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Coral Reef Monitoring In Biscayne National Park, 2000.

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INTRODUCTION

Biscayne National Park's coral reefs are one of the rare and beautiful areas that the park was created to protect and preserve. The Resource Management division began collecting data about the park's coral reef resources in 1998 using underwater videography. Twenty-five meter long transects were video taped along the reef for archival and analysis. In 1998 and 1999 eight sites were surveyed (5 offshore bank reefs and three patch reefs). These videos were reviewed and coral colonies were counted, and density was estimated.

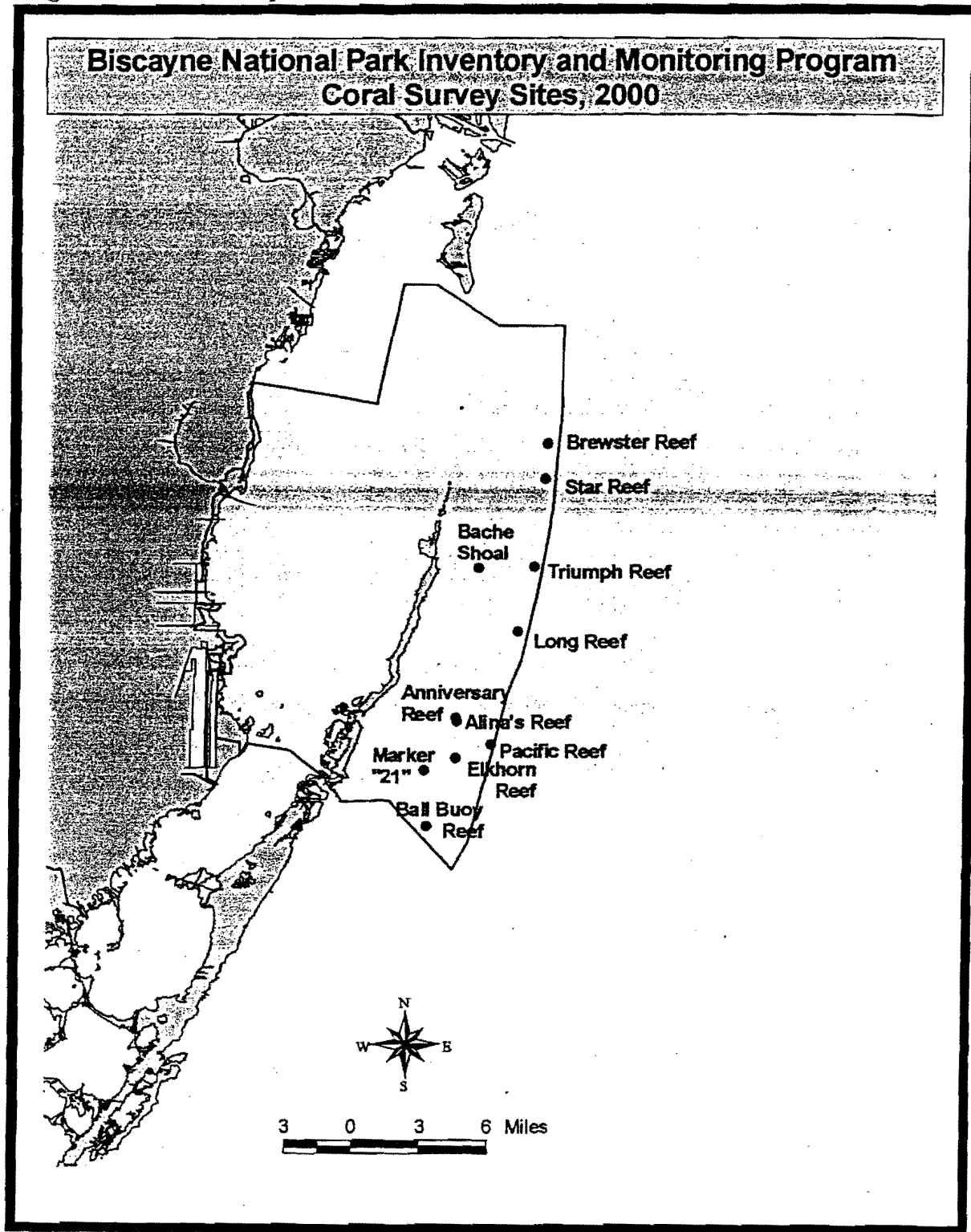
In 2000, the survey was expanded in two ways, both spatially and in the types of data collected. Surveys were conducted at 11 sites (four patch reefs and seven offshore bank reefs). Two methods were used, 25 meter long underwater video transects and 2m by 25m belt transects where stony coral censuses were conducted. Each site was sampled ten times with both methods. The underwater video transect is important for archival purposes, and allows for further analysis of various types including percent cover of the various biologic communities. Underwater video of coral reef systems underestimates the amount of coral due to the cryptic nature of some species. The importance of the stony coral census is that it provides a more robust estimate of species richness for the area, and allows for more exact species identification in the field, which becomes much harder in the lab from the video tape. The coral census also collects data on coral bleaching, black band disease, white diseases, other diseases, and the number of *Diadema antillarum* urchins.

METHODS

Field Data Collection

The survey used two types of data collection, underwater video transects and *in-situ* stony coral species census. This data collection was accomplished by a two person buddy team using SCUBA apparatus. Six sites had been previously video taped, and five new sites were added to provide a more spatially explicit characterization of this important habitat. The eleven sample sites are provided (Table 1, Figure 1), including the five new sites; Alina's Reef, Anniversary Reef, Bache Shoal, Marker "21", and Pacific Reef. Sites that had been previously been surveyed were surveyed at the same coordinates, while new sites were sampled based on random location.

Figure 1. Site Map



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Table 1. Sampling Sites

Site Name	Depth (ft)	Date sampled	Longitude	Latitude
Alina's Reef	22	7/24/00	80.16311645	25.38652992
Anniversary Reef	12	7/11/00	80.16413116	25.38884925
Bache Shoal	12	7/31/00	80.14855	25.48633003
Ball Buoy	20	7/12/00	80.18424987	25.31845092
Brewster Reef	22	7/17/00	80.10037994	25.56678009
Brewster Reef	26	7/20/00	80.09950256	25.56727027
Elkhorn Reef	17	7/13/00	80.16400146	25.36300086
Long Reef	24	8/2/00	80.11927032	25.44479942
Marker 21	10	8/4/00	80.18620300	25.35504913
Pacific Reef	29	8/1/00	80.13817640	25.37166976
Pacific Reef	29	8/1/00	80.13818	25.37166976
Pacific Reef	29	8/1/00	80.13818359	25.37166976
Star Reef	31	7/19/00	80.10047149	25.54500007
Triumph Reef	29	7/20/00	80.10817718	25.48756980

The survey used a 25m fiberglass transect tape stretched taught running offshore to inshore, in an East-West direction. The transects were placed to run perpendicular to the depth contour most times. Sites ranged in depth from 3 to 9.5m (10 to 31 feet). Once securely moored at the sample site, one diver would stretch the tape along the bottom and the other would stay at the transect's origin. The tape would be stretched taught and tied off to the benthos. The videographer would swim slowly along the tape, using a Sony DCR-VX1000 digital video camera housed in a Gates underwater housing. The housing has been modified to hold two underwater laser pointers on top of the housing. The lasers are oriented so that the laser dots converge at 40 cm from the lens of the camera. The video is shot perpendicular to the reef surface, as the diver swims slowly along the transect maintaining the 40 cm distance from the reef. This distance provides for a consistent frame width of roughly 60 cm. The videographer swims along the transect at a constant speed to cover the 25 m length in approximately 4 minutes time. The consistent swimming speed aids in more accurate digital frame grabbing in the lab. The consistent distance ensures that analysis from the frame grabbed images is based on a consistent sample area.

