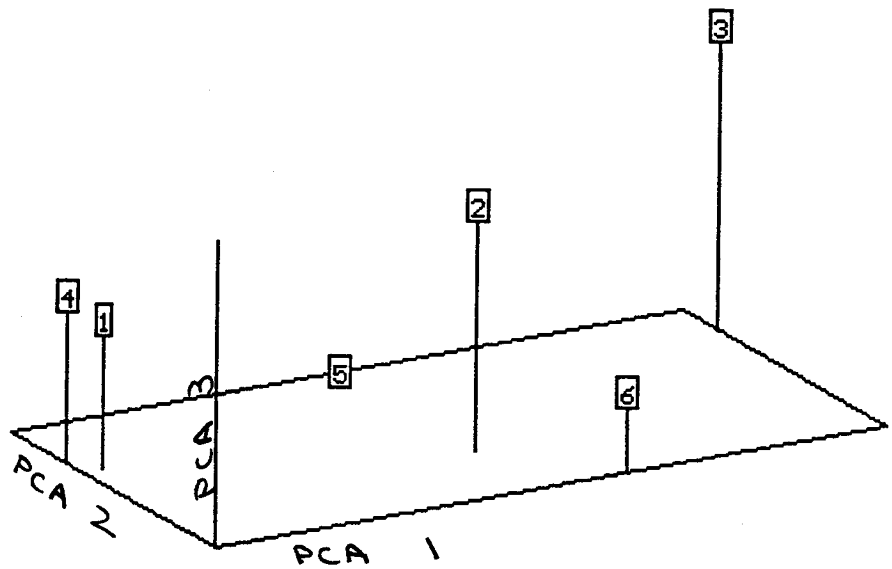


FIGURE F6 GUILD ANALYSIS OF FISHES



97 b= 23 r=99.0

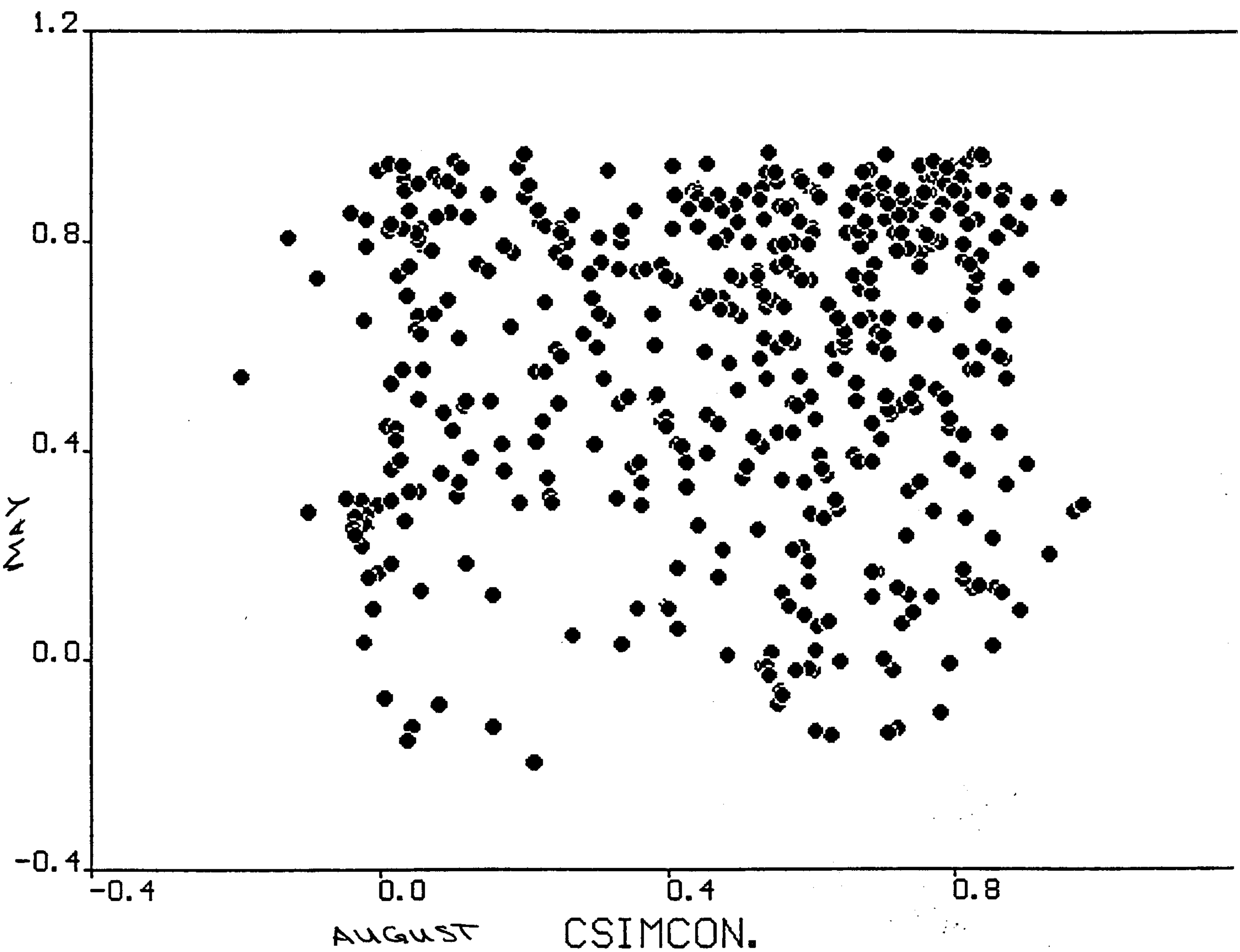
FIGURE F7 GUILD ANALYSIS OF FISHES



30 b= 25 r=99.0

Guild 1 Midwater microcarnivores
Guild 2 Demersal microcarnivores
Guild 3 Demersal mesocarnivores
Guild 4 Macrocarnivores
Guild 5 Planktivores
Guild 6 Herbivores

ɡ. F8 MATRIX COMPARISON OF FISHES AT CONTROLS



G. F9 MATRIX COMPARISON OF FISHES AT MODULES

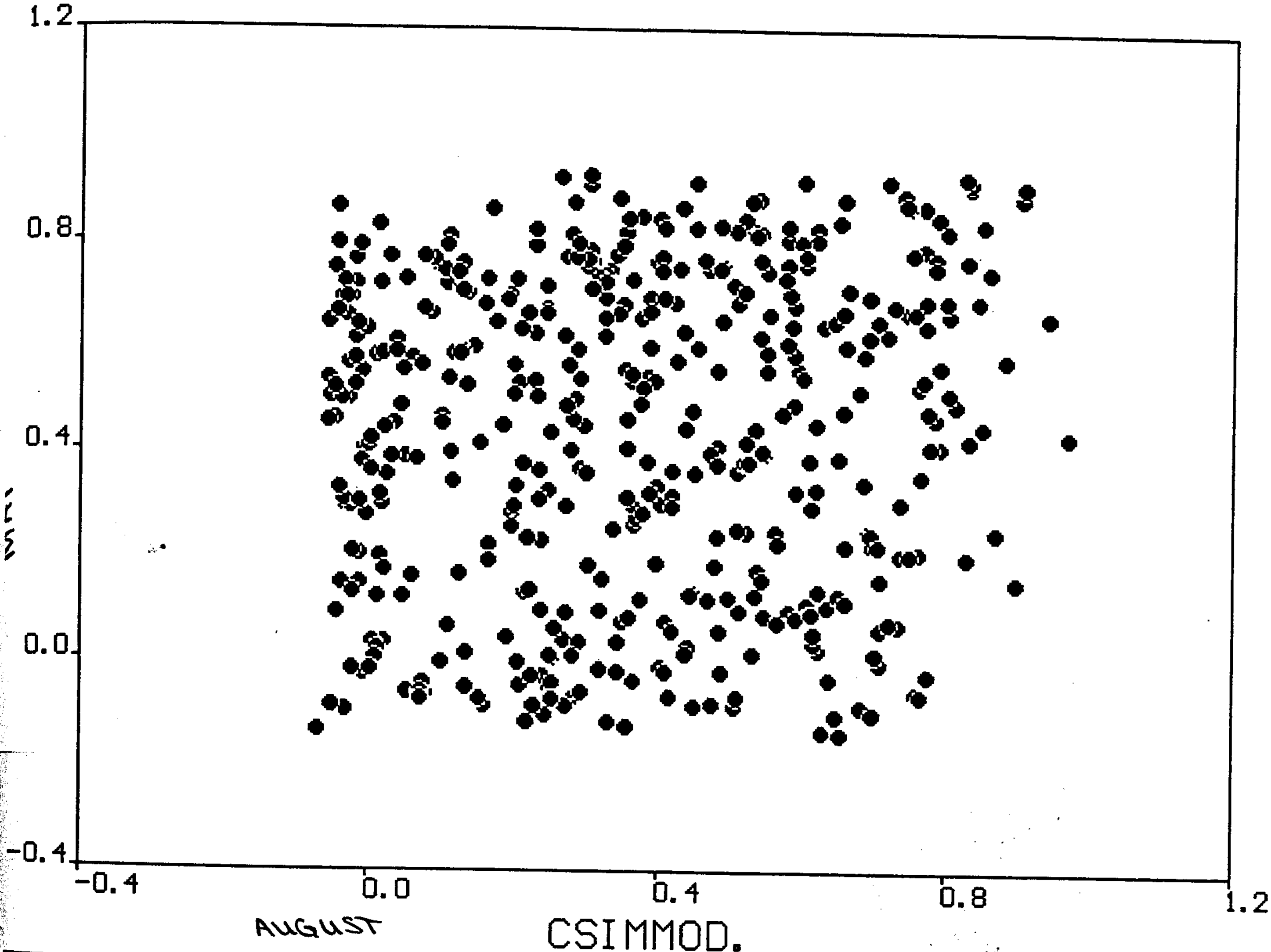


TABLE I1.1 BENTHIC INVERTEBRATE DATA FOR MODULES AND BARREN CONTROLS AND BARREN CONTROLS.

Species	Code	Module D18	D19	D20	D21	D22	D25	D30	D34	D43	D49	D50	M1	M2	M3	M4	M5
Dictyota bartayresii	DICb	0	0	0	0	0	0	0	10	0	0	0	0	0	0	0	0
Halimeda goreaui	HALg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Udotea spp	UDOsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melanostigma nigromaculat	MELn	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
Callyspongia fallax	CALf	0	0	0	0	0	1	0	0	0	1	0	8	1	3	1	0
Ulosa resutzleri	ULOr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holopsamma helwigi	HOLh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliclona rubens	HALr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Verongia longissima	VERsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aplysina spp	APLsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wrangelia argus	WRAa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eucidaris spp	ECUsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Styella plicata	STYp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Niphates digitalis	NIPd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirastrella coccinea	SPIc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callyspongia vaginalis	CALv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telesto riseii	TELr	0	0	0	0	0	0	0	0	0	0	0	10	10	3	0	0
Briareum asbestinum	BRIa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eunicea fusca	EUNf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichocoenia stokesi	DICs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eusmilia fastigiata	EUSf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siderastrea siderea	SIDs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serpula spp	SERsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lima lima	LIMl	2	2	0	2	0	0	2	0	0	1	1	0	0	0	0	0
Spondylus americanus	SPOa	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	1
Stenopus hispidus	STEh	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	2
Stenorhynchus seticornis	STEs	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Parasmittina spp	PARsp	2	0	0	1	0	0	0	0	0	0	0	0	3	15	16	2
Watersipora spp	WATsp	0	0	1	0	0	0	0	0	0	0	1	0	0	1	5	1
Echinometra lucunter	ECHl	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Ascidia nigra	ASCn	0	0	0	0	1	0	0	0	0	0	0	2	1	0	1	1
Stolonicus sabulosa	STOs	0	0	0	1	0	0	2	0	0	5	1	0	0	0	0	0
unid didemnidae	didem	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stephanocoenia michelini	STEm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Millepora alcicornis	MILa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Panulirus argus	PANa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL NUMBER OF INDIVIDUALS		5	3	3	6	1	2	4	11	1	7	4	20	16	22	23	7

TABLE I1.2 BENTHIC INVERTEBRATE DATA FOR MODULES AND BARREN CONTROLS

Species	Code	Module M6	M7	M8	M9	M10	R2	R4	R7	R14	R15	R16	R17	R21	R22	R23
Dictyota bartayresii	DICb	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Halimeda goreaui	HALg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Udotea spp	UDOsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Melanostigma nigromaculat	MELn	0	0	0	3	1	4	0	0	0	0	0	0	2	1	0
Callyspongia fallax	CALf	0	0	0	0	0	2	2	0	0	1	0	0	0	2	0
Ulosa resutzleri	ULOr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Holopsamma helwigi	HOLh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haliclona rubens	HALr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Verongia longissima	VERsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aplysina spp	APLsp	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wrangelia argus	WRAa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eucidaris spp	ECUsp	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0
Styella plicata	STYp	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
Niphates digitalis	NIPd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spirastrella coccinea	SPIc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Callyspongia vaginalis	CALv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Telesto riseii	TELr	0	10	3	0	10	0	0	0	0	0	0	0	0	0	0
Briareum asbestinum	BRIa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eunicea fusca	EUNf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dichocoenia stokesi	DICs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eusmilia fastigiata	EUSf	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siderastrea siderea	SIDs	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Serpula spp	SERsp	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
Lima lima	LIMl	0	0	1	0	0	6	6	3	5	3	7	3	5	2	0
Spondylus americanus	SPOa	3	3	2	3	0	0	1	0	1	0	0	0	0	0	0
Stenopus hispidus	STEh	0	0	2	0	0	0	0	1	0	0	0	1	2	0	0
Stenorhynchus seticornis	STEs	0	0	1	3	2	0	0	0	0	0	0	0	0	0	0
Parasmittina spp	PARsp	8	8	5	4	10	1	0	1	1	0	1	2	0	0	1
Watersipora spp	WATsp	0	7	1	4	1	0	1	0	0	0	0	0	0	0	0
Echinometra lucunter	ECHl	0	0	0	0	0	2	0	0	0	0	0	0	1	0	2
Ascidia nigra	ASCn	0	2	0	0	6	0	0	1	0	1	3	0	2	0	0
Stolonicus sabulosa	STOs	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1
unid didemnidae	didem	0	0	0	0	1	2	6	0	0	0	0	0	0	0	0
Stephanocoenia michelini	STEm	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Millepora alcicornis	MILa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Panulirus argus	PANa	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
TOTAL NUMBER OF INDIVIDUALS		11	30	18	18	31	19	18	6	7	8	11	6	13	5	4

TABLE I1.3 BENTHIC INVERTEBRATE DATA FOR MODULES AND BARREN CONTROLS

		Barren Control										TOTAL
Species	Code	BC3	BC8	BC14	BC19	BC20	BC21	BC27	BC30	BC37	BC39	
Dictyota bartayresii	DICb	0	0	0	10	0	0	0	0	0	0	20
Halimeda goreaui	HALg	0	2	0	1	1	0	2	0	0	3	9
Udotea spp	UDOsp	0	0	0	0	0	8	3	0	4	11	26
Melanostigma nigromaculat	MELn	0	0	0	0	0	0	0	0	0	0	12
Callyspongia fallax	CALf	0	0	0	0	0	0	0	0	0	0	22
Ulosa resutzleri	ULOr	0	0	1	0	0	0	0	0	0	0	1
Holopsamma helwigi	HOLh	0	3	1	5	1	0	2	0	0	3	15
Haliclona rubens	HALr	1	1	0	1	0	0	0	0	0	0	3
Verongia longissima	VERsp	0	0	0	0	0	0	0	0	1	0	1
Aplysina spp	APLsp	0	0	0	0	0	0	1	0	0	0	1
Wrangelia argus	WRAa	10	0	0	0	0	10	0	0	0	0	20
Eucidaris spp	ECUsp	0	0	0	0	0	0	0	0	0	0	2
Styella plicata	STYp	0	0	0	0	0	0	0	0	0	0	3
Niphates digitalis	NIPd	2	1	0	2	0	1	0	0	0	0	6
Spirastrella coccinea	SPIc	0	0	0	1	0	1	0	0	0	0	2
Callyspongia vaginalis	CALv	0	2	0	0	0	0	0	0	0	0	2
Telesto riseii	TELr	0	0	0	0	0	0	0	0	0	0	46
Briareum asbestinum	BRIa	1	0	0	1	0	0	0	0	0	0	2
Eunicea fusca	EUNf	0	0	0	3	0	0	1	0	0	0	4
Dichocoenia stokesi	DICs	1	0	0	0	0	0	0	0	0	0	1
Eusmilia fastigiata	EUSf	0	1	1	0	0	0	0	0	0	0	2
Siderastrea siderea	SIDs	1	0	0	0	0	0	0	0	0	0	1
Serpula spp	SERsp	0	0	0	0	0	0	0	0	0	0	3
Lima lima	LIMl	0	0	0	0	0	0	0	0	0	0	51
Spondylus americanus	SPOa	0	0	0	0	0	0	0	0	0	0	17
Stenopus hispidus	STEh	0	0	0	0	0	0	0	0	0	0	10
Stenorhynchus seticornis	STEs	0	0	0	0	0	0	0	0	0	0	8
Parasmittina spp	PARsp	0	0	0	0	0	0	0	0	0	0	81
Watersipora spp	WATsp	0	0	0	0	0	0	0	0	0	0	23
Echinometra lucunter	ECHl	0	0	0	0	0	0	0	0	0	0	6
Ascidia nigra	ASCn	0	0	0	0	0	0	0	0	0	0	21
Stolonicus sabulosa	STOs	0	0	0	0	0	0	0	0	0	3	15
unid didemnidae	didem	0	0	0	0	0	0	0	0	0	0	11
Stephanocoenia michelini	STEm	0	1	0	0	0	1	0	0	0	0	2
Millepora alcicornis	MILa	0	0	0	0	0	0	0	0	0	0	1
Panulirus argus	PANa	0	0	0	0	0	0	0	0	0	0	1
TOTAL NUMBER OF INDIVIDUALS		16	11	3	24	2	21	9	0	5	20	451

TABLE 12. Summary statistics of invertebrate data for the four study sites (D, M, R, and BC)

MODULE	N	Diversity Index H	Total # indiv.	Range	Total # species	Range	Most common species
D	11	0.93	47	1 to 11	12	1 to 4	Lima lima n=10 Dictyota sp. n=10 (one colony) Stolonicus sabulosa n=9 Spondylus americanus n=3 Parasmittina sp. n=3
M	10	0.82	196	7 to 31	14	2 to 10	Parasmittina sp. n=71 Telesto riseii n=46 Watersipora sp. n=20 Callyspongia fallax n=13
R	10	0.91	97	6 to 19	16	3 to 8	Lima lima n=40 Didemnidae n=8 Ascidia nigra n=7 Parasmittina sp. n=7 Callyspongia falax n=7 Melanostigma nigromaculata n=7
BC	31	1.03	111	0 to 24	19	0 to 8	Udotea sp. n=26 Wrangelia argus n=20 (two colonies) Holopsamma helwigi n=15 Dictyota sp. n=10 (one colony) Halimeda goreaui n=9

Module	N	$\bar{X}$ of indiv. per module	s.e.	$\bar{X}$ species per module	s.e.
D	11	4.27	0.89	2.36	0.31
M	10	19.6	2.37	5.1	0.71
R	10	9.7	5.38	4.3	0.56
BC	31	11.1	2.75	4.2	0.79

TABLE I3. One-way Analysis of Variance for the four study site types (D, M, R, and BC) for invertebrate data.