As the videographer video tapes the transect, the dive buddy performs a census of stony coral species, noting any special conditions. The data is based on presence along the transect, 25 m long by 2 m wide, with 1 m on either side of the transect tape. As the observer swims along the transect, species are observed and logged on an underwater data sheet. If the colony has bleaching, black band disease, a white disease, and/or other disease, it is noted. The number of *Diadema antillarum*, the long-spined urchin nearly wiped out by disease in the early 1980's, is also enumerated along the transect.

Transects were placed parallel to one another along the reef generally greater than 5 meters apart, with the exception to Alina's Reef which is a circular patch reef. At Alina's Reef, transects started on the eastern deep edge at the reef/sand interface and ran towards the center of the patch. Transects were established in this manner, in a

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counterclockwise direction covering the majority of the patch reef like spokes of a wagon wheel. Tapes were placed to ensure the shallow ends did not overlap. Differential GPS coordinates were taken at each reef site. Some sites have multiple coordinates where ten transects would need to hop over wide sand channels to ensure proper reef characterization.

Video Data

Digital video data was reviewed in the lab using the Sony digital video camera plugged into a Pentium computer using 'firewire' technology (IEEE-1394). A miroVideo DV300 image capture card (Pinnacle Systems, Inc.) along with miroVideo DVTools image capture software was used to review and capture the images into the computer's local hard drive. Adobe Photoshop (ver. 5.5) was used to convert the images to high-resolution JPEG format and resize the images to 640 x 480 pixels. Each site was then archived to CD-ROM for storage and analysis.

PointCount for Coral Reef '99, created by the Florida Keys National Marine Sanctuary's Coral Reef Hardbottom Monitoring Project was used to analyze the digital image data. Each image is opened and 10 random points are placed on the image. The benthos below each point is analyzed and the species or functional group is stored to a comma separated value file (*.csv) for further analysis. All analyzed files are entered into MS Access and linked to a point coverage in ArcView for visualization and summarization.

Species Inventory Data

The stony coral species inventory data sheets are rinsed and dried after returning from the field. The data is entered into a MS Access database using a Graphical User Interface (GUI) form (Fig. 2) which mirrors the datasheet to minimize data entry errors. This data is then summarized and exported for further analysis. This summarized data is linked to the ArcView point coverage for data visualization.

Figure 2. Species Inventory Data Entry Tool.

The screenshot displays a Microsoft Access database window titled "Species Inventory Data Entry Tool". The window contains a data entry form for Pacific Reef sites. The form is organized into a table with columns for site information and species data. The visible data includes:

Site	BRZ	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Pacific Reef	BRZ	6																								
Pacific Reef	BRZ	7																								
Pacific Reef	BRZ	8																								
Pacific Reef	BRZ	9																								

The form also includes a section for "Mr. Mail" and "Enter on" with a text input field. The bottom of the window shows a status bar with "Page 5" and "Page 6".

RESULTS

Observations made during the 2000 field sampling year provided valuable information regarding the species diversity and health of the coral reefs of Biscayne National Park. The most notable was the increase in species richness from *in-situ* species identification compared with species richness derived from video from the past two years. Brewster Reef was observed to have the highest site species richness for the 1998-99 surveys with 15 species, however the 2000 survey observed 21 species, an increase of 40%. Overall, the mean increase in number of species is nearly 8 per site, with a mean percentage increase of 96%. The 2000 survey observed Ball Buoy Reef to have the highest stony coral species richness of 24 species. Ball Buoy Reef, Star Reef, and Brewster Reef all shared the highest transect species richness with 16 species for the most diverse transect (Table 3). The lowest site species richness was observed at Anniversary Reef with 14 stony coral species (Figure 3,4).

Table 2. Stony Coral Species Number by Site

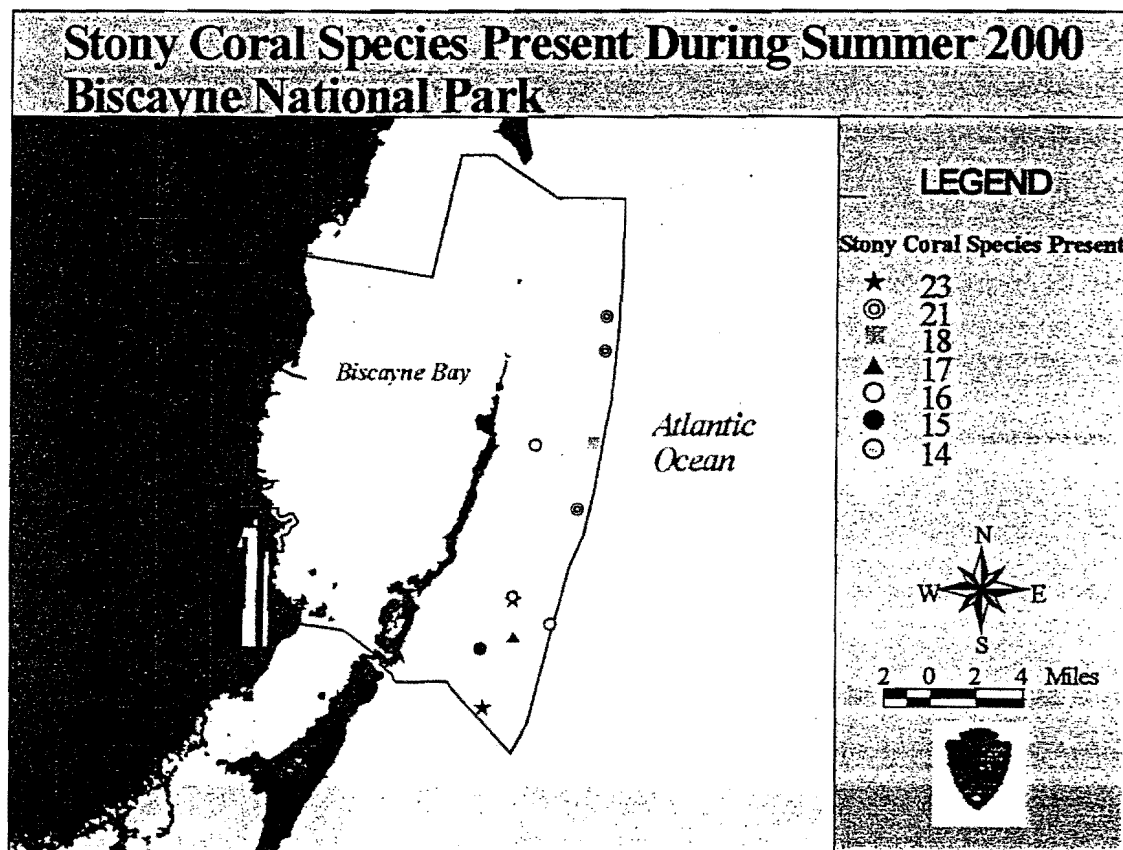
Site Name	Stony Coral Species Observed 1998-99	Stony Coral Species Observed 2000	Change in #	Change in %
Alina's Reef	Not sampled	23		
Anniversary Reef	Not sampled	14		
Bache Shoal	Not sampled	16		
Ball Buoy	13	24	11	85%↑
Brewster Reef	15	21	6	40%↑
Elkhorn Reef	10	18	8	80%↑
Long Reef	13	22	9	69%↑
Marker 21	Not sampled	15		
Pacific Reef	Not sampled	16		
Star Reef	7	21	14	200%↑
Triumph Reef	9	18	9	100%↑

The most common stony coral species seen in this study was the encrusting fire coral, *Millepora alcicornis*, which was seen 107 times (Table 4.). The next four most common were Massive starlet coral (*Siderastrea siderea*, 104 observations), Finger coral (*Porites porites*, 102 observations), Elliptical star coral (*Dichocoenia stokesii*, 95 observations), and Lettuce coral (*Agaricia agaricites*, 94 observations). Staghorn coral (*Acropora cervicornis*) was seen at 12 stations during the survey and appears to be showing signs of recruitment and recovery from the die-off in the early 1990's from white band disease, throughout the coral reef platform at Biscayne. The only occurrence of coral bleaching was seen at Bache Shoal on two finger coral (*Porites porites*) colonies. Black band disease was seen on great star coral (*Montastrea cavernosa*) at Alina's reef and Long reef. Elliptical star coral (*Dichocoenia stokesii*) was seen at Brewster reef, Elkhorn reef, and Long reef with white disease or other disease. White disease was also noted at Marker 21 patch reef on symmetrical brain coral (*Diploria strigosa*) and at Star reef on lesser starlet coral (*Siderastrea radians*).

Table 3. Highest Number of Stony Coral Species by Transect

Sitename	Number of Stony Coral Species
Triumph Reef	10
Pacific Reef	11
Anniversary Reef	11
Pacific Reef	12
Marker 21	12
Pacific Reef	13
Elkhorn Reef	13
Brewster Reef	13
Long Reef	14
Bache Shoal	15
Alina's Reef	15
Star Reef	16
Brewster Reef	16
Ball Buoy	16

Figure 3. Stony Coral Site Species Richness, All Sites, 2000

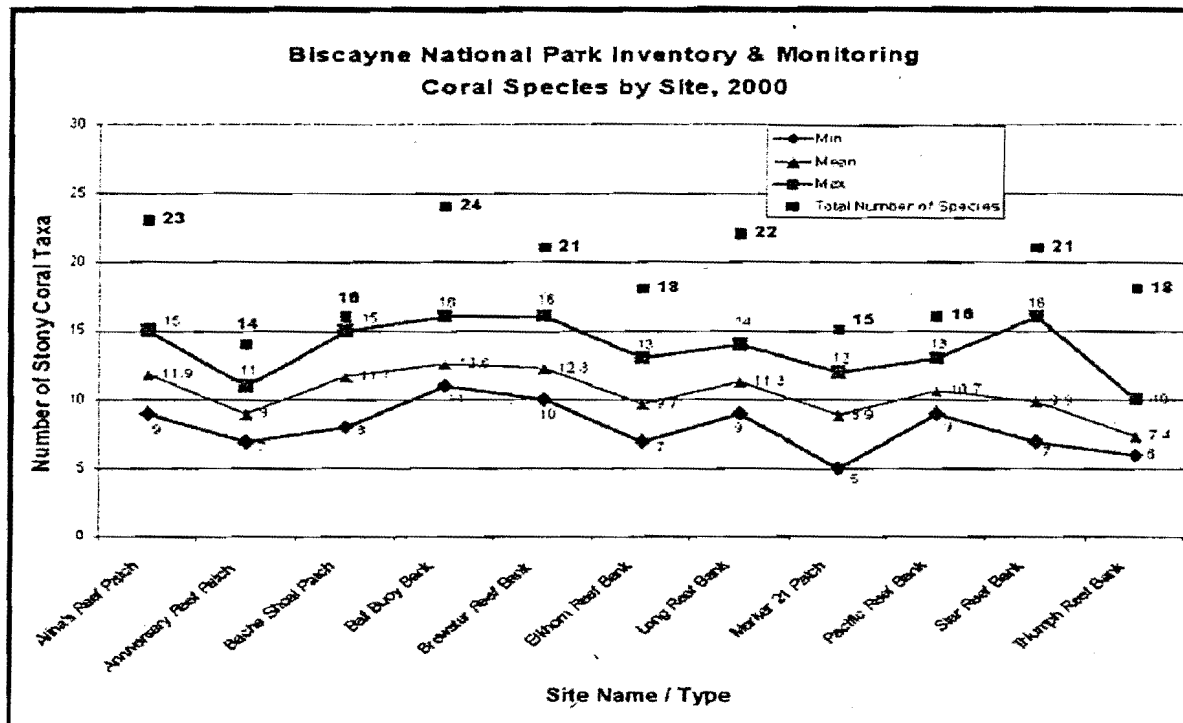


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Table 4. Stony Coral Species Observations at all Sites.

Species Name	Number of Stony Coral Observations
<i>Millepora alcicornis</i>	107
<i>Siderastrea siderea</i>	104
<i>Porites porites</i>	102
<i>Dichocoenia stokesii</i>	95
<i>Agaricia agaricites</i> complex	94
<i>Porites astreoides</i>	86
<i>Siderastrea radians</i>	73
<i>Montastraea cavernosa</i>	69
<i>Montastraea annularis</i> complex	65
<i>Meandrina meandrites</i>	48
<i>Diploria strigosa</i>	47
<i>Diploria labyrinthiformis</i>	47
<i>Diploria clivosa</i>	28
<i>Stephanocoenia michelinii</i>	28
<i>Colpophyllia natans</i>	27
<i>Millepora complanata</i>	23
<i>Agaricia fragilis</i>	19
<i>Eusmilia fastigiata</i>	19
<i>Solenastrea bournoni</i>	17
<i>Favia fragum</i>	15
<i>Acropora cervicornis</i>	12
<i>Madracis decactis</i>	9
<i>Leptoseris cucullata</i>	5
<i>Diadema antillarum</i>	4
<i>Mycetophyllia danaana</i>	4
<i>Acropora palmata</i>	4
<i>Mycetophyllia aliciae</i>	2
<i>Scolymia lacera</i>	2
<i>Oculina diffusa</i>	1
<i>Mycetophyllia ferox</i>	1
<i>Mussa angulosa</i>	1

Figure 4. Stony Coral Species by Site; Min, Mean, Max, and Total by Site, 2000.