Number of individuals:

Source	df	Sum of Squares	Mean Squares	F-value	p
Between	3	1254.4	418.1	10.09	<0.000
Within	37	1533.6	41.4		

The calculated F-value indicates that there are significant differences among the means of the populations (p<0.000).

Number of species:

Source	df	Sum of Squares	Mean Squares	F-value	p
Between	3	42.8	14.3	3.79	0.0182
Within	37	139.1	3.8		

The calculated F-value indicates that there are significant differences among the means of the populations (p=0.0182).

Table I4. Results of t-tests (independent samples, separate variance) comparing mean number of individuals and mean number of species in the four study sites (D, M, R, and BC).

Mean Number of Individuals:

Sites	df	t	p
D vs M	19	-6.281	<0.000
D vs R	19	-2.910	0.009
M vs R	18	-3.392	0.003
D vs BC	19	-2.459	0.024
M vs BC	18	2.340	0.031
R vs BC	18	-0.433	0.670

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Mean Number of Species:

Sites	df	t	p
D vs M	19	-3.666	0.002
D vs R	19	-3.107	0.006
M vs R	18	0.888	0.386
D vs BC	19	-2.253	0.036
M vs BC	18	0.851	0.406
R vs BC	18	0.104	0.919

TABLE I5. Summary of Invertebrate data for modules (D, M, and R) and Barren controls (BC).

Species	Code	D n=11	M n=10	R n=10	BC n=10	TOTAL
Dictyota bartayresii	DICb	10	0	0	10	20
Halimeda goreaui	HALg	0	0	0	9	9
Udotea spp	UDOsp	0	0	0	26	26
Melanostigma nigromaculat	MELn	0	5	7	0	12
Callyspongia fallax	CALf	2	13	7	0	22
Ulosa resutzleri	ULOr	0	0	0	1	1
Holopsamma helwigi	HOLh	0	0	0	15	15
Haliclona rubens	HALr	0	0	0	3	3
Verongia longissima	VERsp	0	0	0	1	1
Aplysina spp	APLsp	0	0	0	1	1
Wrangelia argus	WRAa	0	0	0	20	20
Eucidaris spp	ECUsp	0	1	1	0	2
Styella plicata	STYp	0	2	1	0	3
Niphates digitalis	NIPd	0	0	0	6	6
Spirastrella coccinea	SPIc	0	0	0	2	2
Callyspongia vaginalis	CALv	0	0	0	2	2
Telesto riseii	TELr	0	46	0	0	46
Briareum asbestinum	BRIa	0	0	0	2	2
Eunicea fusca	EUNf	0	0	0	4	4
Dichocoenia stokesi	DICs	0	0	0	1	1
Eusmilia fastigiata	EUSf	0	0	0	2	2
Siderastrea siderea	SIDs	0	0	0	1	1
Serpula spp	SERsp	0	0	3	0	3
Lima lima	LIMl	10	1	40	0	51
Spondylus americanus	SPOa	3	12	2	0	17
Stenopus hispidus	STEh	2	4	4	0	10
Stenorhynchus seticornis	STEs	2	6	0	0	8
Parasmittina spp	PARsp	3	71	7	0	81
Watersipora spp	WATsp	2	20	1	0	23
Echinometra lucunter	ECHl	1	0	5	0	6
Ascidia nigra	ASCn	1	13	7	0	21
Stolonicus sabulosa	STOs	9	1	2	3	15
unid didemnidae	didem	2	1	8	0	11
Stephanocoenia michelini	STEm	0	0	0	2	2
Millepora alcicornis	MILa	0	0	1	0	1
Panulirus argus	PANa	0	0	1	0	1
TOTAL NUMBER OF INDIVIDUALS		47	196	97	111	451

Table I6. Results of t-tests (independent samples, separate variance) comparing mean number of individuals and mean number of species in the four study sites (D, M, R, and BC) in May and August.

Mean Number of Individuals:

Sites	df	t	p
D modules	13	0.728	0.479
M modules	18	-0.111	0.913
R modules	17	-0.905	0.378
BC sites	16	0.183	0.857

Mean Number of Species:

Sites	df	t	p
D modules	13	0.473	0.644
M modules	18	1.308	0.208
R modules	17	-1.110	0.282
BC sites	16	0.279	0.784

FIGURE I1 Number of species and number of individuals at modules and background control sites.

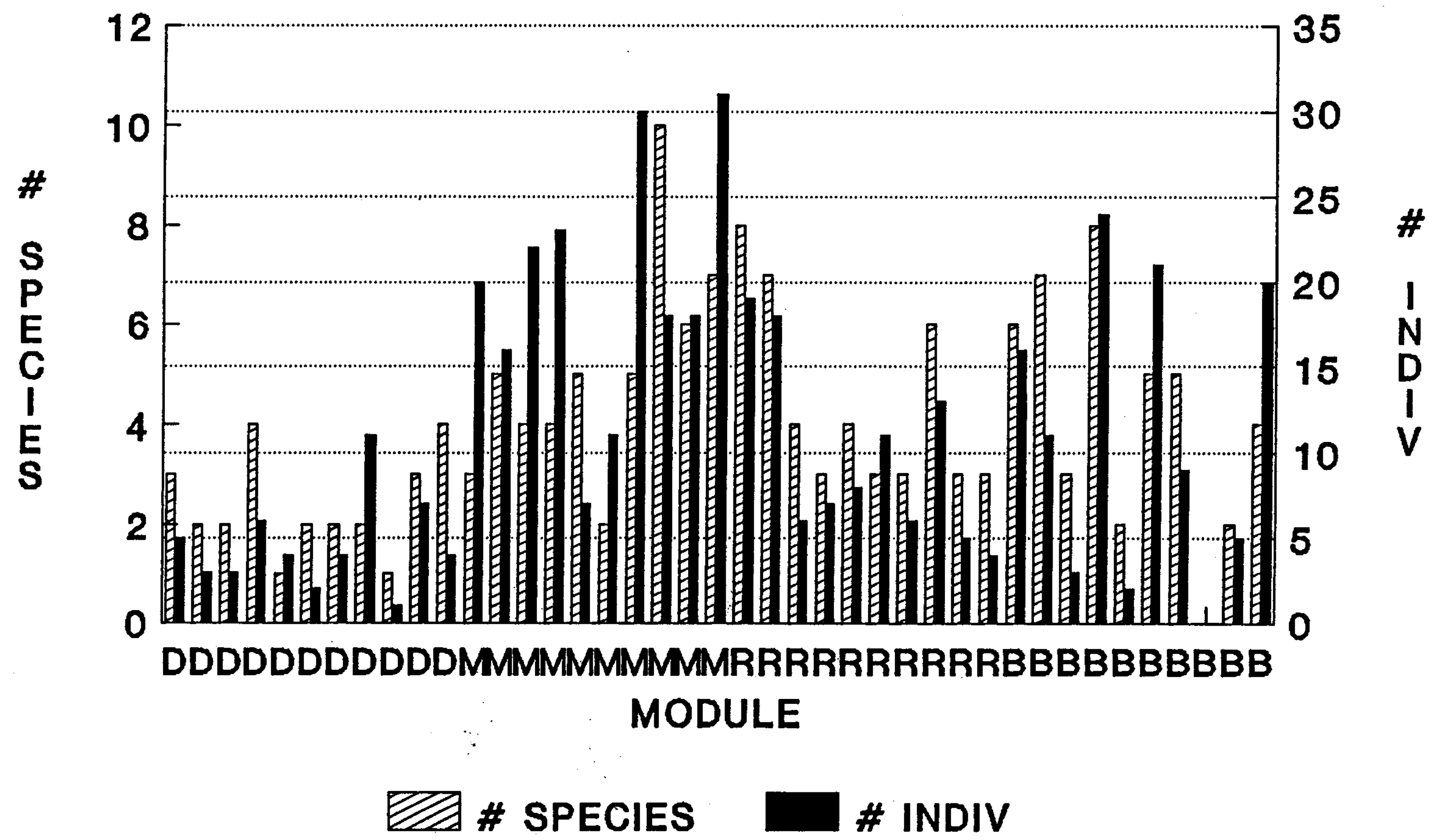


FIGURE II SCALED DOWN INVERTEBRATE ANALYSIS

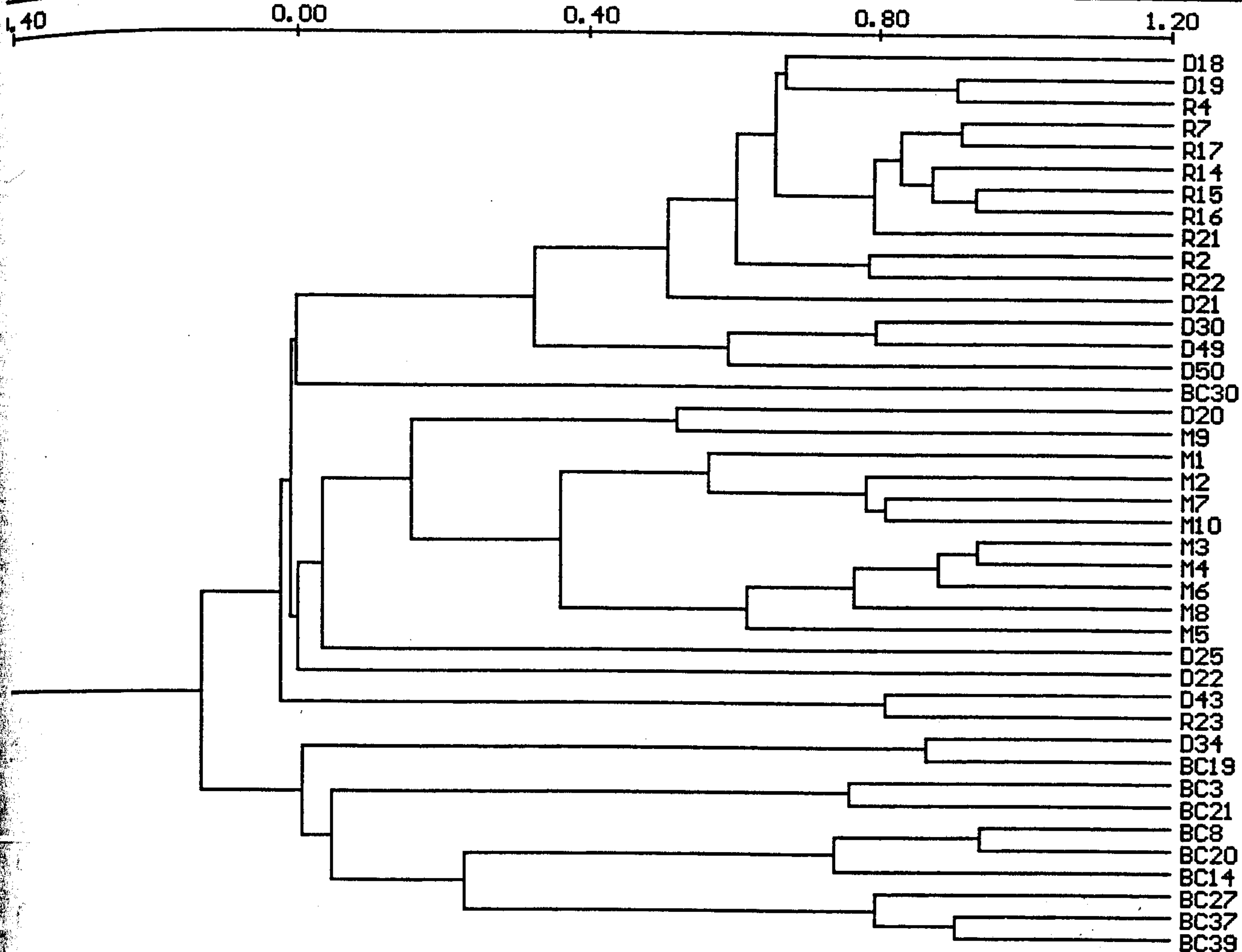
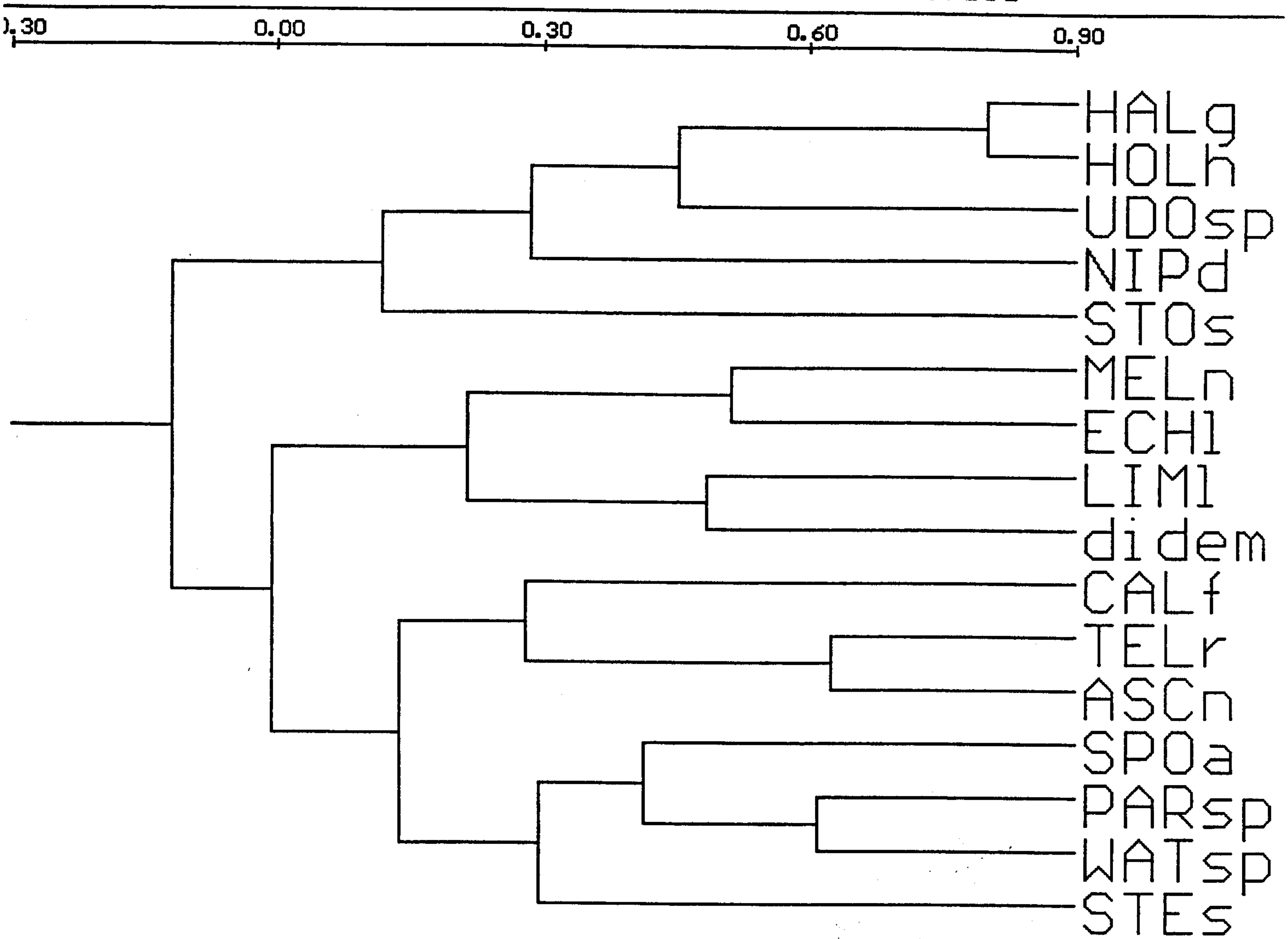
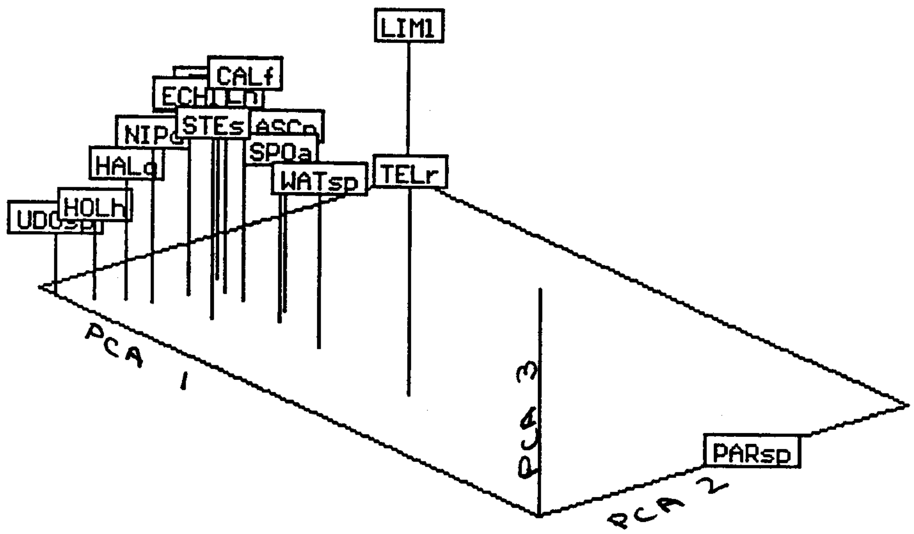