Appendix A provides species lists for each site broken down by transect. The data collected is presence/absence data, which shows the presence of a species on the transect represented by a 1. *Diadema antillarum* is included when observed on the transect. Appendix B provides agglomerative hierarchical clustering using Euclidean dissimilarity to help see how sites are grouped based on species similarities. As sites or species cluster to the left, they share more in common than others grouped, or branched farther to the right, or increasing in height. Similarities are based on species observed together on transects the same number of times. This allows for comparisons to be made on sites which share similar species composition.

DISCUSSION

Corals and coral reefs have received a great amount of attention in the past decade. Both the Department of the Interior and the Department of Commerce have spent millions of dollars on mapping and monitoring of coral reefs, both domestically and abroad to help gain a better understanding of these fragile and highly valuable ecosystems. The National Park Service has shown support to the cause by providing base increases to coral reef parks to assist with monitoring and protection of these critical habitats. The service has an obligation to use these funds responsibly to move towards a consistent, servicerwide resource management philosophy that includes stronger measures to protect these areas from extraction and anthropogenic damage, more intense monitoring that addresses key issues such as why there is a loss of coral cover, where are diseases introduced from, can mooring systems help protect these resources, and strive for regional understanding of overall processes that help or destroy these precious areas.

Biscayne National Park's Coral Monitoring Program is a step in the right direction, however, it is just a small part of the overall management needs for this area. In addition, efforts should be made to designate a section of the park's coral resources as "no-take" where any extractive use would be prohibited. This would move the park towards those action items established through the Coral Reef Task Force's action plan, which has a phased approach to setting aside up to 20% of public managed coral reefs from extractive uses by 2010. National Parks have to be the leaders in this movement to first help protect an ecosystem that is severely imperiled, and by not taking action, basically the park is ignoring the Organic Act's call to "protect and preserve for future generations".

Biscayne National Park's current mooring buoy system is in need of further expansion and regular maintenance to ensure the visitor can enjoy the reef without dropping their anchor on it. By expecting volunteers to ensure the availability and integrity of this system, not only is the park increasing their liability, but it show a lack of care to the visitor about how the park want's to protect the reef resources. More buoys are needed park wide, placed strategically to ensure the visitor will have multiple mooring locations at key reef sites while other reefs will be protected by not allowing any anchoring at all, and no mooring buoys. In these areas, divers may be dropped off by the vessel captain and rendezvous at the completion of the dive.

The park's General Management Plan (GMP) process is the perfect opportunity to set aside areas in the park to meet the 20% "no-take" area challenge by 2010. Using a phased approach, current areas like the Legare Anchorage could be expanded and closed to fishing with minimal controversy, while in future years, areas in both the south and north (Elkhorn Reef and Brewster Reef, for example), could be closed to public use and used as control sites to compare with sites used by the visitor. These closure areas not only help protect the corals, but also allow for the reef inhabitants like the lobster, snapper, and grouper to have a place to grow without fishing pressure and try to help allow these critically important species to keep from being exploited in the future. Areas such as these in other parts of the Florida Keys have shown increases in fish abundance and size in just a few years after "no-take" areas have been established.

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Biscayne National Park need to take a hard look at it's current monitoring program and examine how it needs to fit into the regional monitoring framework. The past three years have used haphazard transects to characterize the reef resources. The need for permanent transects at each sampling site is understood by all doing reef monitoring as the best way to statistically sample these ecosystems for long term trend analysis. Before Biscayne National Park makes the move towards permanent transect placement, those involved need to take a close look at what the purpose of the monitoring will be. There are different ways to monitor the reef if you are looking for anthropogenic impacts, for disease, for trends in coral cover and species richness, or to evaluate how management zones are working. If all those items are to be incorporated into a single monitoring program, then the aforementioned questions will need some agreement to ensure the permanent sites reflect areas in question.

The time it takes to develop Biscayne's plan may be advantageous because it will give the park time to decide on buoy strategy, "no-take" zone placement, questions to be answered, and which methods to adopt. The monitoring that is currently being performed in the rest of the Florida Keys and what is being done by the park units in the Caribbean has some differences in the methodology. The Caribbean parks use a 10m long transect, while the Florida Keys National Marine Sanctuary uses 22m long transect. All are using digital video at 40 cm above the reef, but two types of analysis software programs are being used to make for regional data assimilation problems. Discussion has been currently started about generalizing these idiosyncrasies.

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

Appendix A.

Species By Site

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

**Biscayne National Park Inventory and Monitoring Program
Brewster Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1		1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>		1			1	1					1
<i>Colpophyllia natans</i>		1					1				
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria labyrinthiformis</i>				1	1	1	1	1	1	1	1
<i>Diploria strigosa</i>			1				1	1	1		1
<i>Eusmilia fastigiata</i>		1								1	
<i>Leptoseris cucullata</i>				1							
<i>Madracis decactis</i>									1		1
<i>Meandrina meandrites</i>		1	1	1		1	1	1	1	1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>		1					1	1			
<i>Montastraea annularis</i> complex		1	1	1	1	1	1	1		1	1
<i>Montastraea cavernosa</i>			1	1	1		1			1	1
<i>Porites astreoides</i>			1	1	1	1	1			1	1
<i>Porites porites</i>		1	1	1		1		1	1	1	1
<i>Scolymia lacera</i>					1						
<i>Siderastrea radians</i>		1	1	1					1		1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea bourmoni</i>				1	1		1		1	1	1
<i>Stephanocoenia michelinii</i>		1				1		1	1	1	1

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

Biscayne National Park Inventory and Monitoring Program
Alina's Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>		1	1	1					1	1	1
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1		
<i>Agaricia fragilis</i>								1			
<i>Colpophyllia natans</i>								1			1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria clivosa</i>				1					1	1	
<i>Diploria labyrinthiformis</i>			1	1			1				1
<i>Diploria strigosa</i>		1		1					1	1	1
<i>Eusmilia fastigiata</i>		1	1			1		1			
<i>Favia fragum</i>		1									
<i>Leptoseris cucullata</i>								1			
<i>Meandrina meandrites</i>				1	1	1					
<i>Millepora alcicornis</i>		1	1	1	1		1	1		1	1
<i>Montastraea annularis</i> complex		1	1		1	1	1	1	1		1
<i>Montastraea cavernosa</i>		1	1	1	1	1	1		1	1	1
<i>Mussa angulosa</i>								1			
<i>Mycetophyllia ferox</i>								1			
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1		1	1	1	1	1	1		1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea bourmoni</i>			1			1					
<i>Stephanocoenia michelinii</i>		1				1		1			1

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

**Biscayne National Park Inventory and Monitoring Program
Anniversary Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>							1				1
<i>Agaricia agaricites</i> complex					1	1	1	1	1		
<i>Dichocoenia stokesii</i>		1	1		1	1	1	1	1	1	1
<i>Diploria clivosa</i>		1	1	1				1		1	1
<i>Diploria labyrinthiformis</i>					1	1			1		
<i>Diploria strigosa</i>		1	1	1	1	1				1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1							1	1
<i>Montastraea cavernosa</i>		1			1	1	1	1	1		
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1		1		
<i>Stephanocoenia michelinii</i>						1					

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

Biscayne National Park Inventory and Monitoring Program
Bache Shoal, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1				1	1	
<i>Colpophyllia natans</i>			1				1	1	1	1	1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1				1
<i>Diploria clivosa</i>		1	1		1	1	1		1	1	1
<i>Diploria labyrinthiformis</i>		1	1	1	1	1		1	1	1	1
<i>Diploria strigosa</i>		1	1	1	1	1	1		1	1	1
<i>Eusmilia fastigiata</i>			1								
<i>Favia fragum</i>		1	1	1		1	1	1			
<i>Meandrina meandrites</i>		1				1			1	1	
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Montastraea cavernosa</i>		1	1	1	1	1		1	1	1	
<i>Porites astreoides</i>		1	1	1	1	1	1			1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1	1		1	1			1		
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1

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Appendix A. Species Observations by Site and Transect.

**Biscayne National Park Inventory and Monitoring Program
Ball Buoy Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora palmata</i>		1							1	1	1
<i>Agaricia agaricites</i> complex		1		1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>		1	1	1		1		1			
<i>Colpophyllia natans</i>			1		1		1	1			
<i>Diadema antillarum</i>											1
<i>Dichocoenia stokesii</i>		1		1	1	1	1	1		1	1
<i>Diploria clivosa</i>									1		
<i>Diploria labyrinthiformis</i>			1		1	1		1		1	
<i>Diploria strigosa</i>			1	1			1		1		1
<i>Eusmilia fastigiata</i>					1						
<i>Leptoseris cucullata</i>			1								
<i>Meandrina meandrites</i>		1		1	1		1	1	1	1	
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>			1		1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1	1		1	1	1	1	1	1
<i>Montastraea cavernosa</i>		1	1	1	1	1	1	1	1	1	1
<i>Mycetophyllia aliciae</i>				1							
<i>Mycetophyllia danaana</i>			1			1		1			1
<i>Oculina diffusa</i>			1								
<i>Porites astreoides</i>		1	1	1	1				1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>			1	1	1			1	1		
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Stephanocoenia michelinii</i>			1								

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

**Biscayne National Park Inventory and Monitoring Program
Elkhorn Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>				1							
<i>Colpophyllia natans</i>			1			1	1	1	1		
<i>Diadema antillarum</i>		1						1			
<i>Dichocoenia stokesii</i>		1	1	1		1	1	1	1	1	1
<i>Diploria clivosa</i>							1	1			
<i>Diploria labyrinthiformis</i>		1			1			1		1	
<i>Diploria strigosa</i>							1		1		1
<i>Eusmilia fastigiata</i>							1				
<i>Meandrina meandrites</i>						1		1			
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>		1	1			1	1				
<i>Montastraea annularis</i> complex			1				1	1	1		
<i>Montastraea cavernosa</i>		1	1	1	1	1		1	1		
<i>Porites astreoides</i>			1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1		1			1		1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

Biscayne National Park Inventory and Monitoring Program
Long Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>					1						
<i>Agaricia agaricites complex</i>		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>					1						1
<i>Colpophyllia natans</i>			1			1		1			
<i>Diadema antillarum</i>											1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	
<i>Diploria clivosa</i>				1	1	1					
<i>Diploria strigosa</i>			1		1	1	1		1		
<i>Eusmilia fastigiata</i>		1								1	1
<i>Favia fragum</i>				1						1	
<i>Leptoseris cucullata</i>		1									
<i>Meandrina meandrites</i>			1		1		1	1	1	1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>		1	1		1	1	1	1			
<i>Montastraea annularis complex</i>			1		1					1	1
<i>Montastraea cavernosa</i>		1	1	1			1	1	1	1	1
<i>Porites astreoides</i>			1		1	1	1	1	1		1
<i>Porites porites</i>		1	1	1		1	1	1	1	1	1
<i>Siderastrea radians</i>			1	1	1	1		1	1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea boumonii</i>			1								1
<i>Stephanocoenia michelinii</i>		1				1					1

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

Biscayne National Park Inventory and Monitoring Program
Marker "21", Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>				1	1						
<i>Agaricia agaricites</i> complex			1	1	1	1	1		1		1
<i>Colpophyllia natans</i>									1		
<i>Dichocoenia stokesii</i>				1	1	1	1	1	1	1	
<i>Diploria clivosa</i>		1			1				1	1	1
<i>Diploria labyrinthiformis</i>				1						1	
<i>Diploria strigosa</i>				1	1			1	1	1	1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex		1	1	1	1	1	1				
<i>Montastraea cavernosa</i>				1	1		1	1			1
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	1
<i>Porites porites</i>		1		1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>				1	1	1	1	1	1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Solenastrea boumonii</i>						1					

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

Biscayne National Park Inventory and Monitoring Program
Pacific Reef, Stony Coral and other taxa; Presence/Absence, 2000

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria labyrinthiformis</i>		1	1			1	1	1			1
<i>Eusmilia fastigiata</i>					1	1			1	1	
<i>Favia fragum</i>					1	1					1
<i>Madracis decactis</i>		1	1			1	1			1	
<i>Meandrina meandrites</i>		1		1	1	1		1	1		1
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Montastraea annularis</i> complex			1				1				
<i>Montastraea cavernosa</i>			1		1		1				
<i>Porites astreoides</i>		1	1	1	1	1	1	1	1	1	
<i>Porites porites</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea radians</i>		1	1	1	1	1	1	1	1	1	1
<i>Siderastrea siderea</i>		1		1	1	1	1	1	1	1	1
<i>Solenastrea bournoni</i>		1	1			1					
<i>Stephanocoenia michelinii</i>			1	1	1		1	1		1	

Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

**Biscayne National Park Inventory and Monitoring Program
Star Reef, Stony Coral and other taxa; Presence/Absence, 2000**

<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>									1		1
<i>Colpophyllia natans</i>					1						
<i>Dichocoenia stokesii</i>		1	1	1	1	1	1	1	1	1	1
<i>Diploria labyrinthiformis</i>			1		1	1	1			1	
<i>Eusmilia fastigiata</i>									1	1	1
<i>Favia fragum</i>							1		1		
<i>Leptoseris cucullata</i>									1		
<i>Madracis decactis</i>									1		1
<i>Meandrina meandrites</i>		1		1	1	1	1	1	1		1
<i>Millepora alcicornis</i>		1	1	1	1	1		1	1	1	1
<i>Montastraea annularis</i> complex			1				1	1	1	1	1
<i>Montastraea cavernosa</i>			1			1			1		1
<i>Mycetophyllia aliciae</i>									1		
<i>Porites astreoides</i>				1		1			1	1	1
<i>Porites porites</i>		1	1	1	1	1	1	1		1	1
<i>Scolymia lacera</i>									1		
<i>Siderastrea radians</i>		1		1	1		1	1			
<i>Siderastrea siderea</i>		1	1			1	1	1	1	1	1
<i>Solenastrea boumonii</i>				1	1			1			
<i>Stephanocoenia michelinii</i>							1		1	1	1