FIGURE I3 SCALED DOWN INVERTEBRATE ANALYSIS

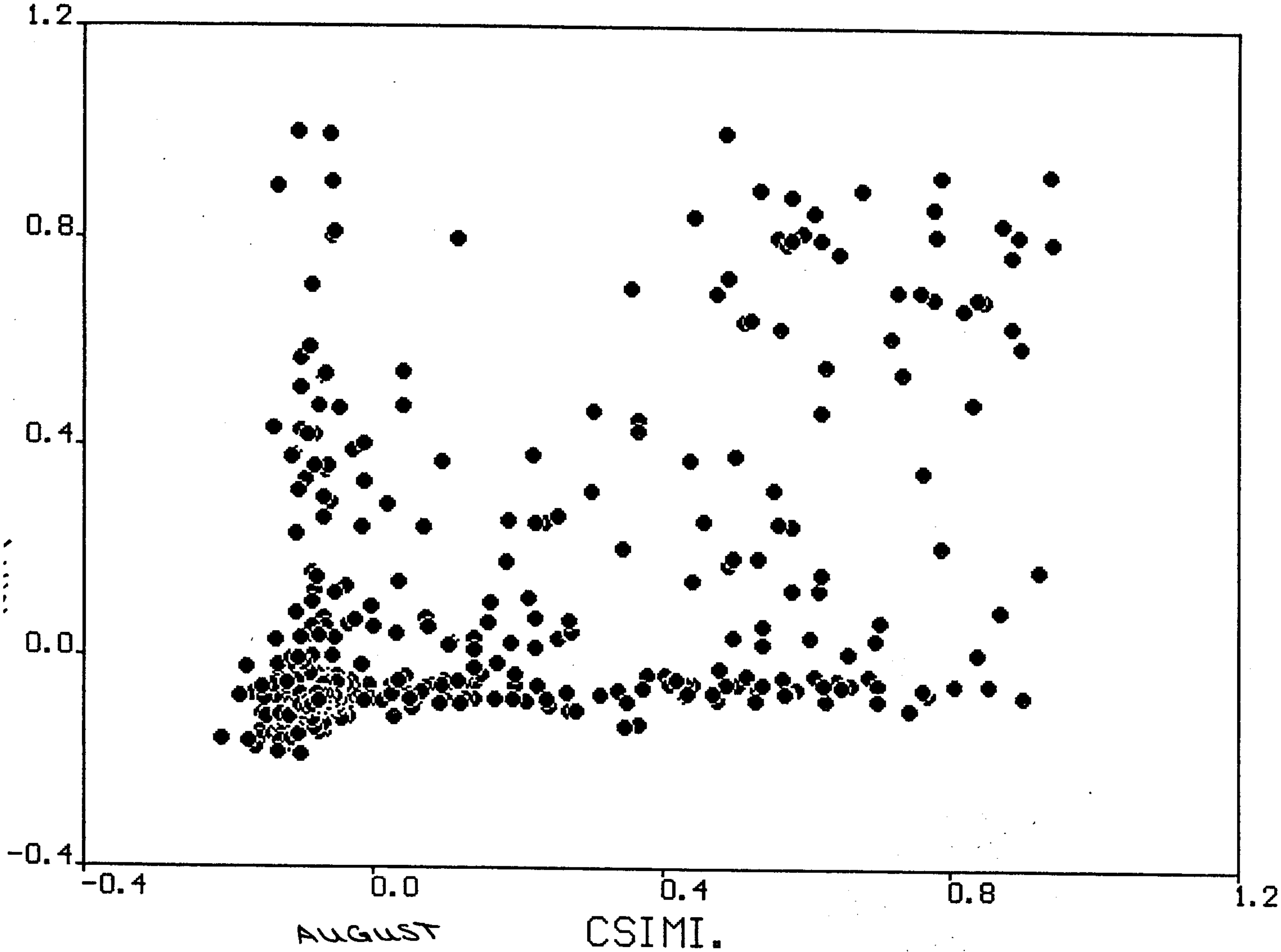


GURE I4 SCALED DOWN INVERTEBRATE ANALYSIS



40 b= 29 r=99.0

URE 15 MATRIX COMPARISON OF INVERTEBRATE DATA



APPENDIX C

PHOTOGRAPHIC LOG

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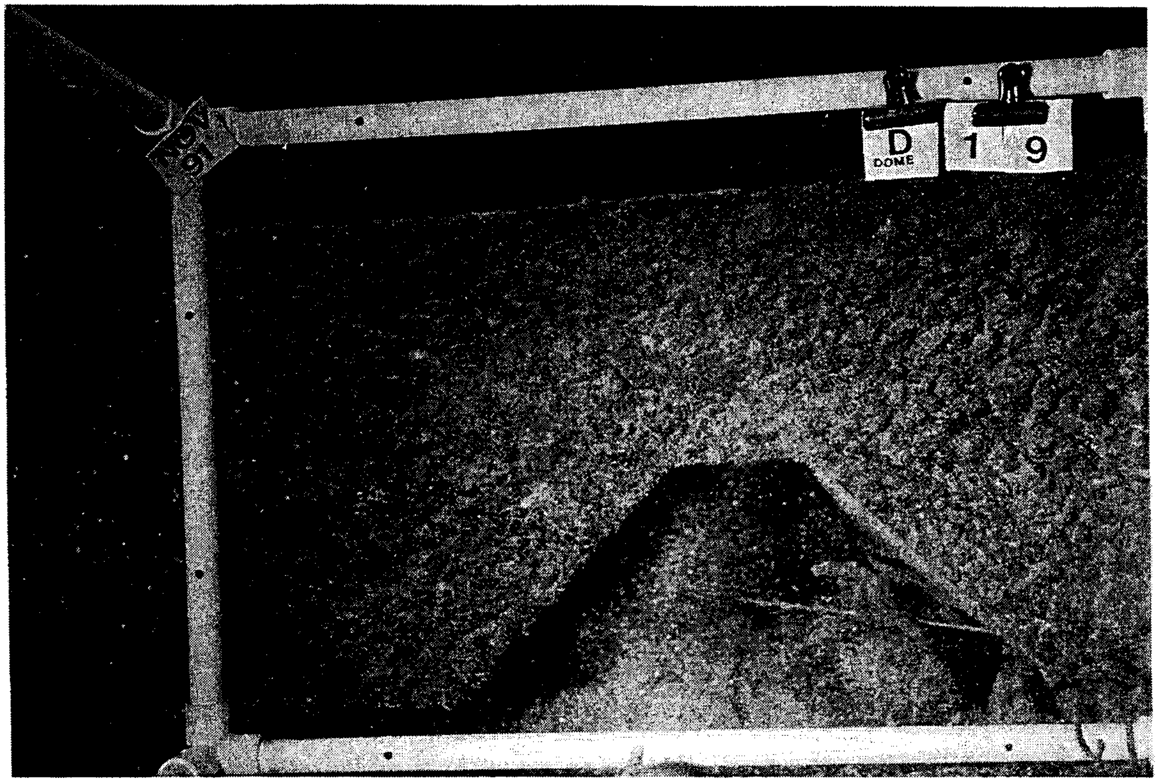

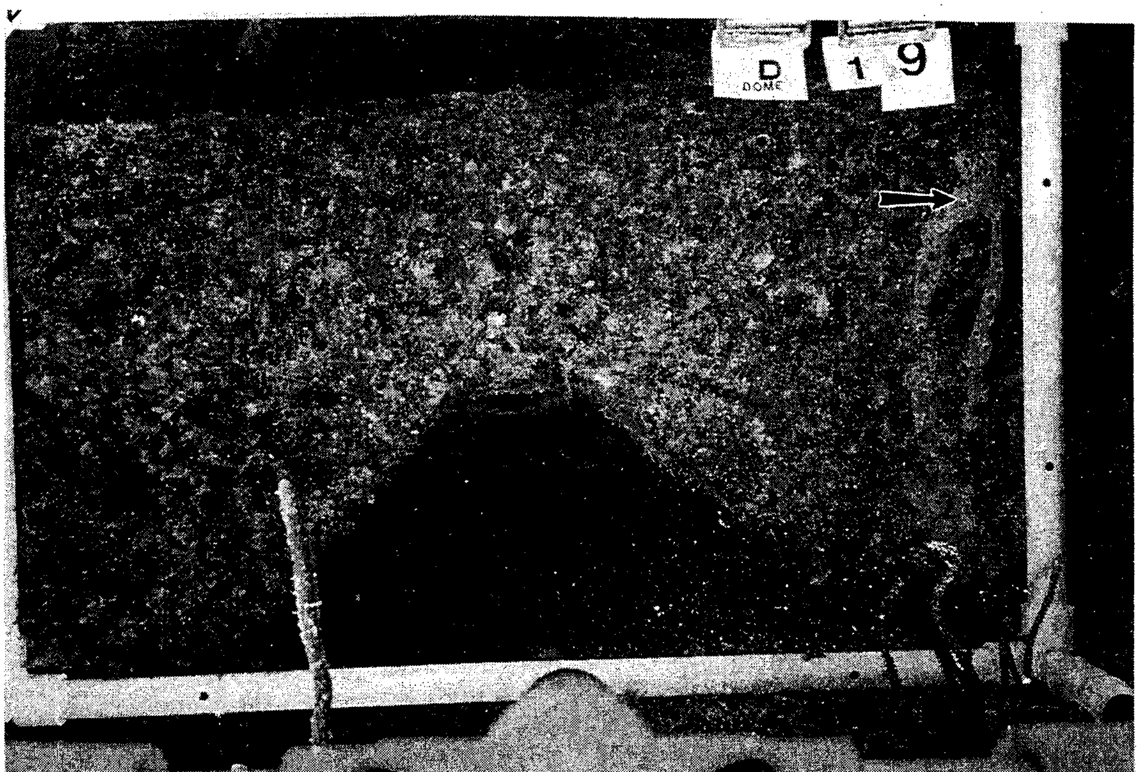

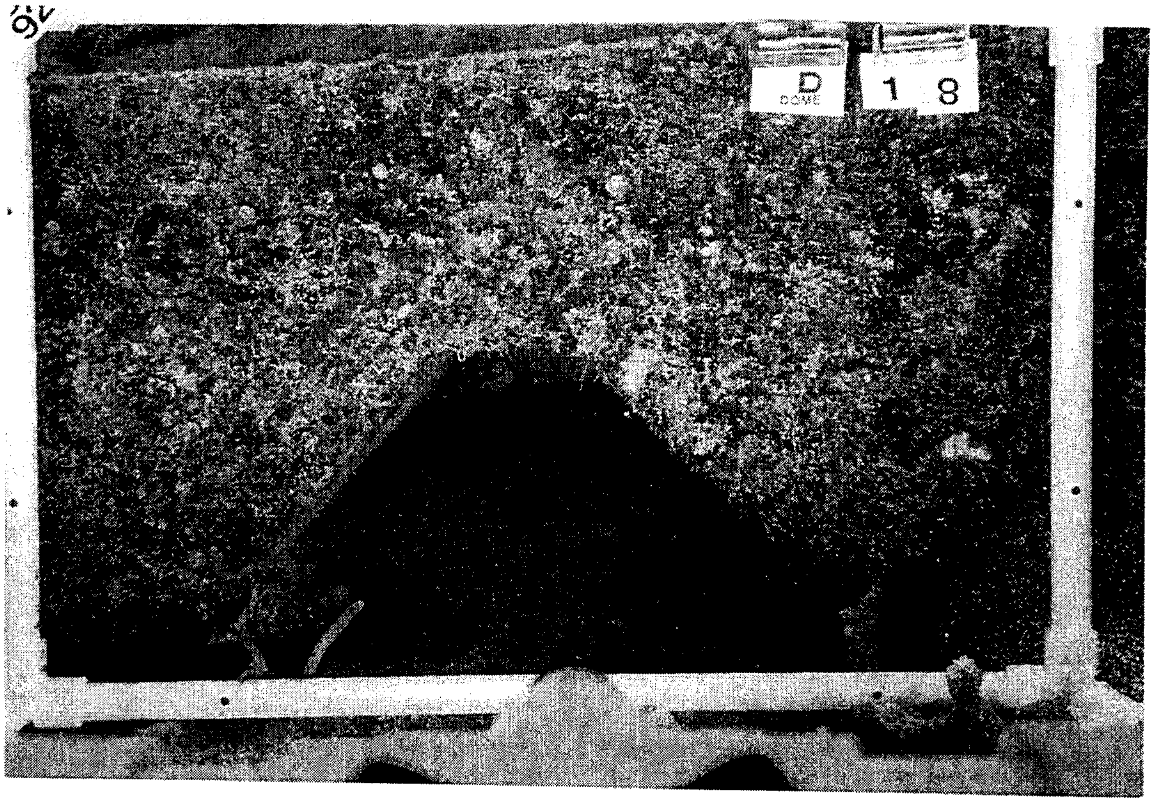
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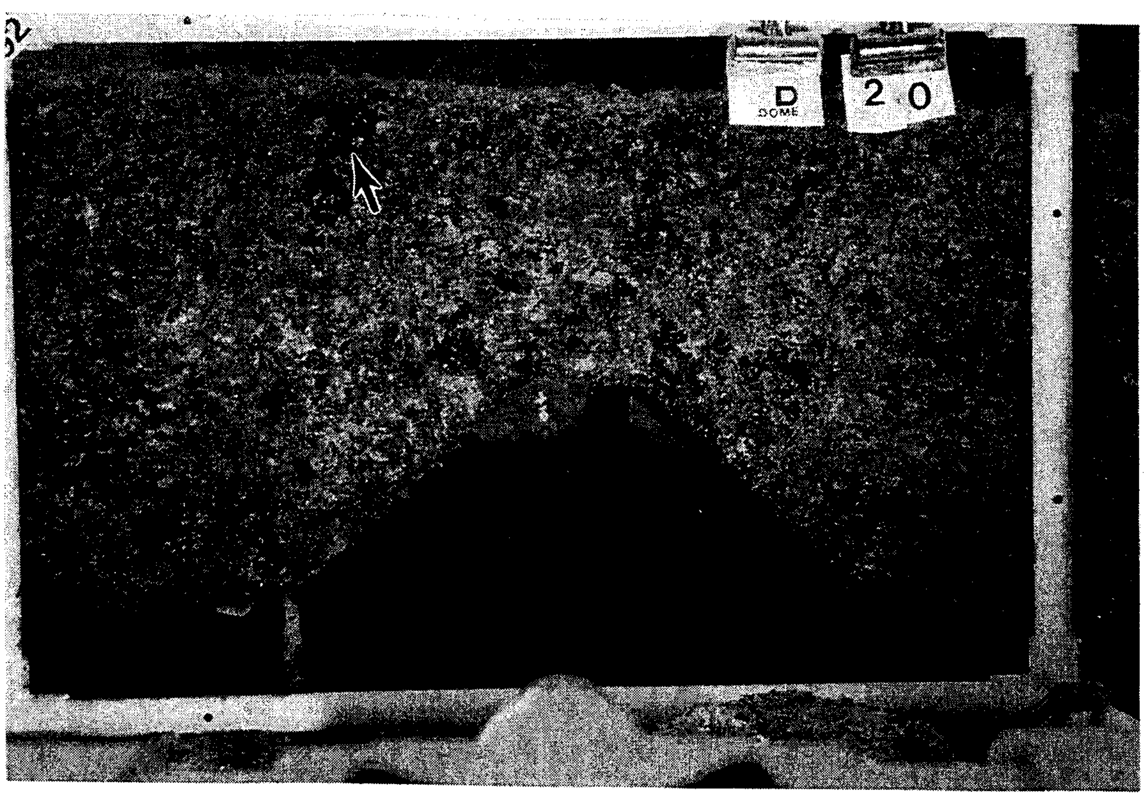
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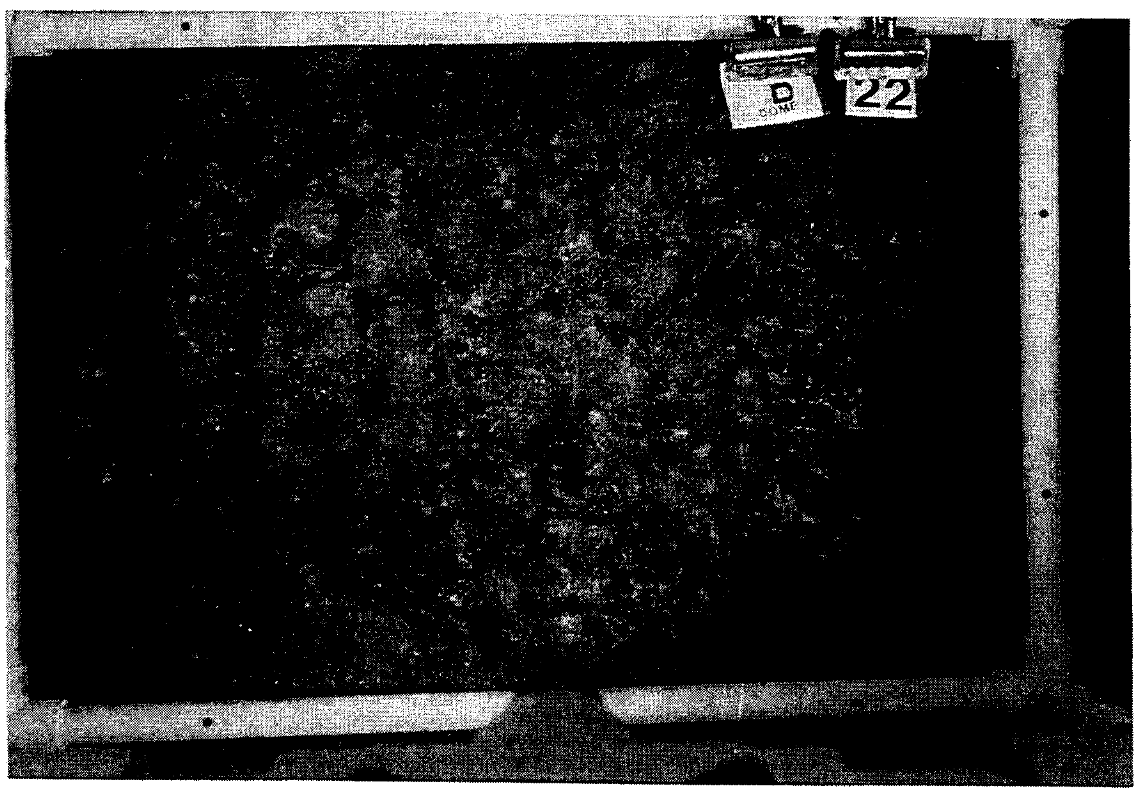
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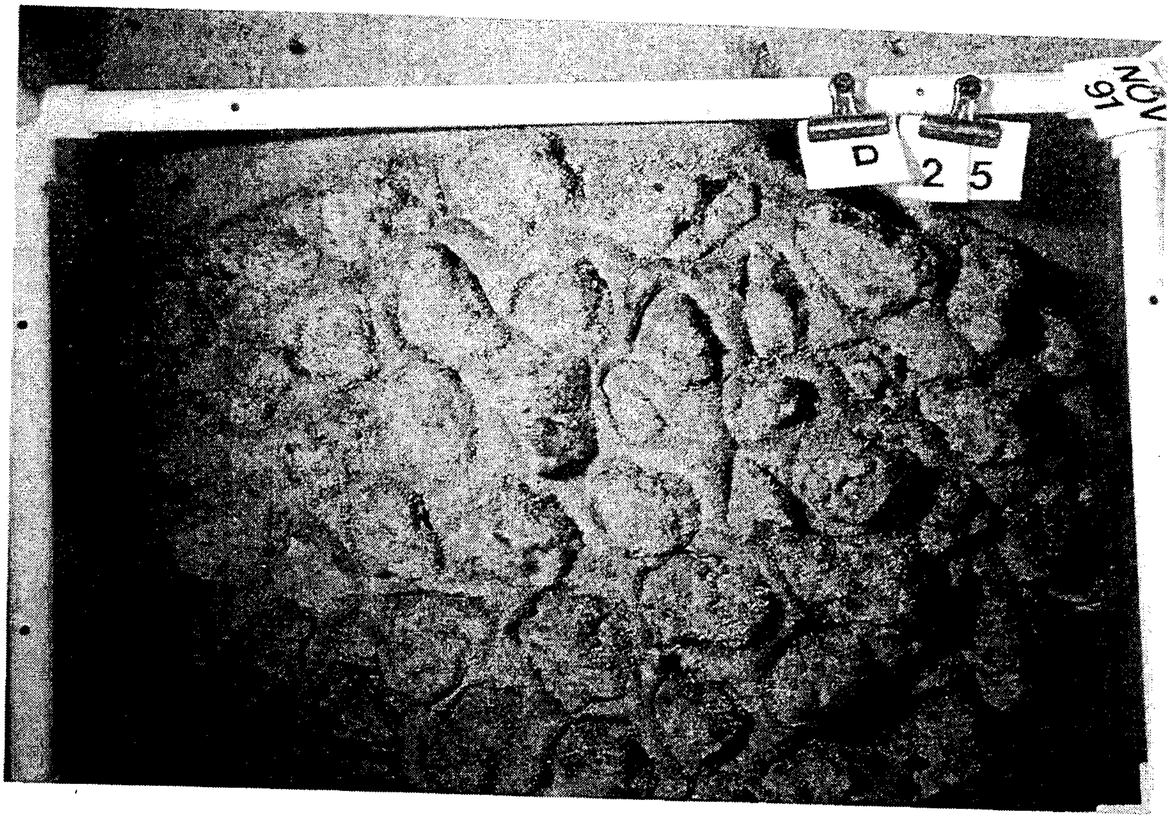
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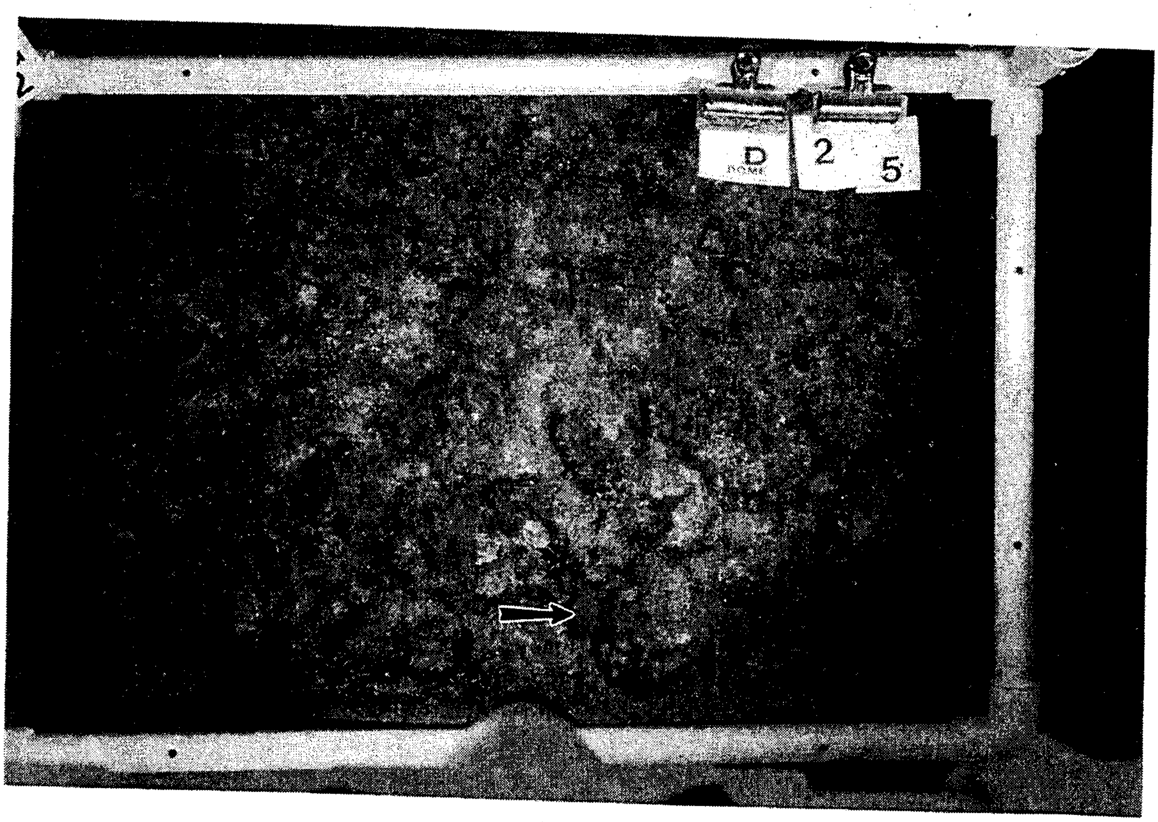
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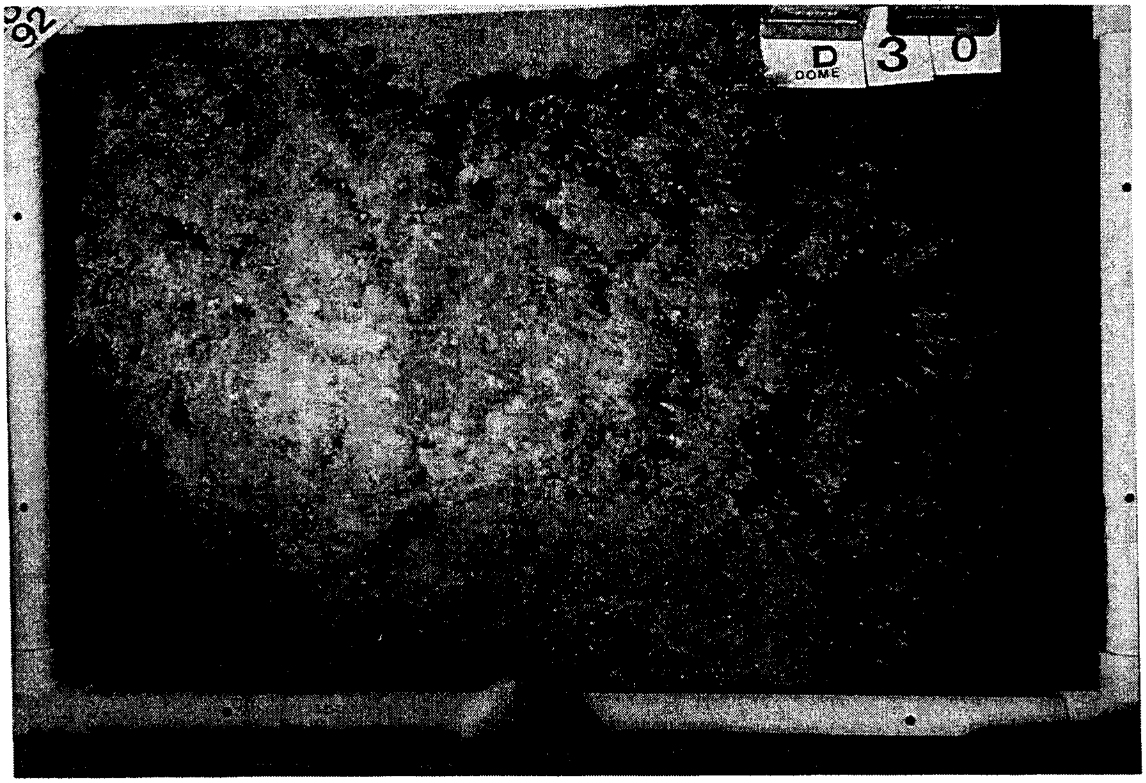