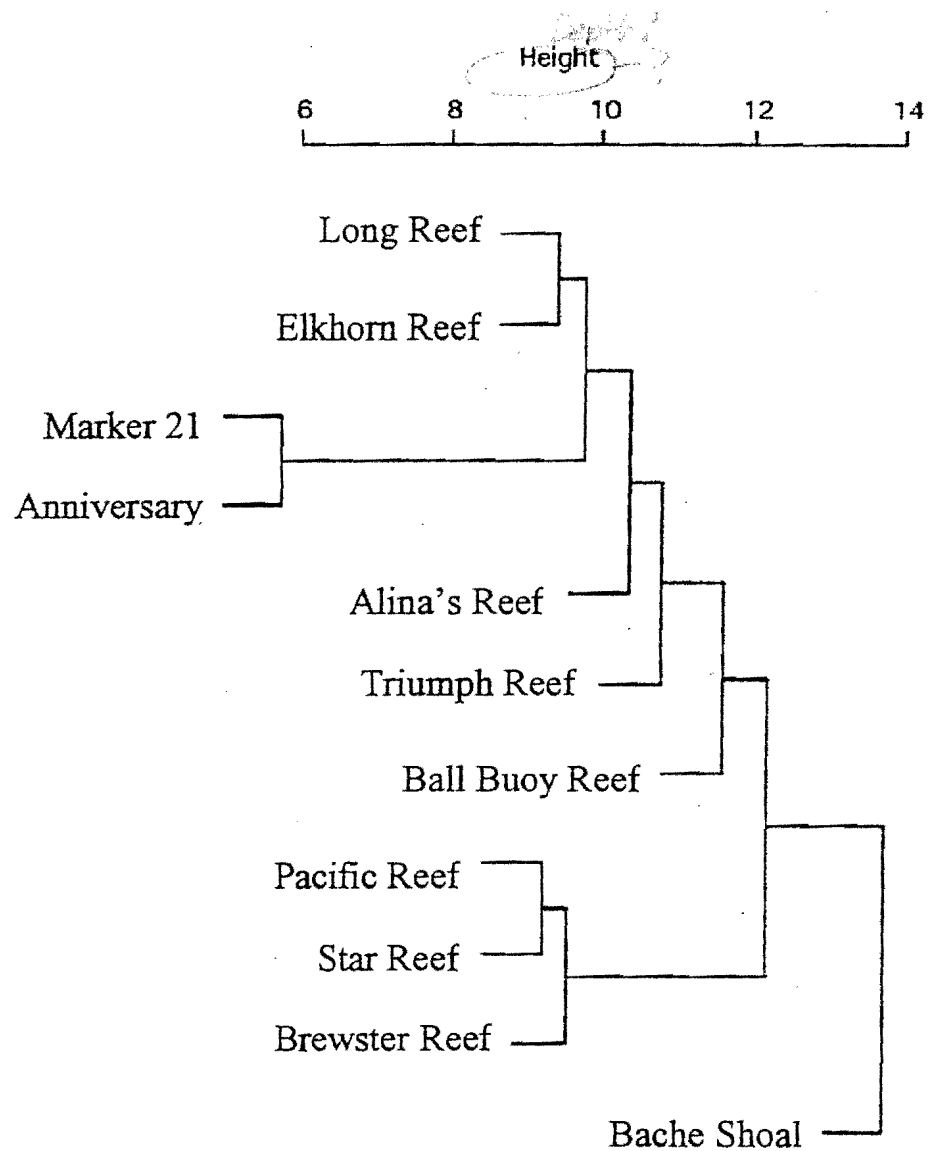
Coral Reef Monitoring In Biscayne National Park, 2000.
Appendix A. Species Observations by Site and Transect.

**Biscayne National Park Inventory and Monitoring Program
Triumph Reef, Stony Coral and other taxa; Presence/Absence, 2000**

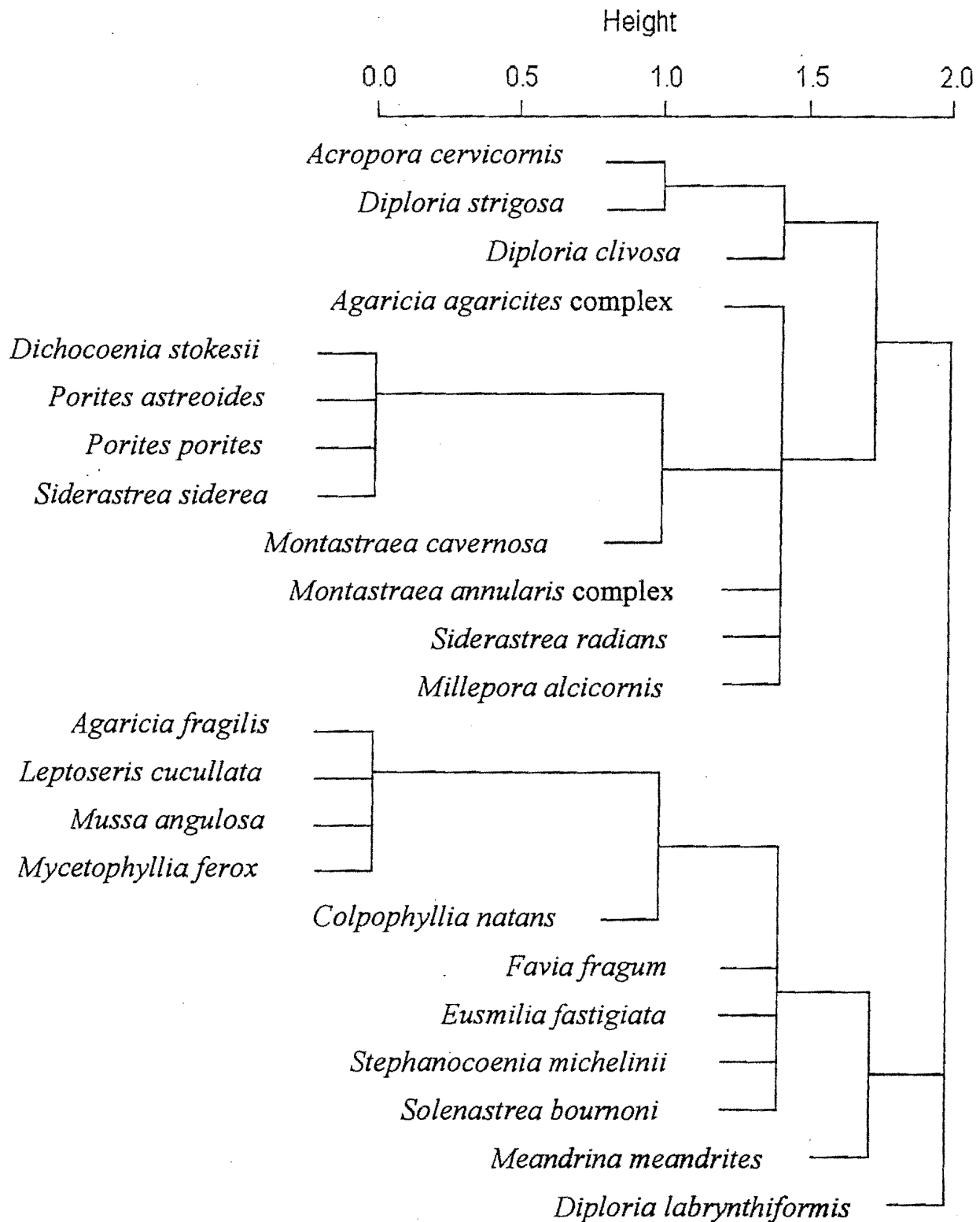
<i>Species Name</i>	<i>Transect #</i>	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>	<i>10</i>
<i>Acropora cervicornis</i>							1				
<i>Agaricia agaricites</i> complex		1	1	1	1	1	1	1	1	1	1
<i>Agaricia fragilis</i>		1	1				1				1
<i>Colpophyllia natans</i>			1		1				1		
<i>Dichocoenia stokesii</i>			1	1				1	1	1	1
<i>Diploria labyrinthiformis</i>						1					
<i>Diploria strigosa</i>			1				1				
<i>Favia fragum</i>		1									
<i>Meandrina meandrites</i>			1								
<i>Millepora alcicornis</i>		1	1	1	1	1	1	1	1	1	1
<i>Millepora complanata</i>					1					1	
<i>Montastraea annularis</i> complex				1		1				1	
<i>Montastraea cavernosa</i>		1				1		1			
<i>Porites astreoides</i>					1			1	1	1	
<i>Porites porites</i>		1	1	1				1	1	1	1
<i>Siderastrea radians</i>									1	1	1
<i>Siderastrea siderea</i>		1	1	1	1	1	1	1	1	1	1
<i>Stephanocoenia michelinii</i>			1					1			1