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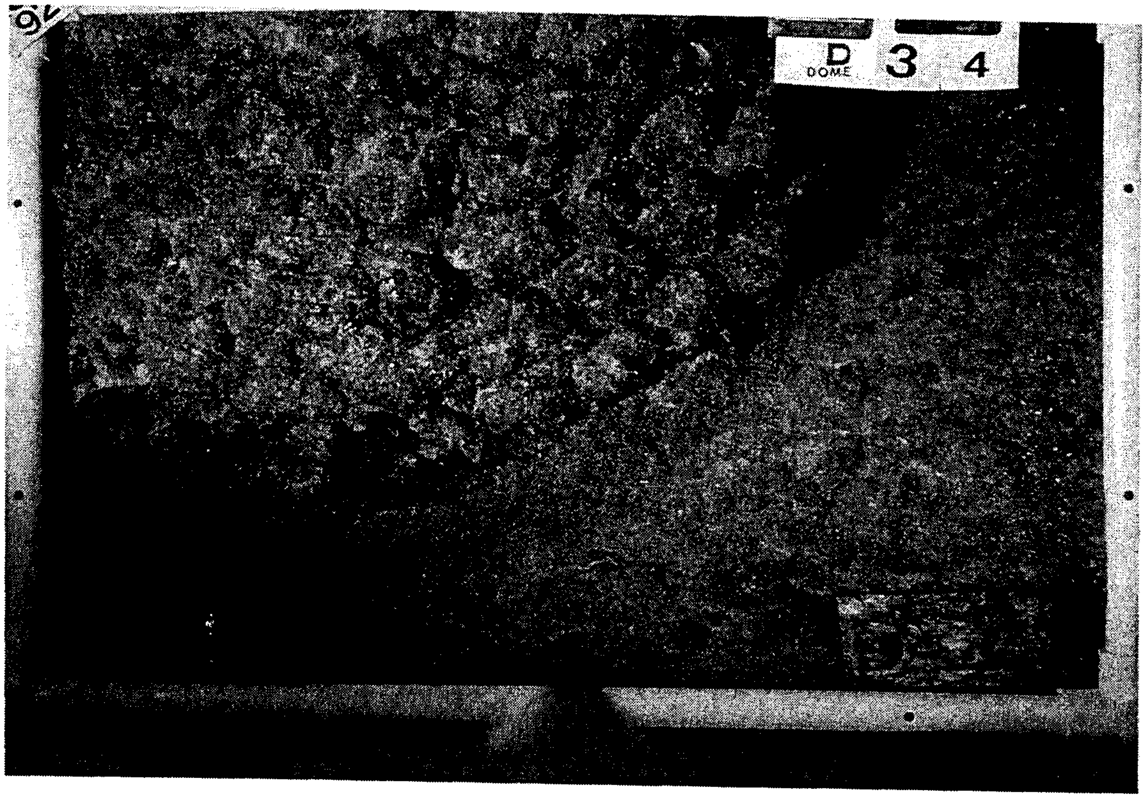
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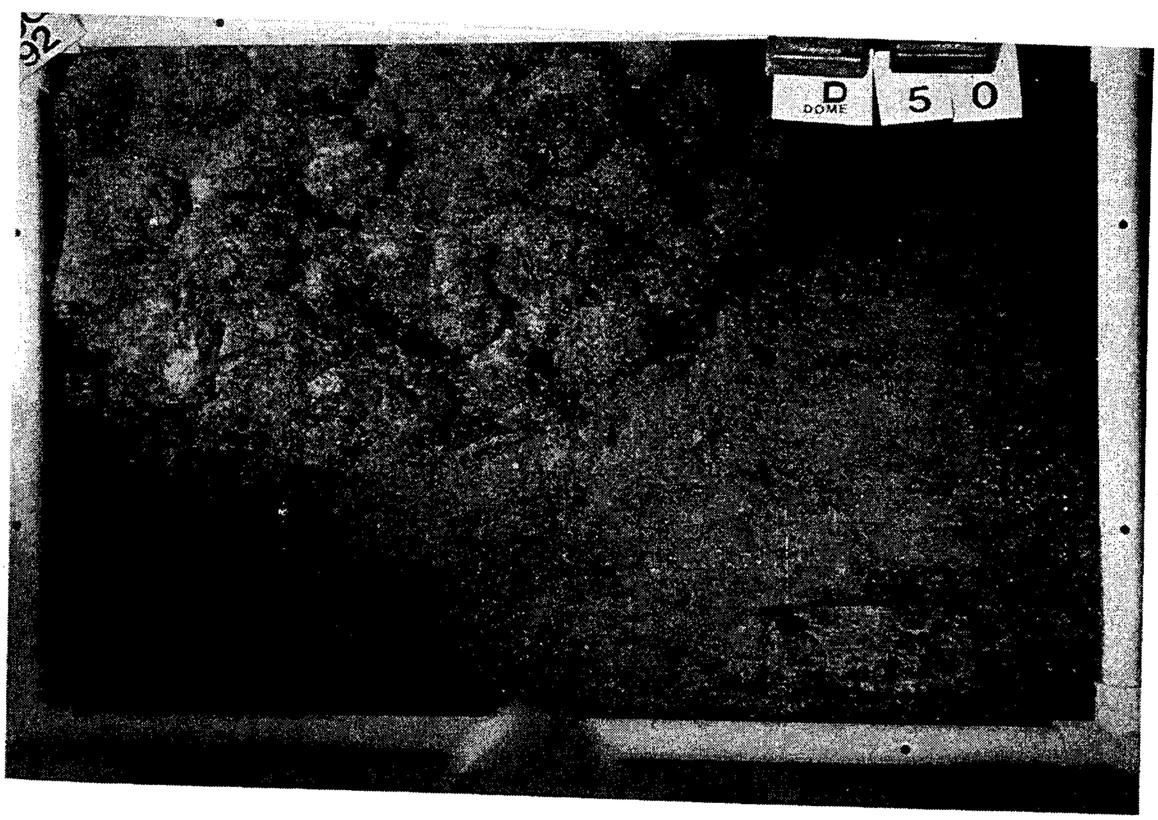
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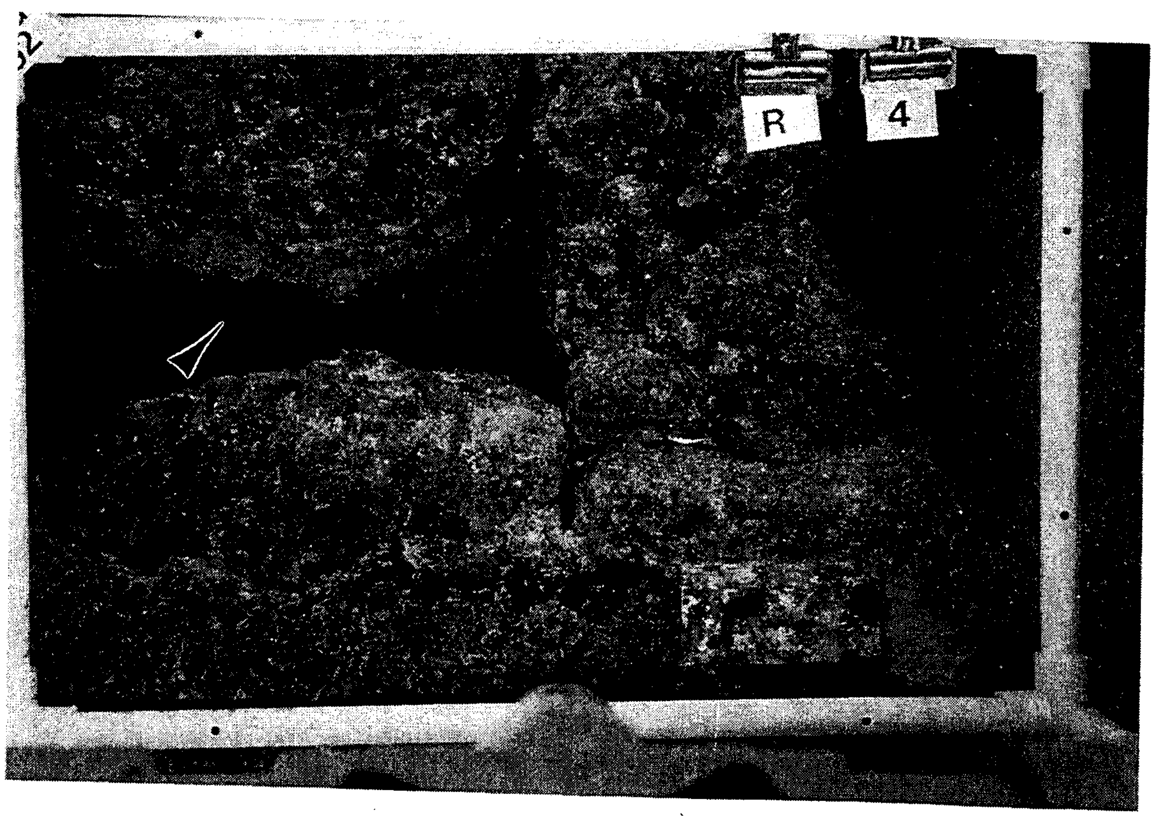
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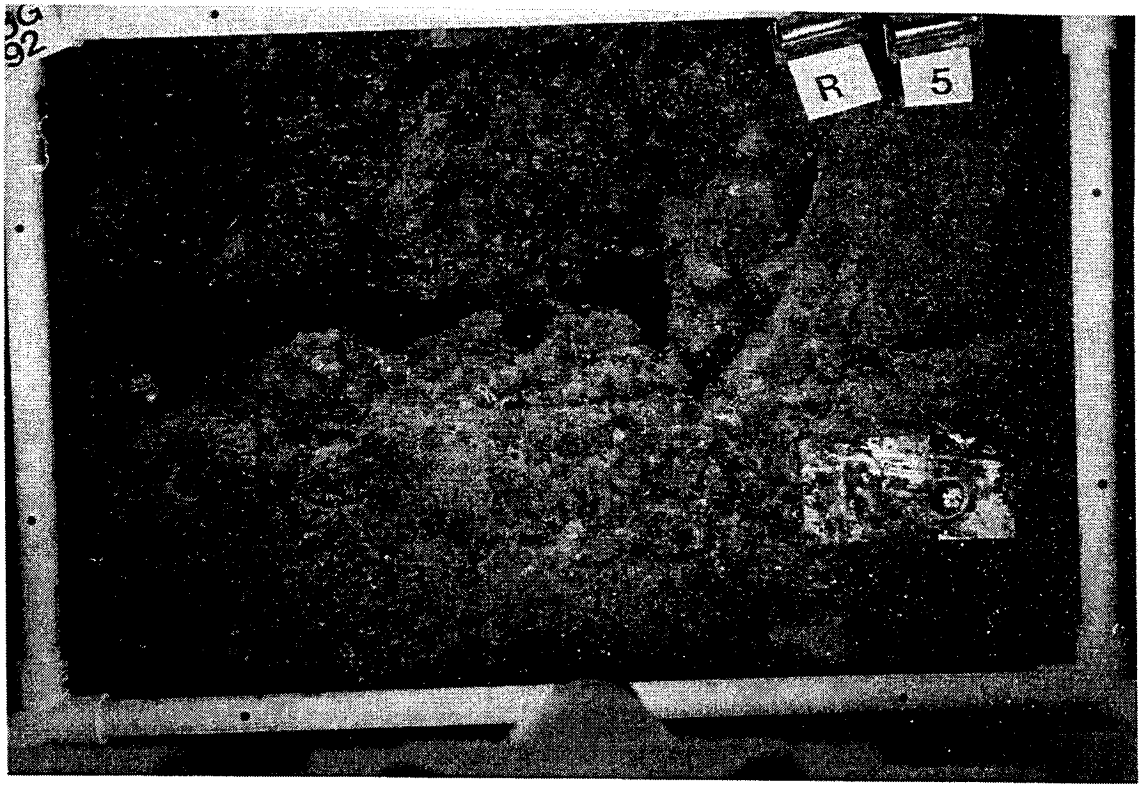
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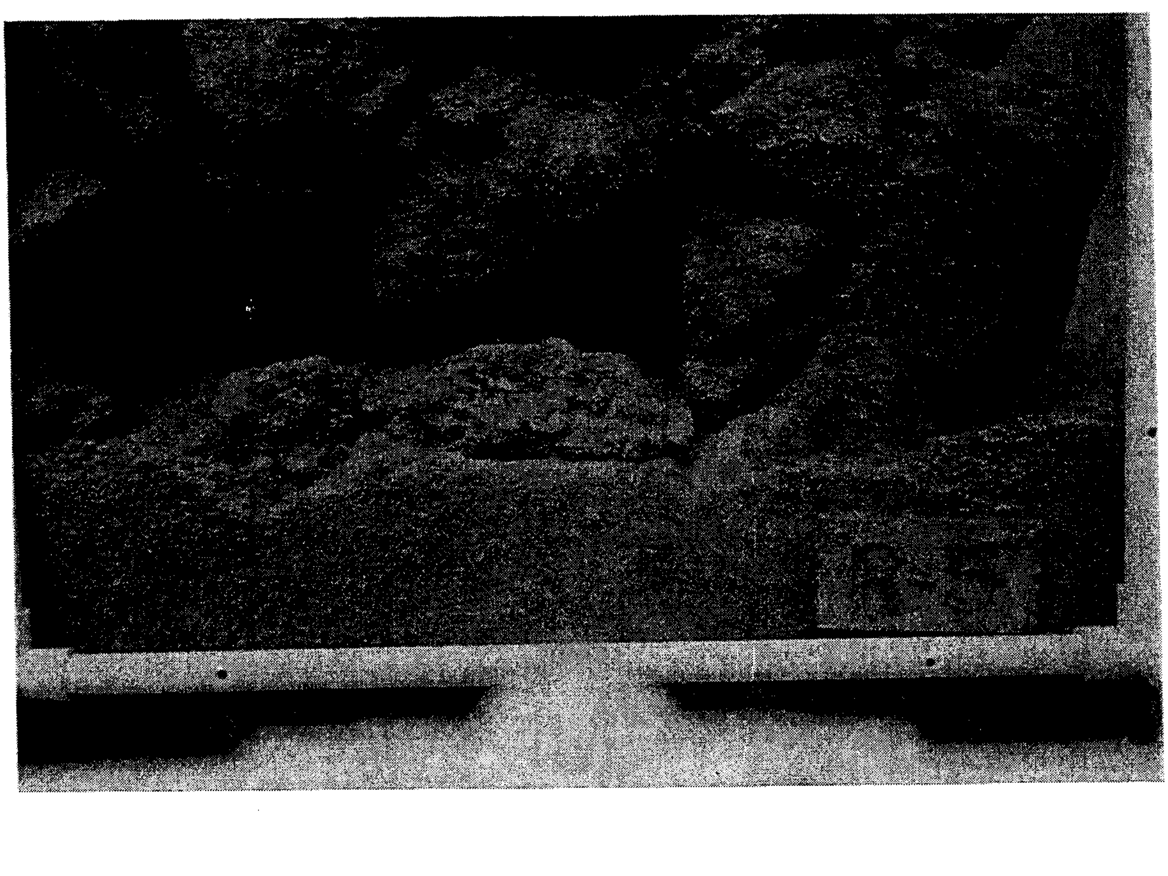


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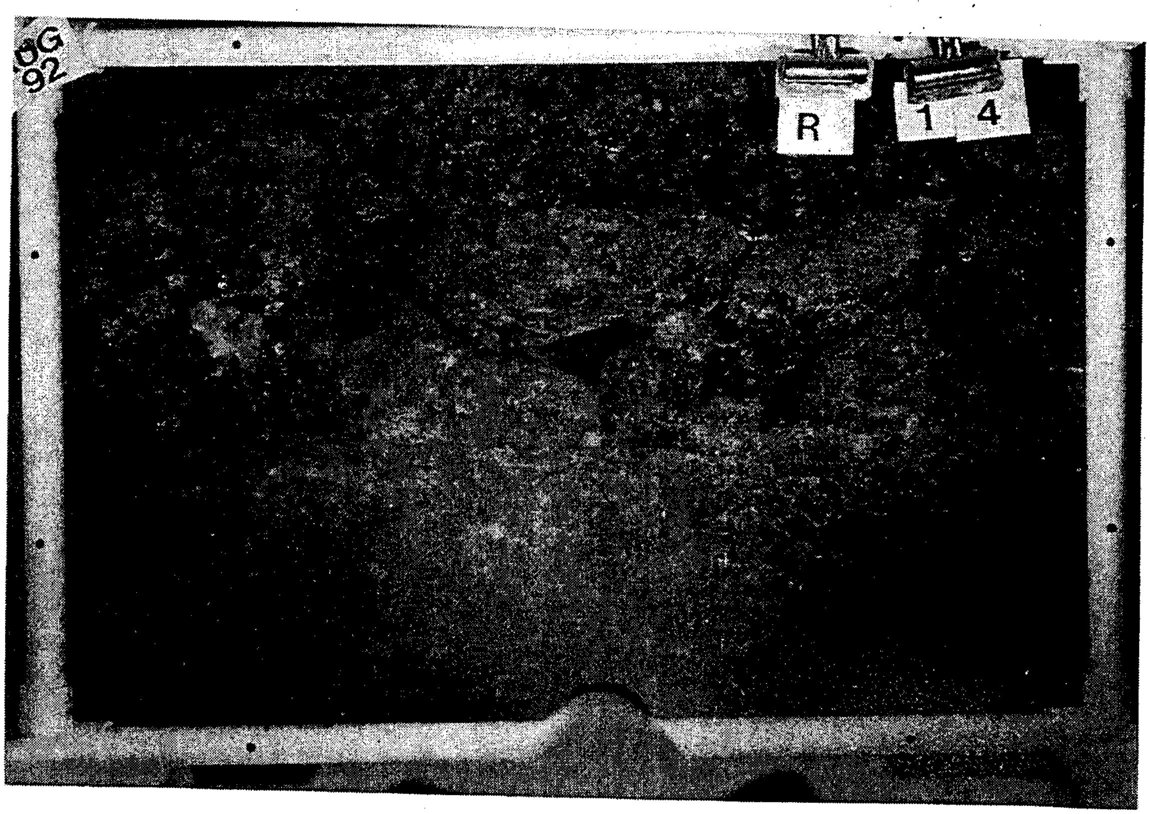
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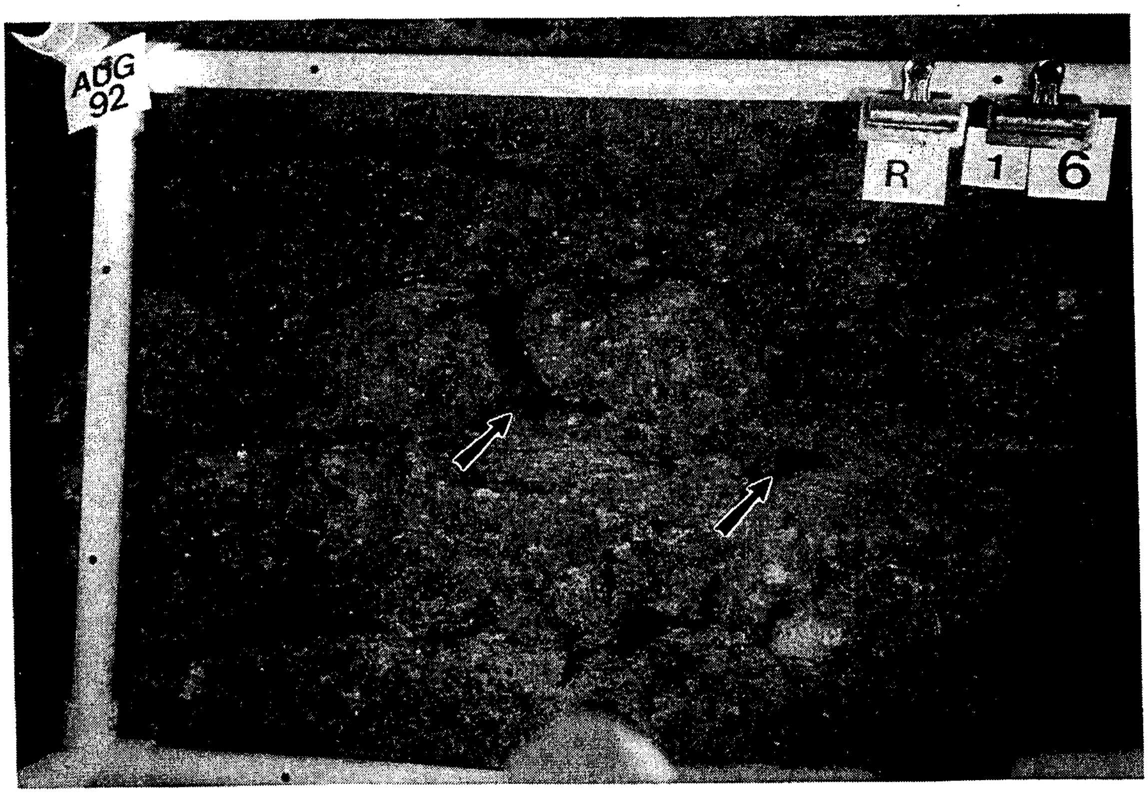
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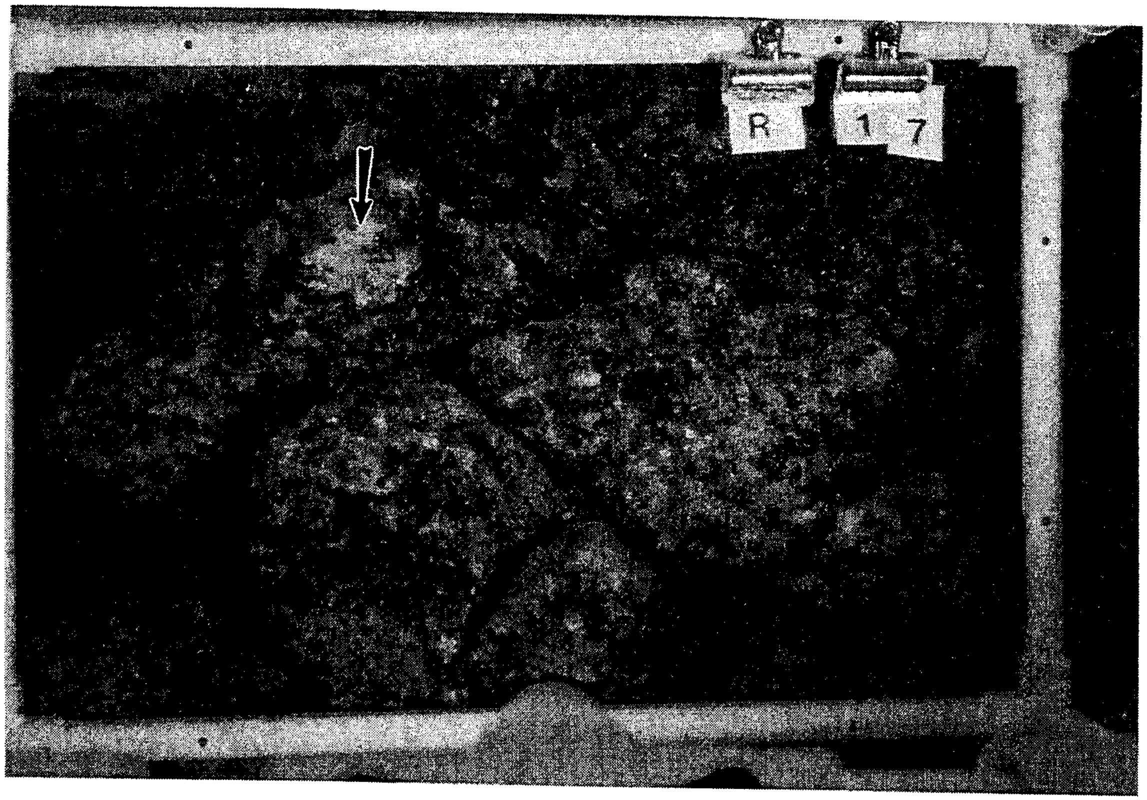
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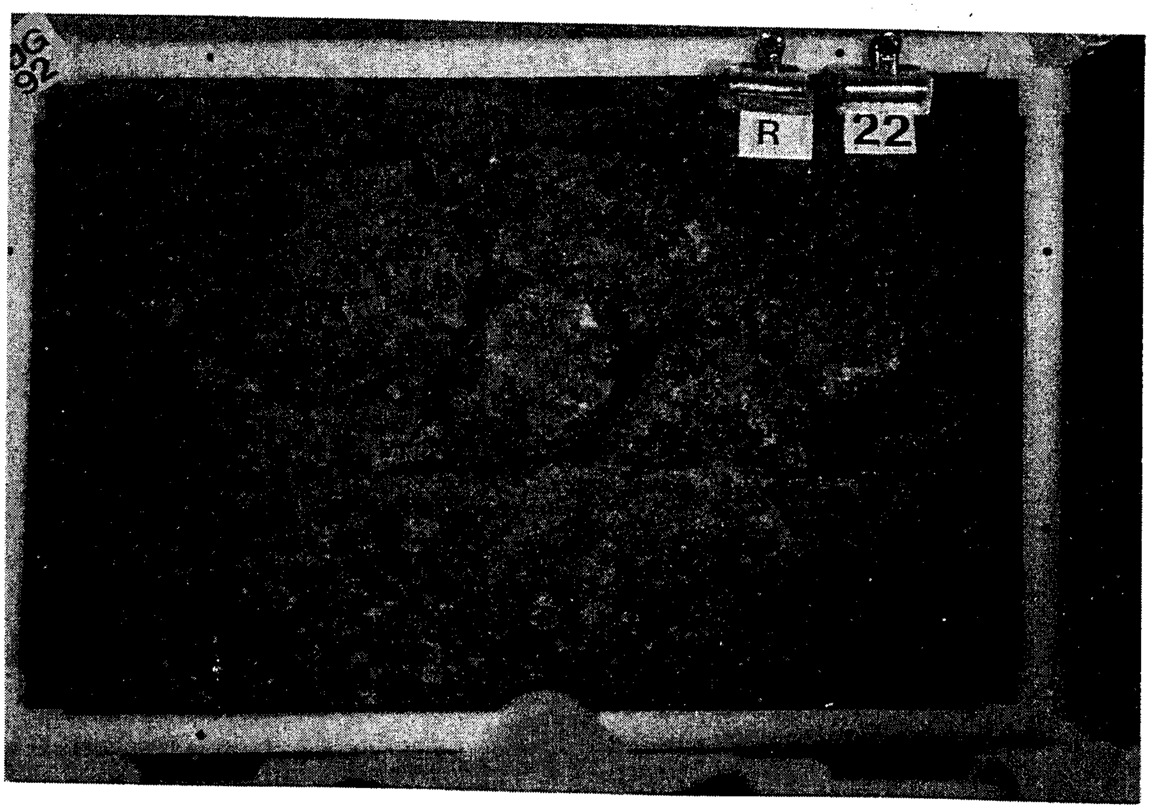
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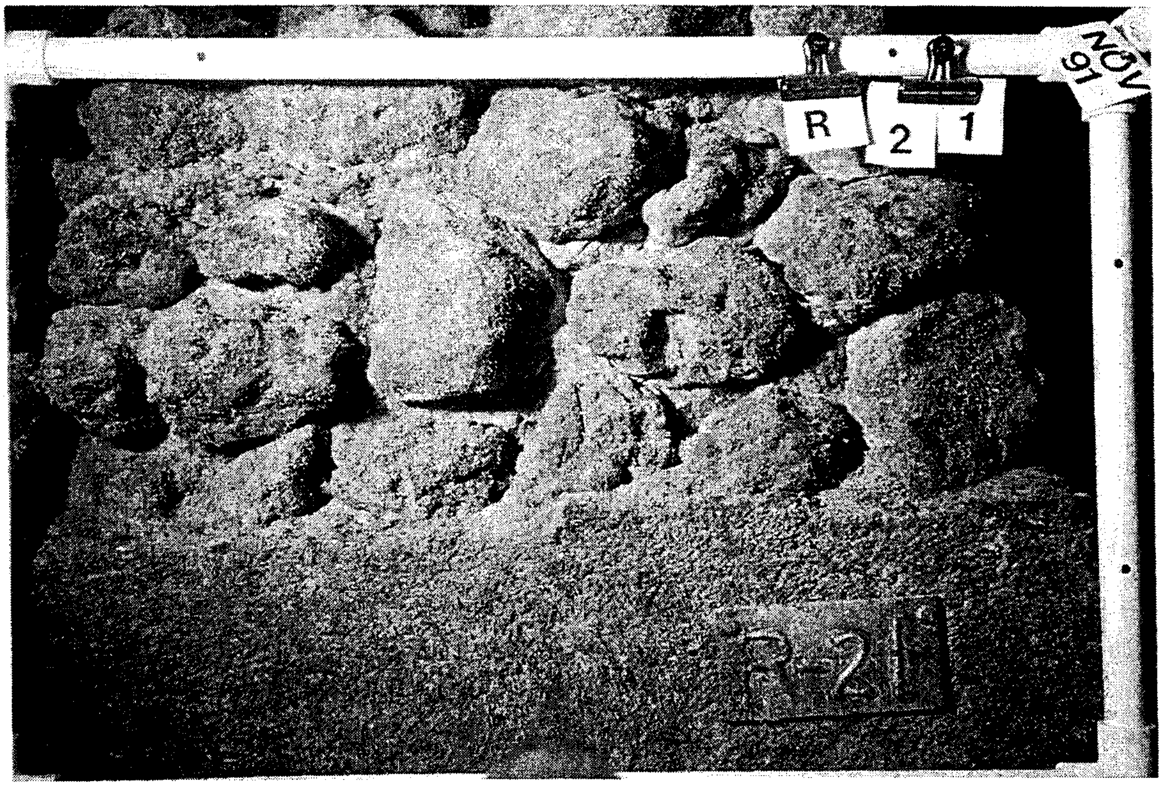
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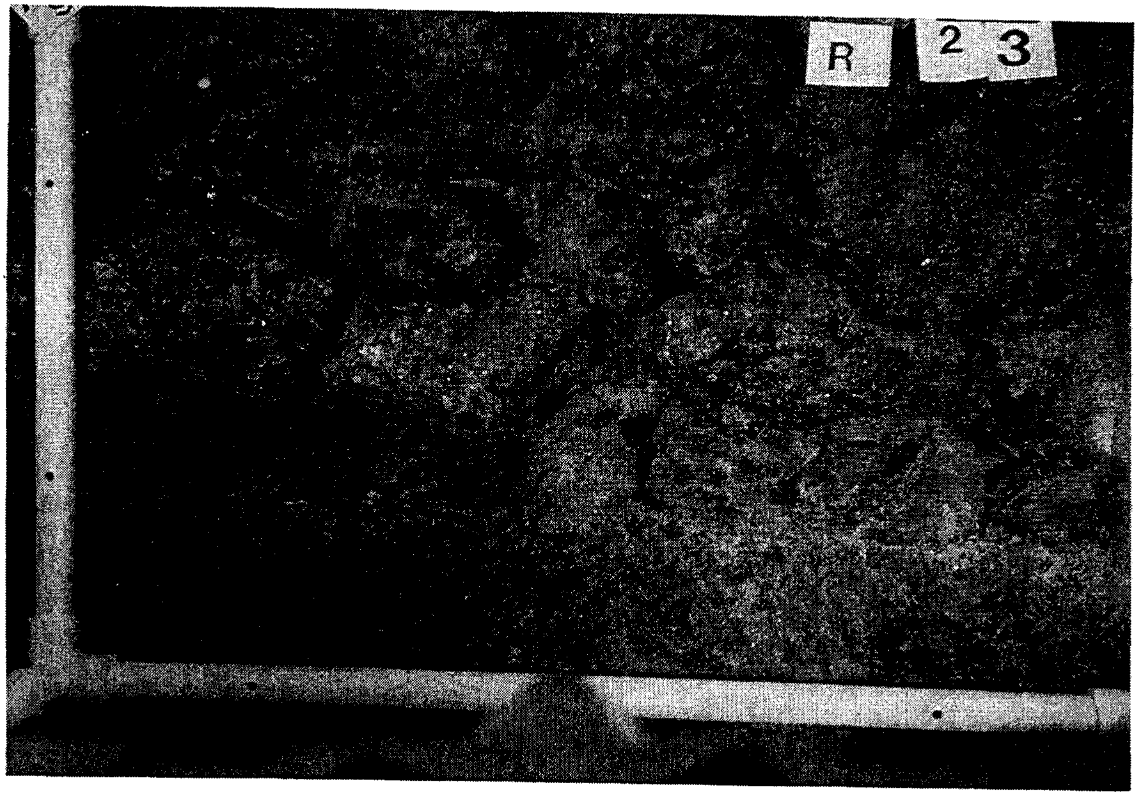
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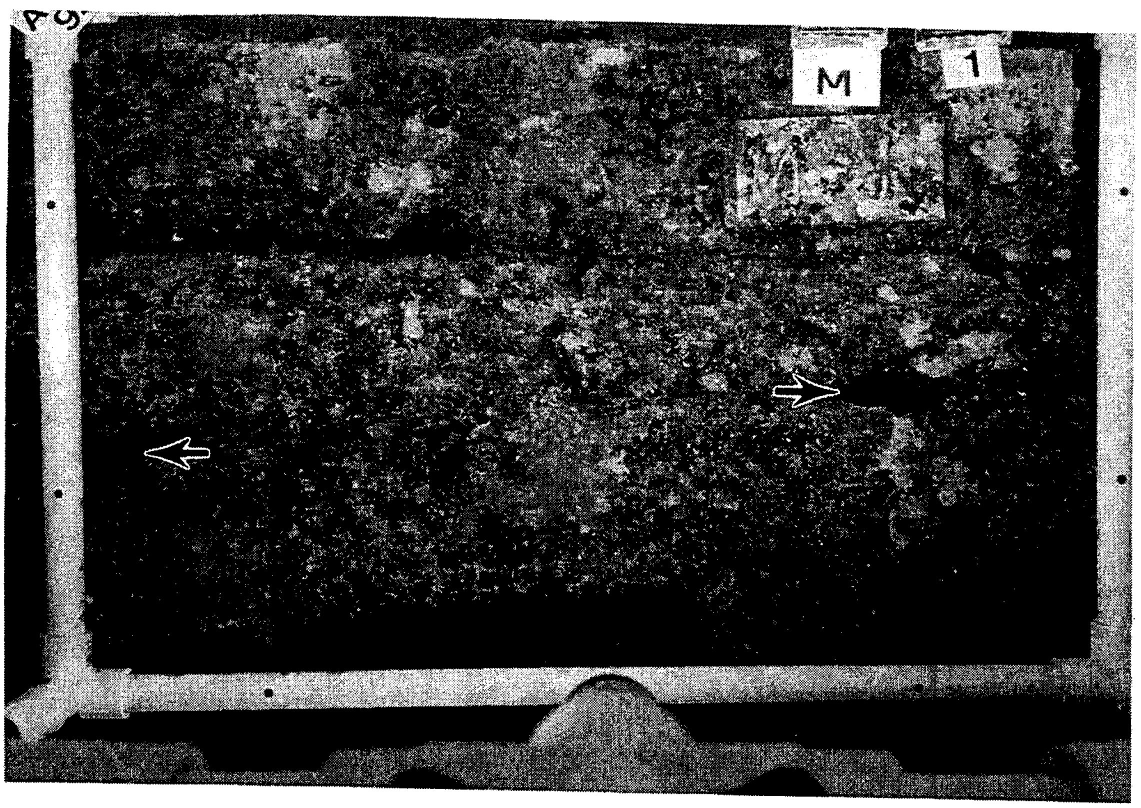