**Appendix B. Agglomerative Hierarchical Clustering using
Euclidean Dissimilarity Diagram by Site**

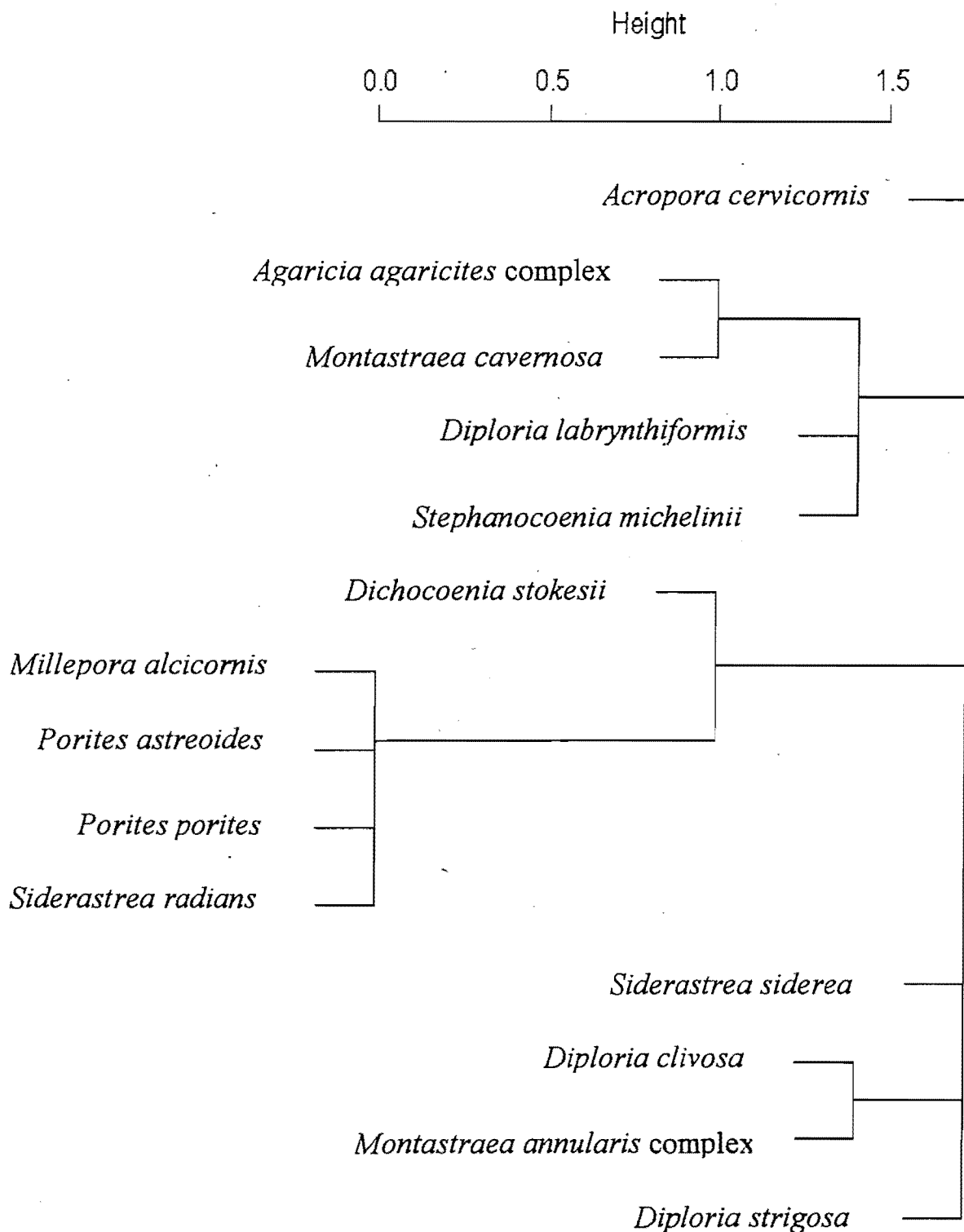
All Sampling Sites, 2000