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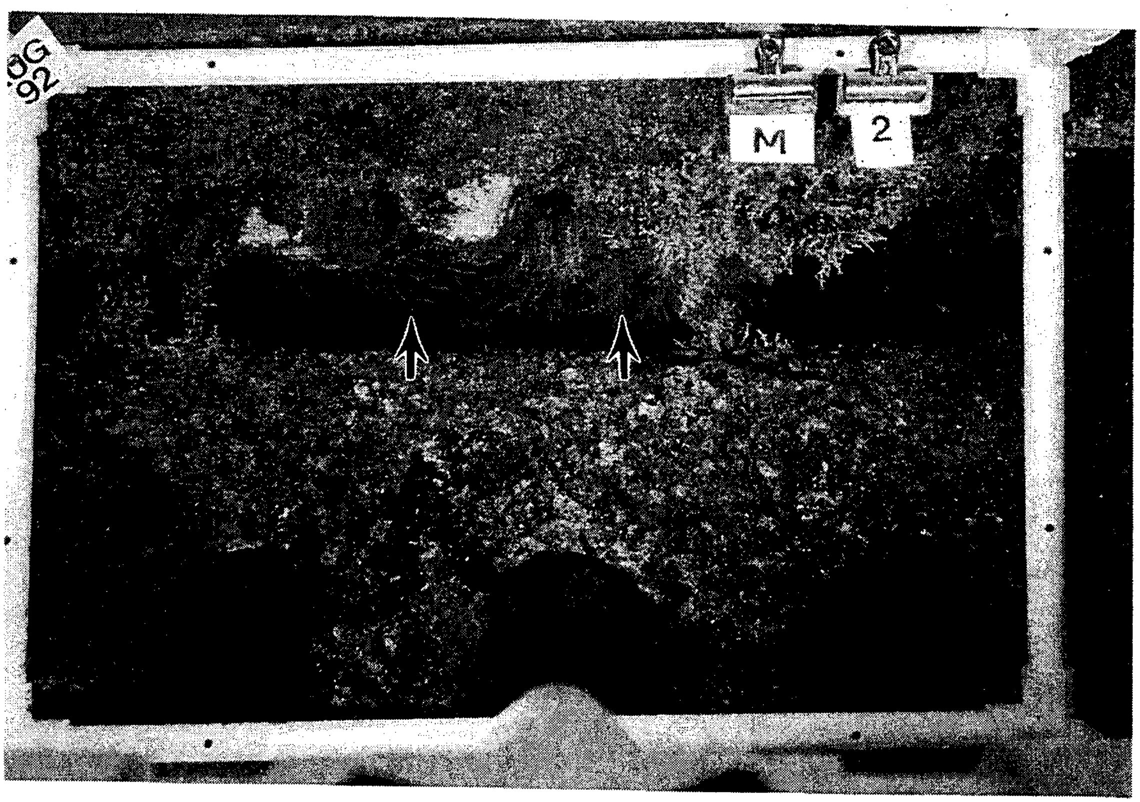
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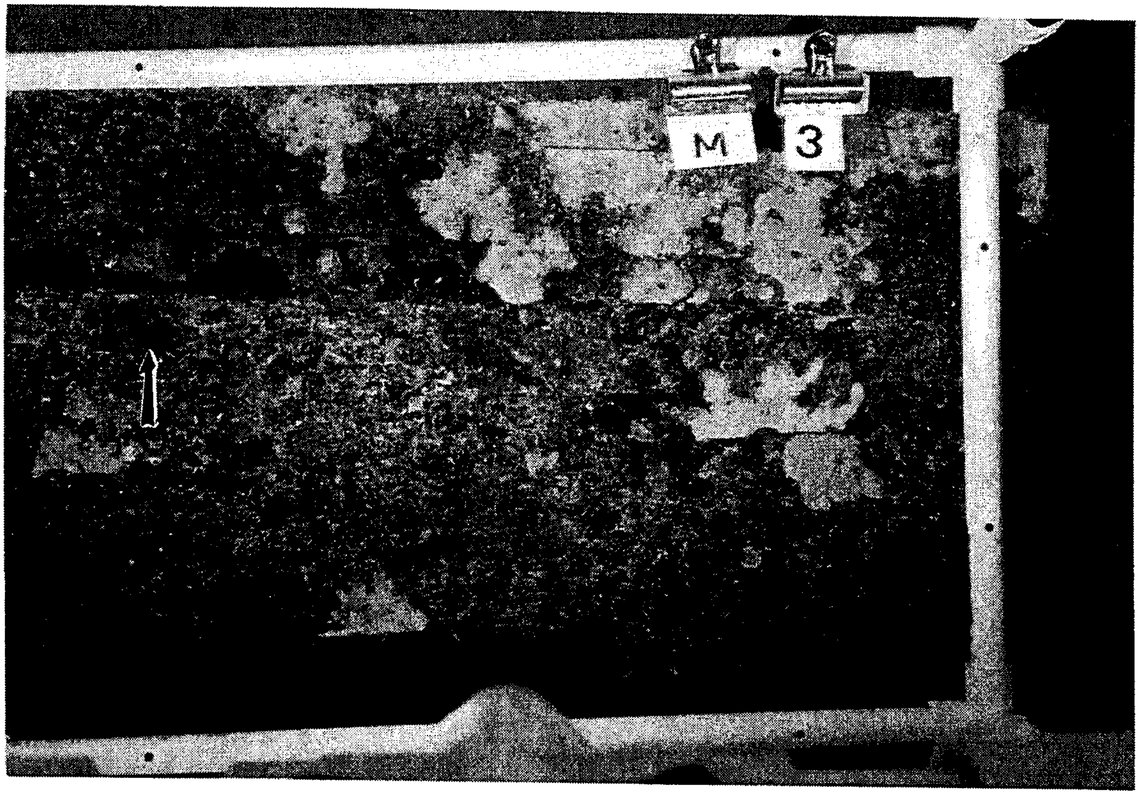
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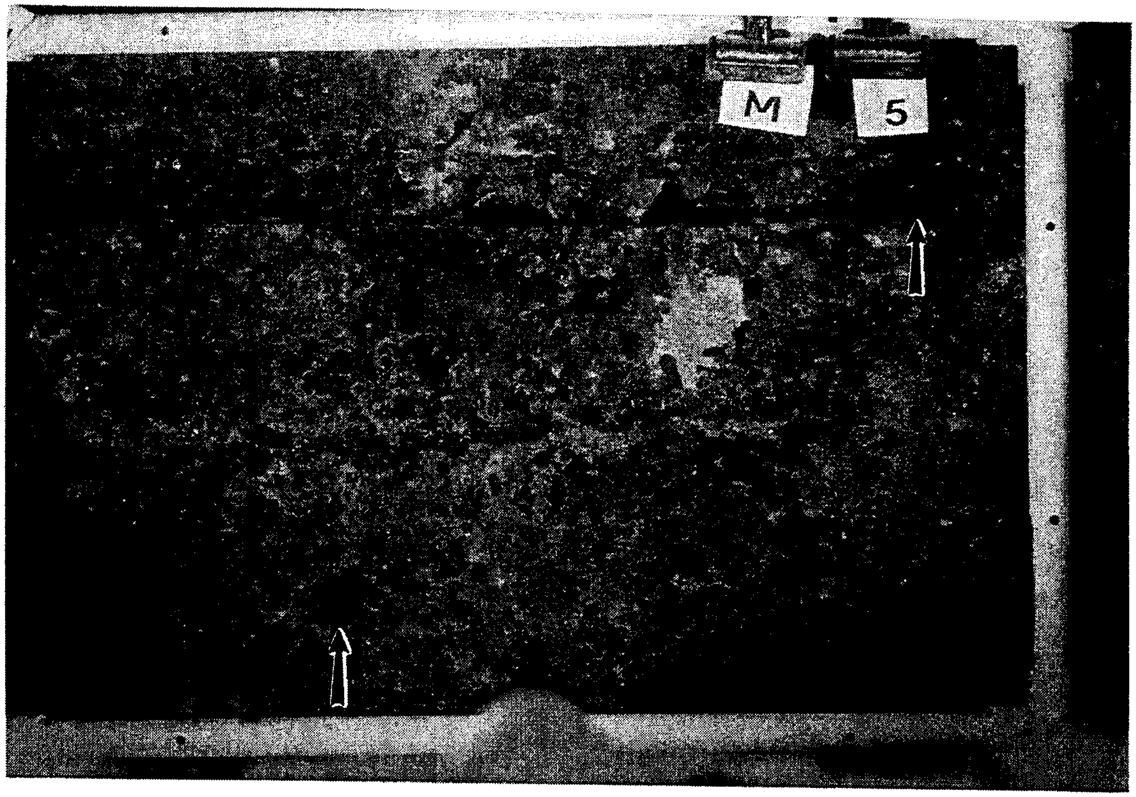
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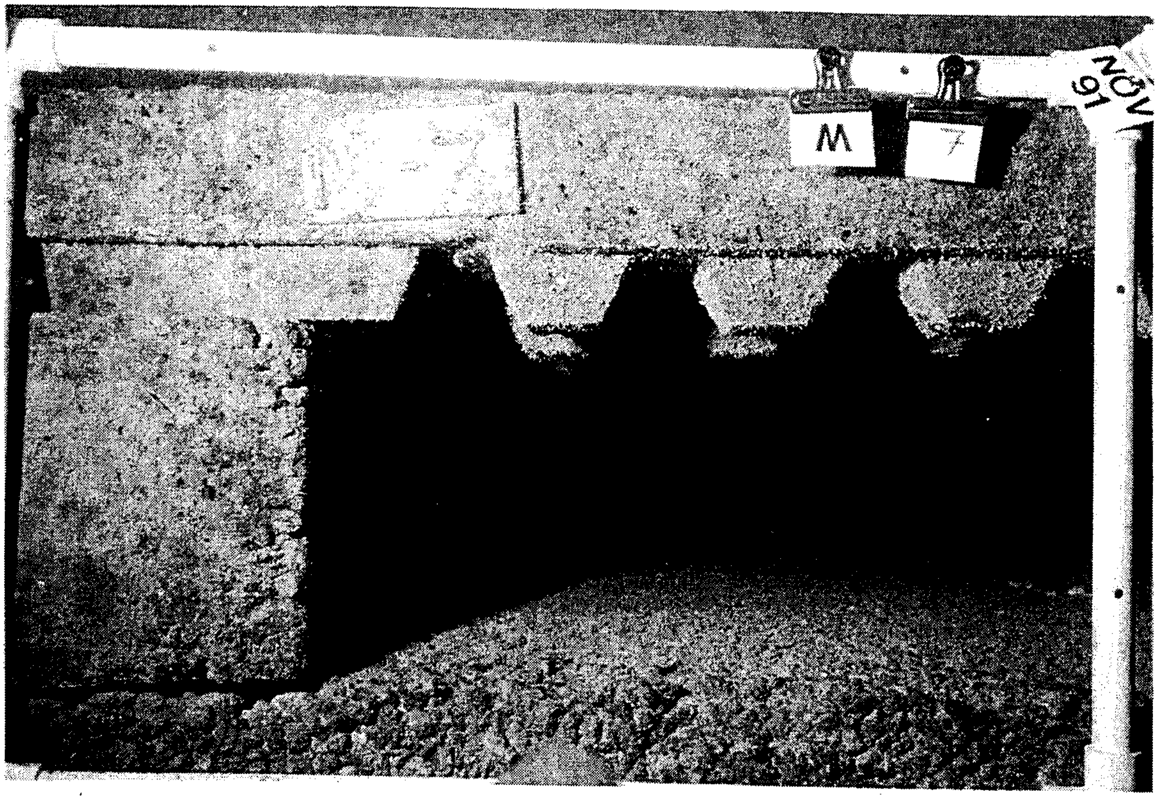
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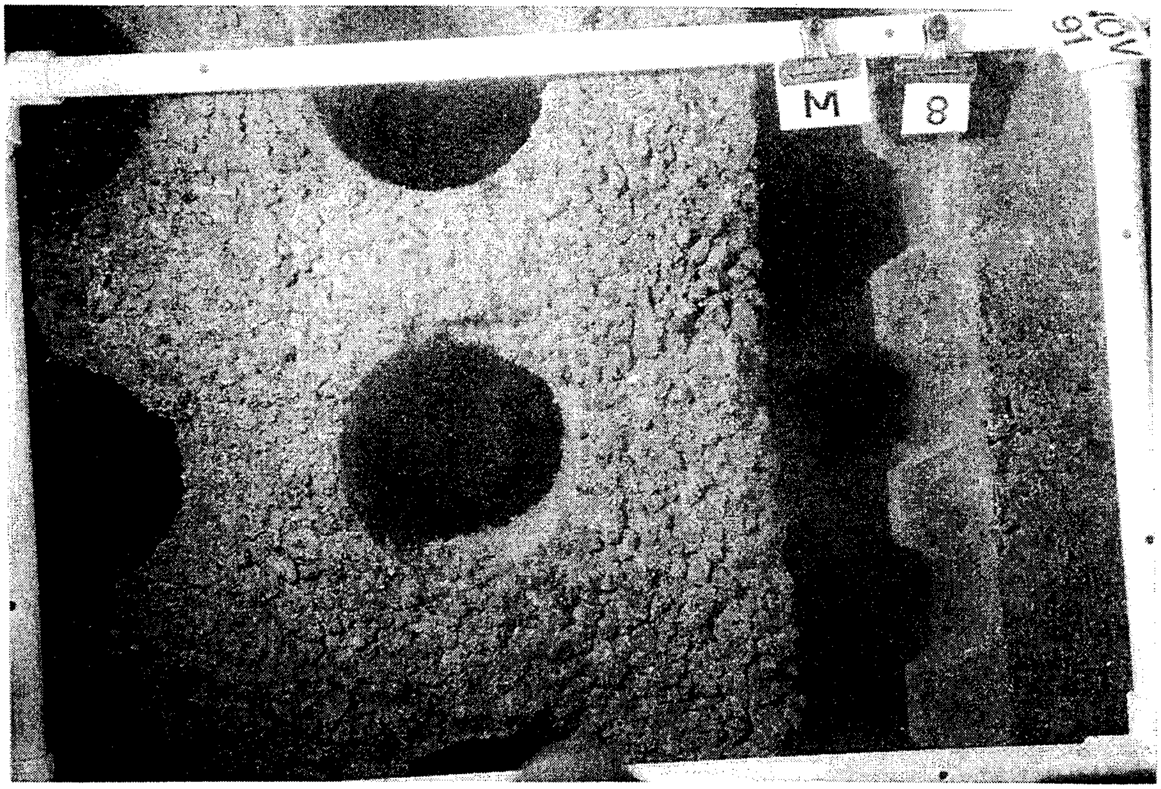
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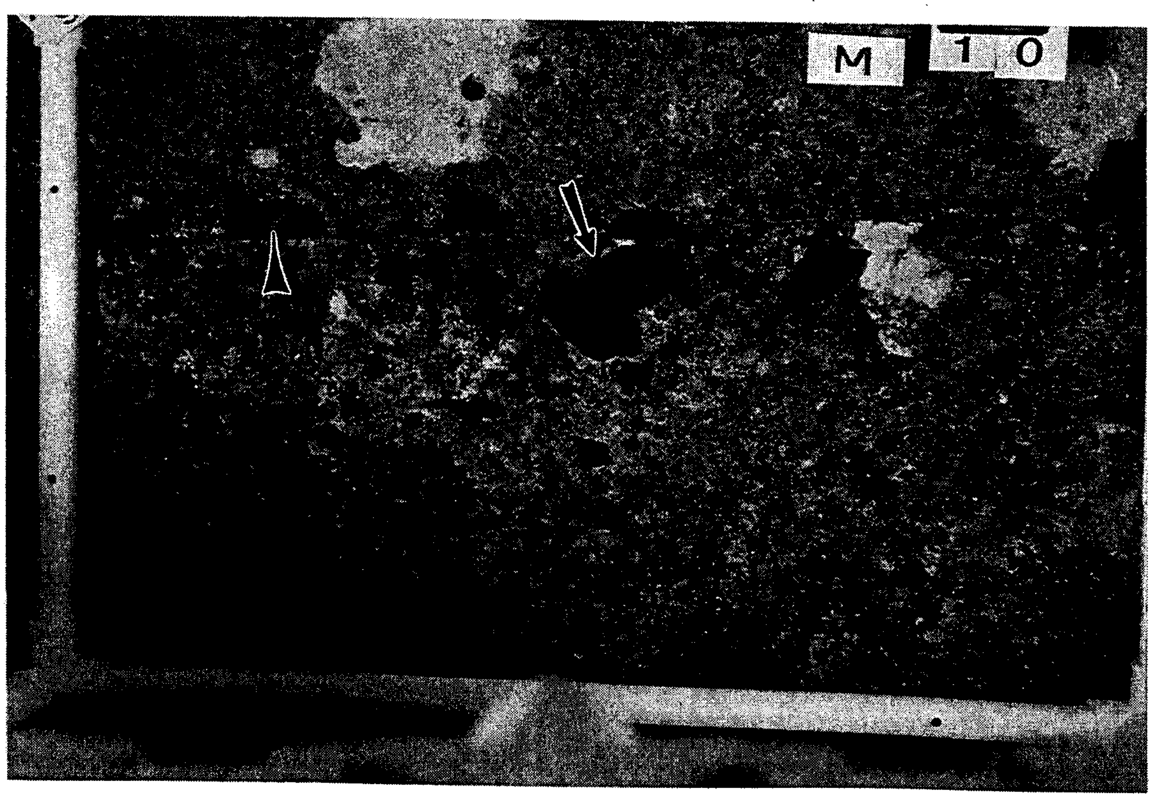
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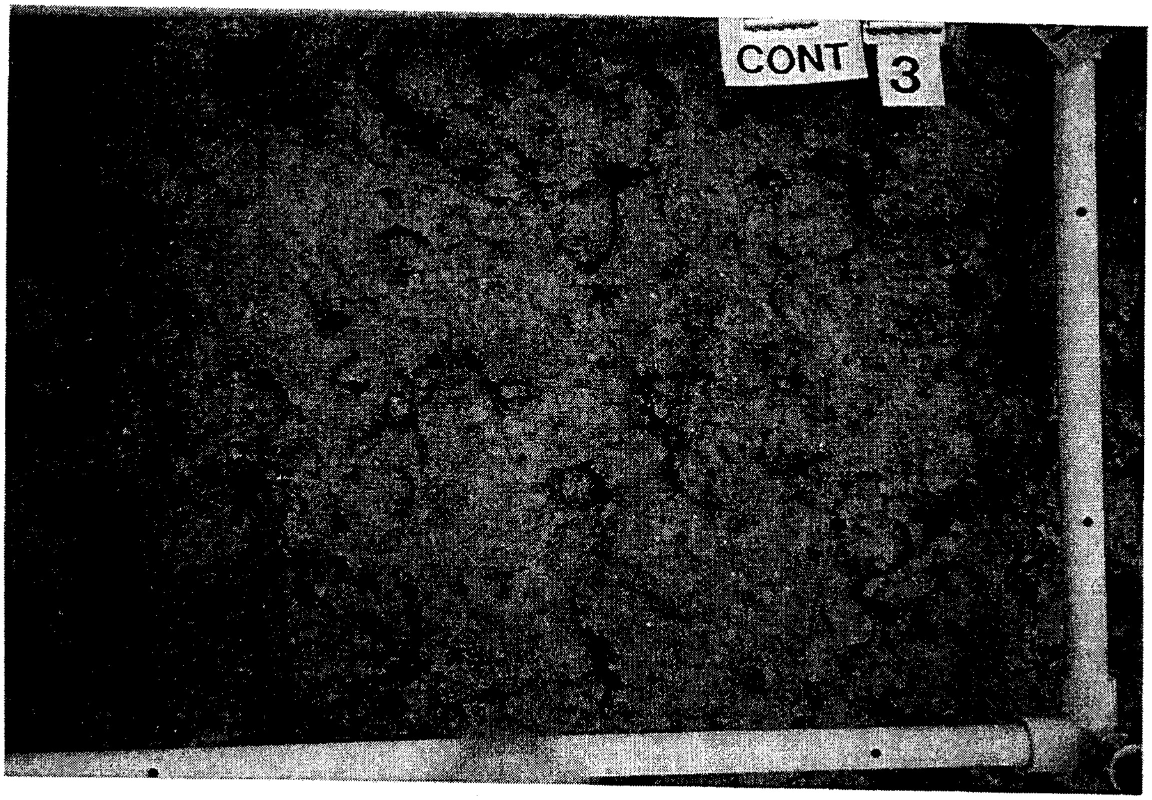
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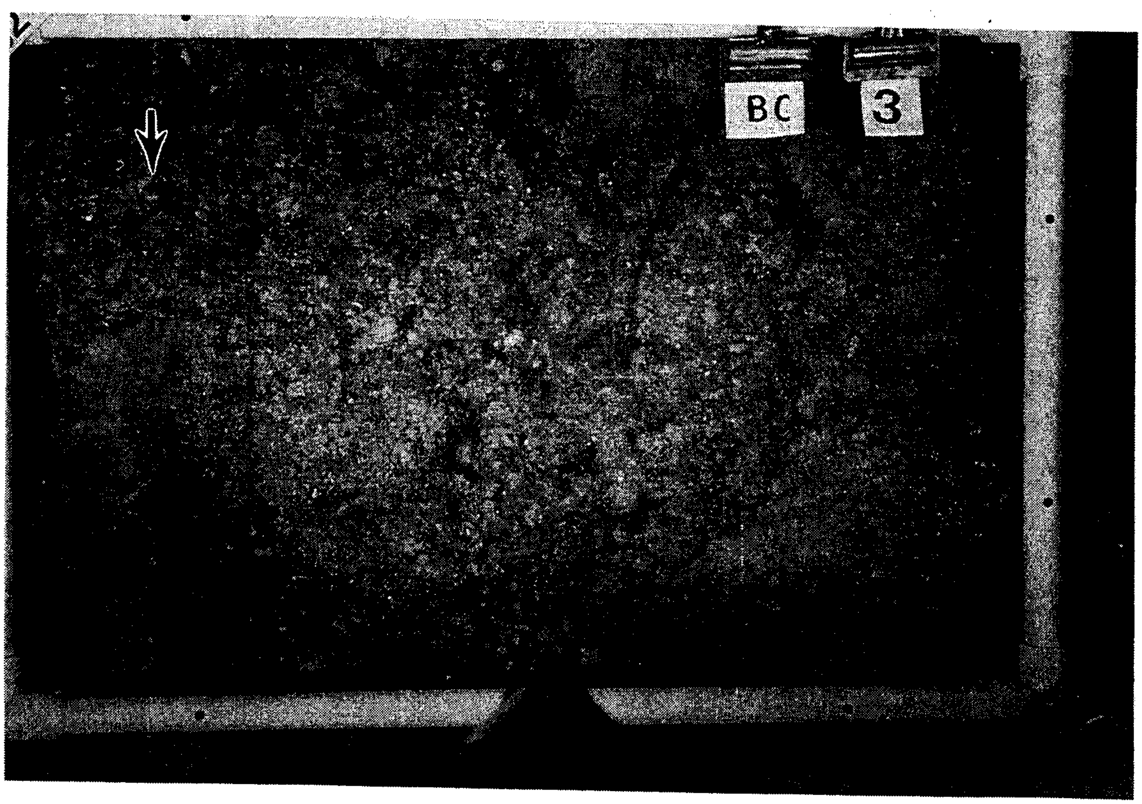
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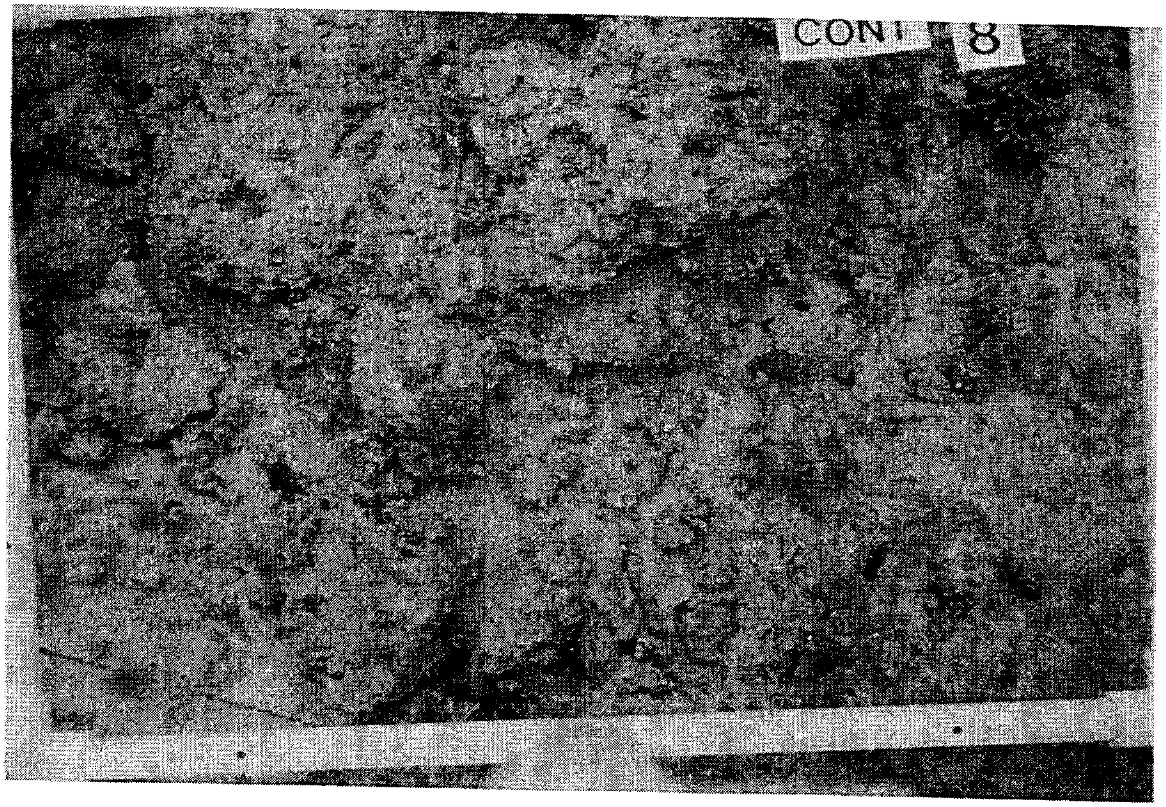
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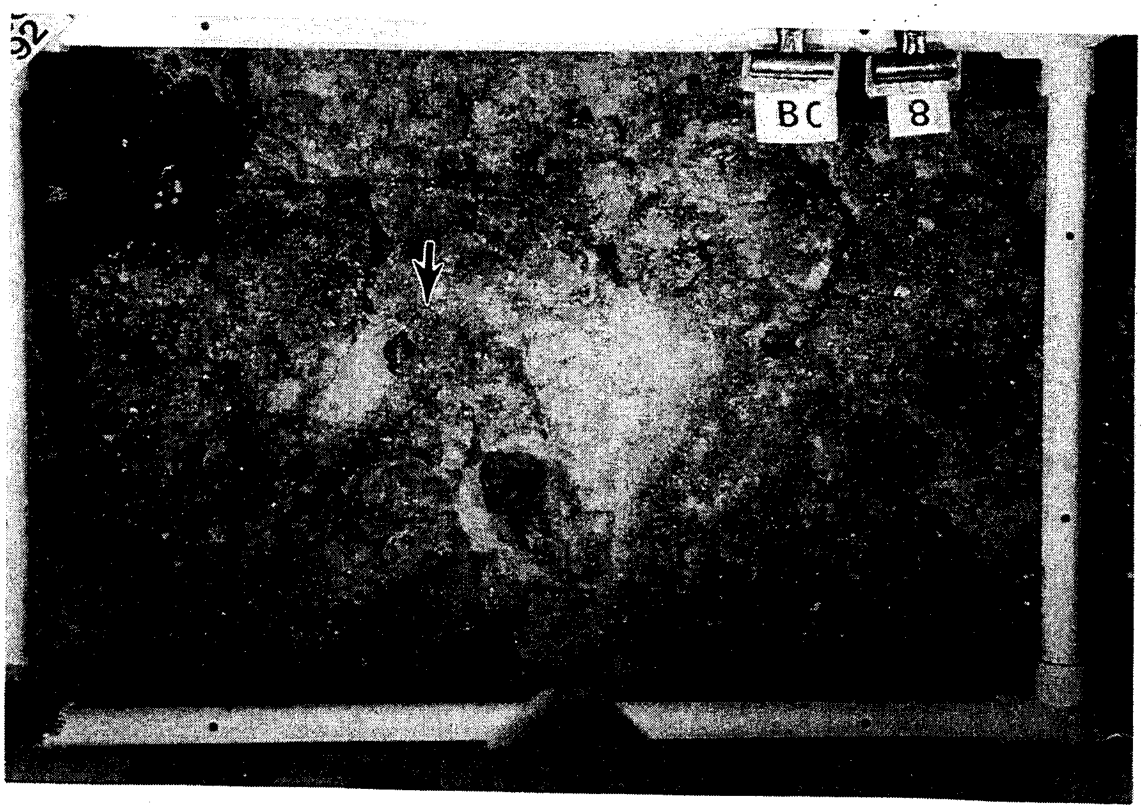
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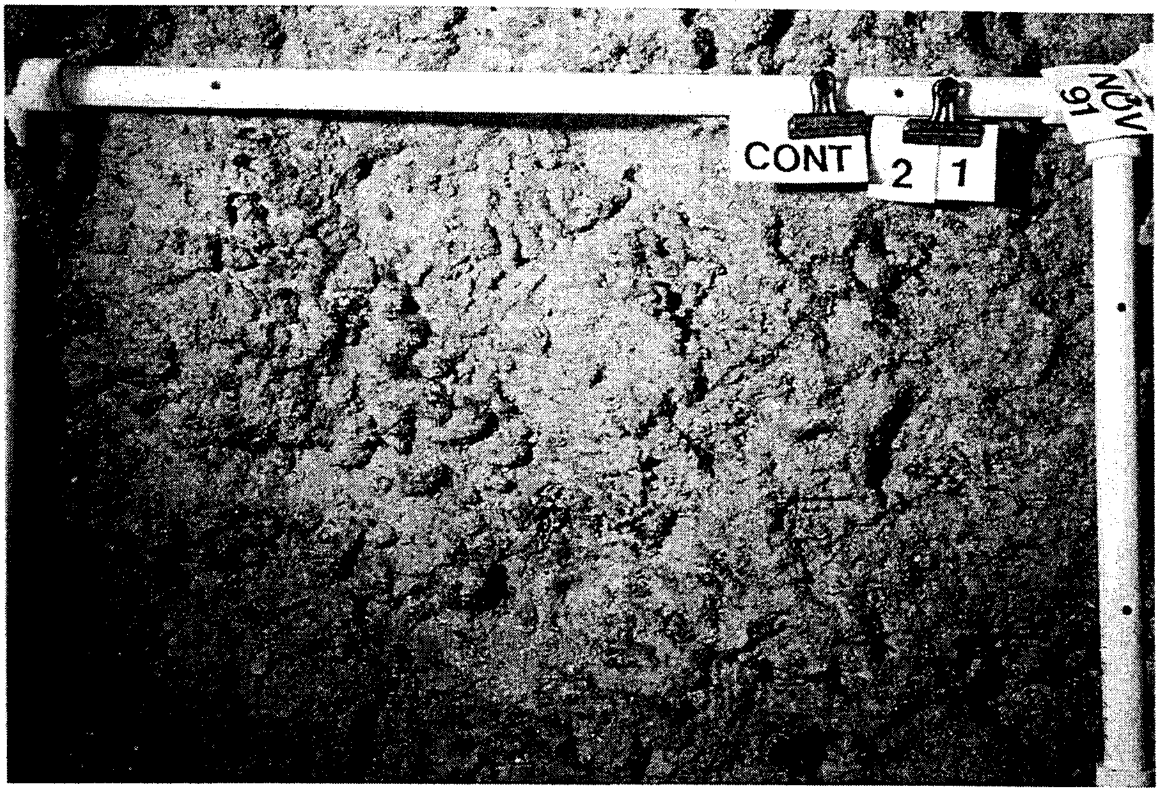
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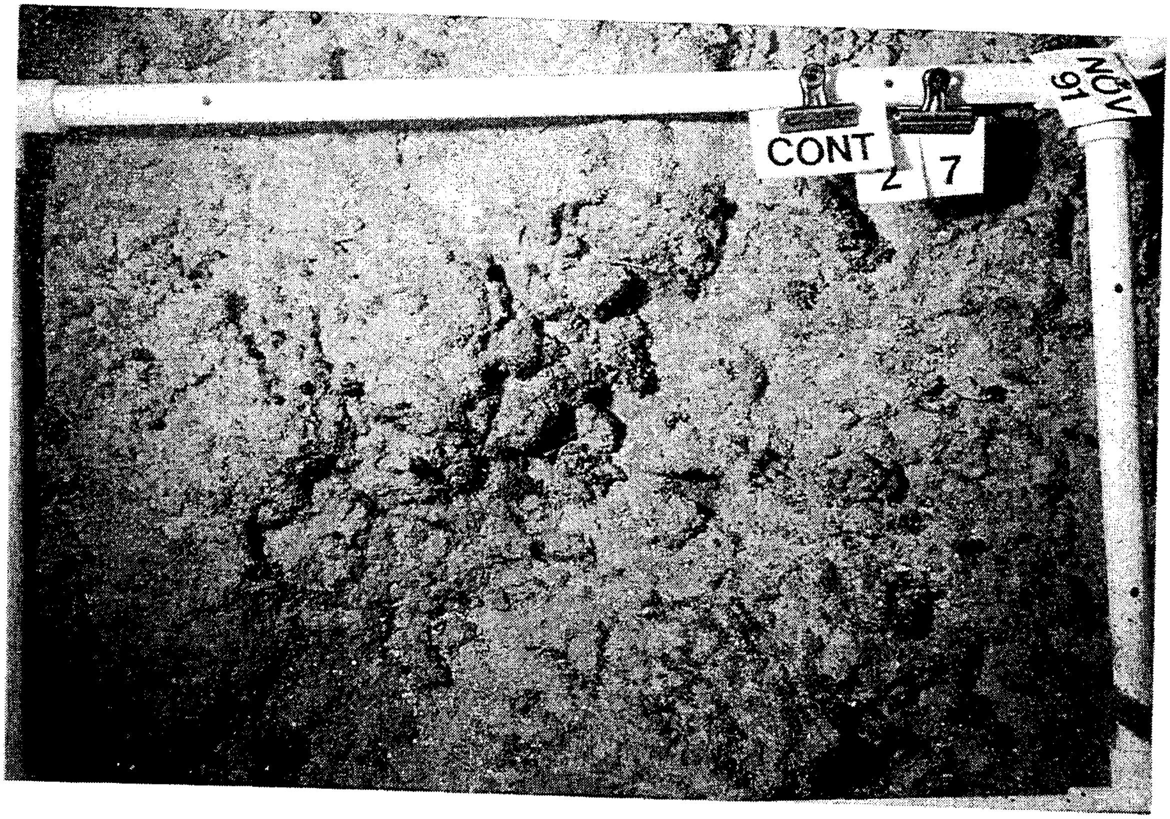
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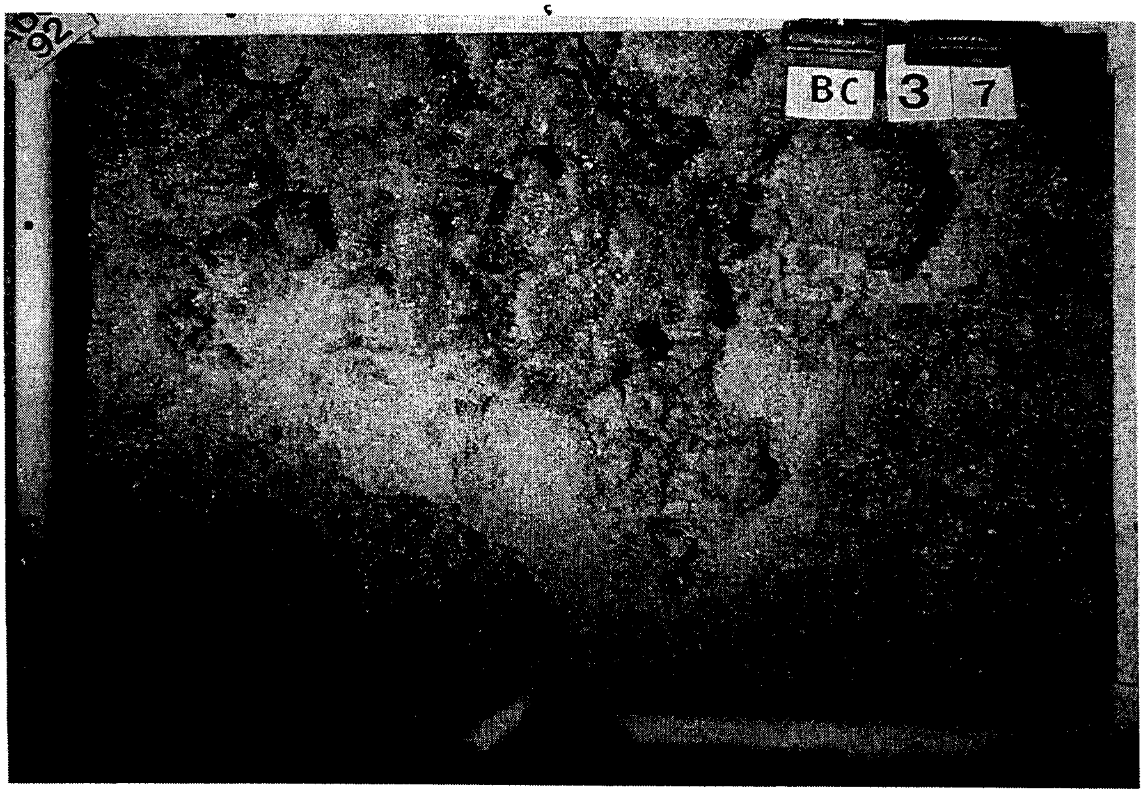
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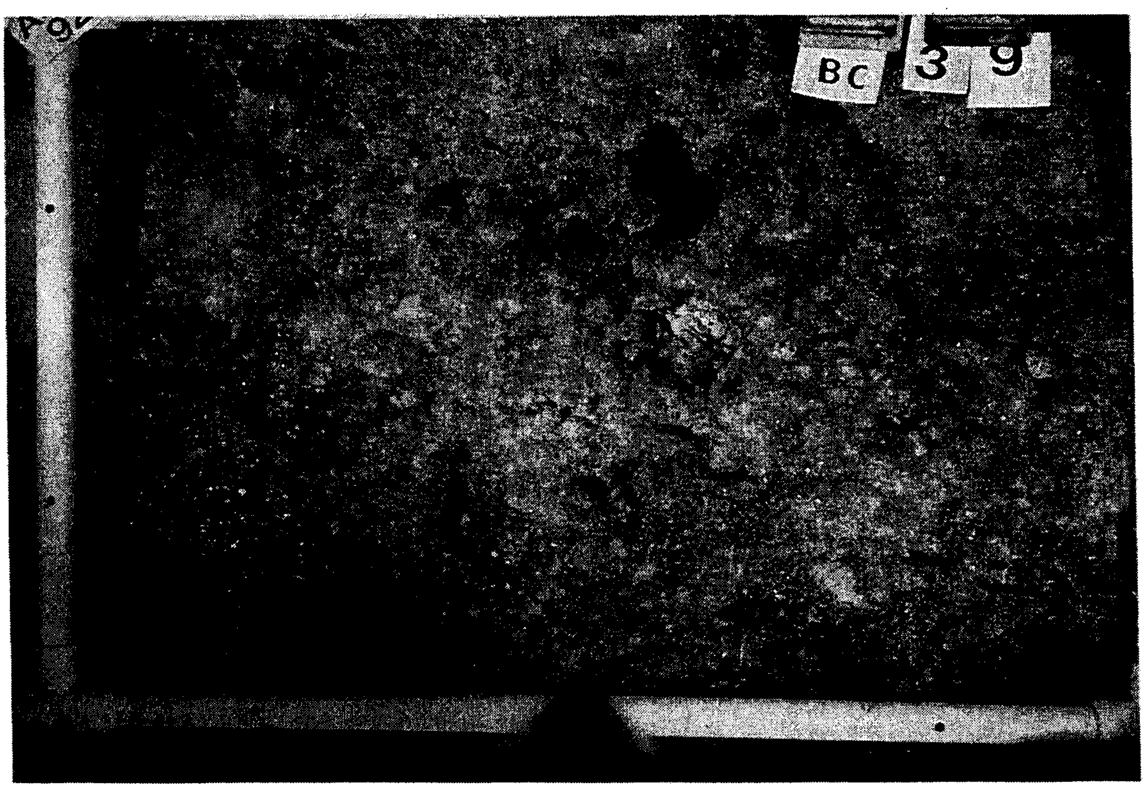
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