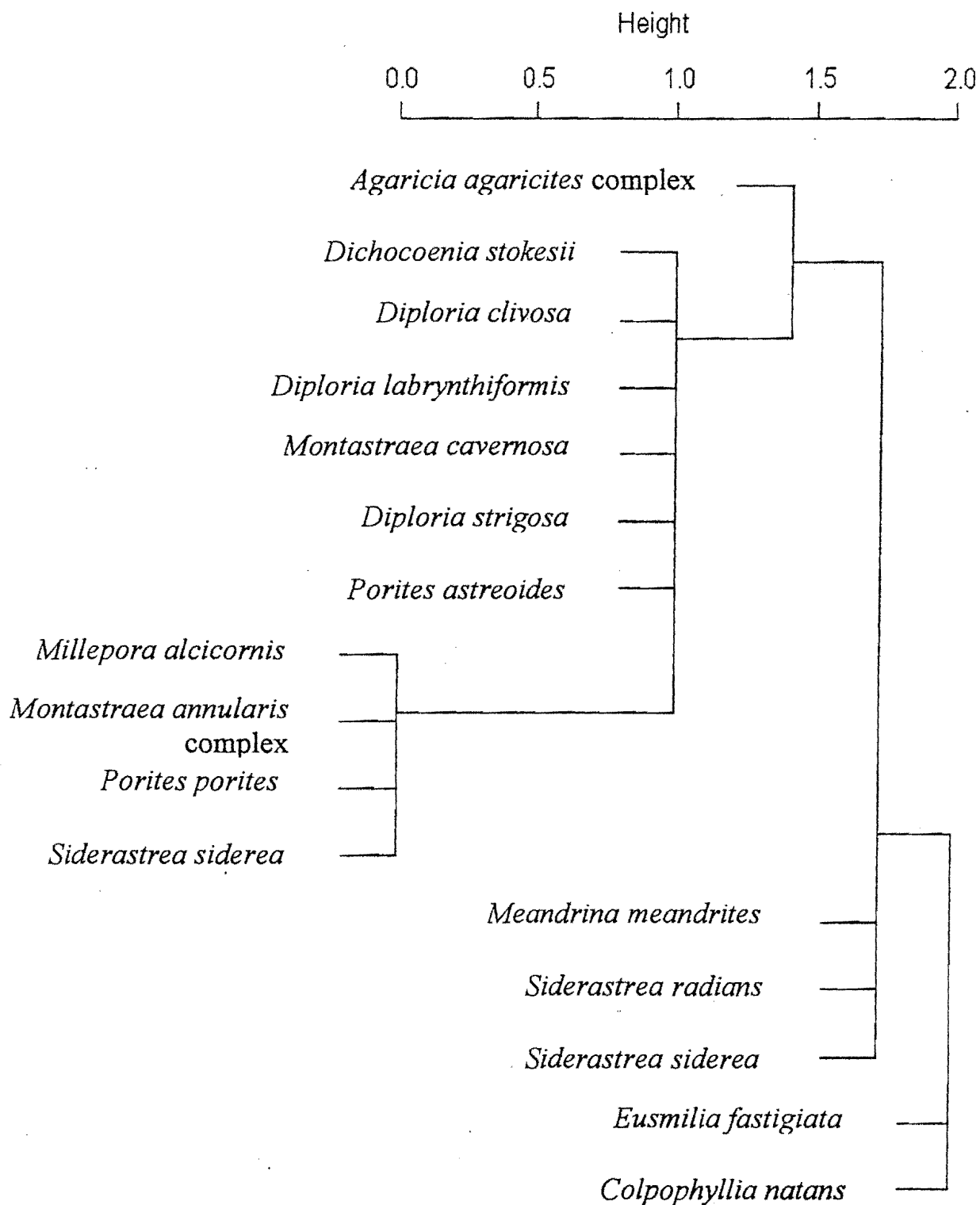
Alina's Reef Stony Coral, 2000



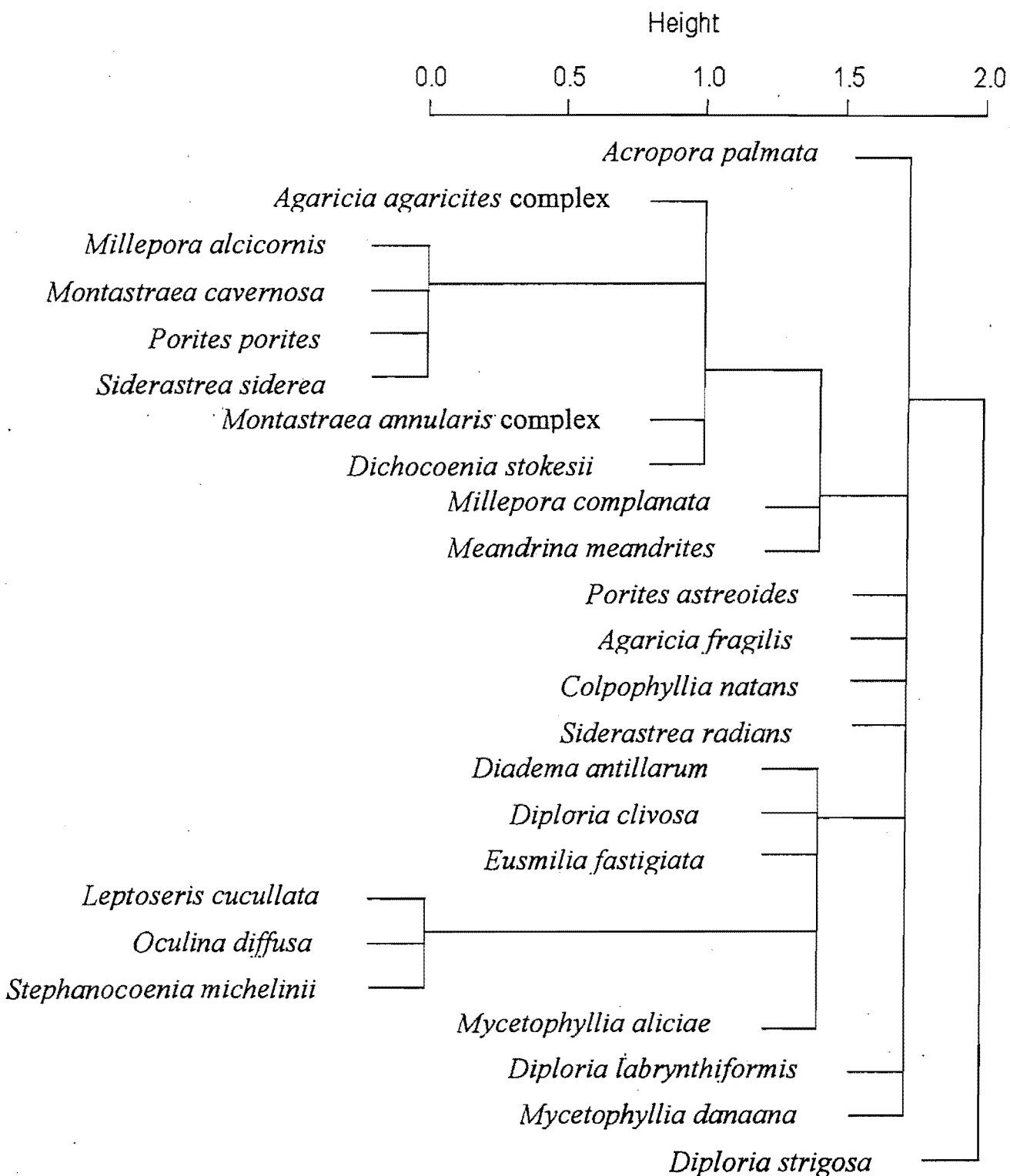
Anniversary Reef Stony Coral, 2000



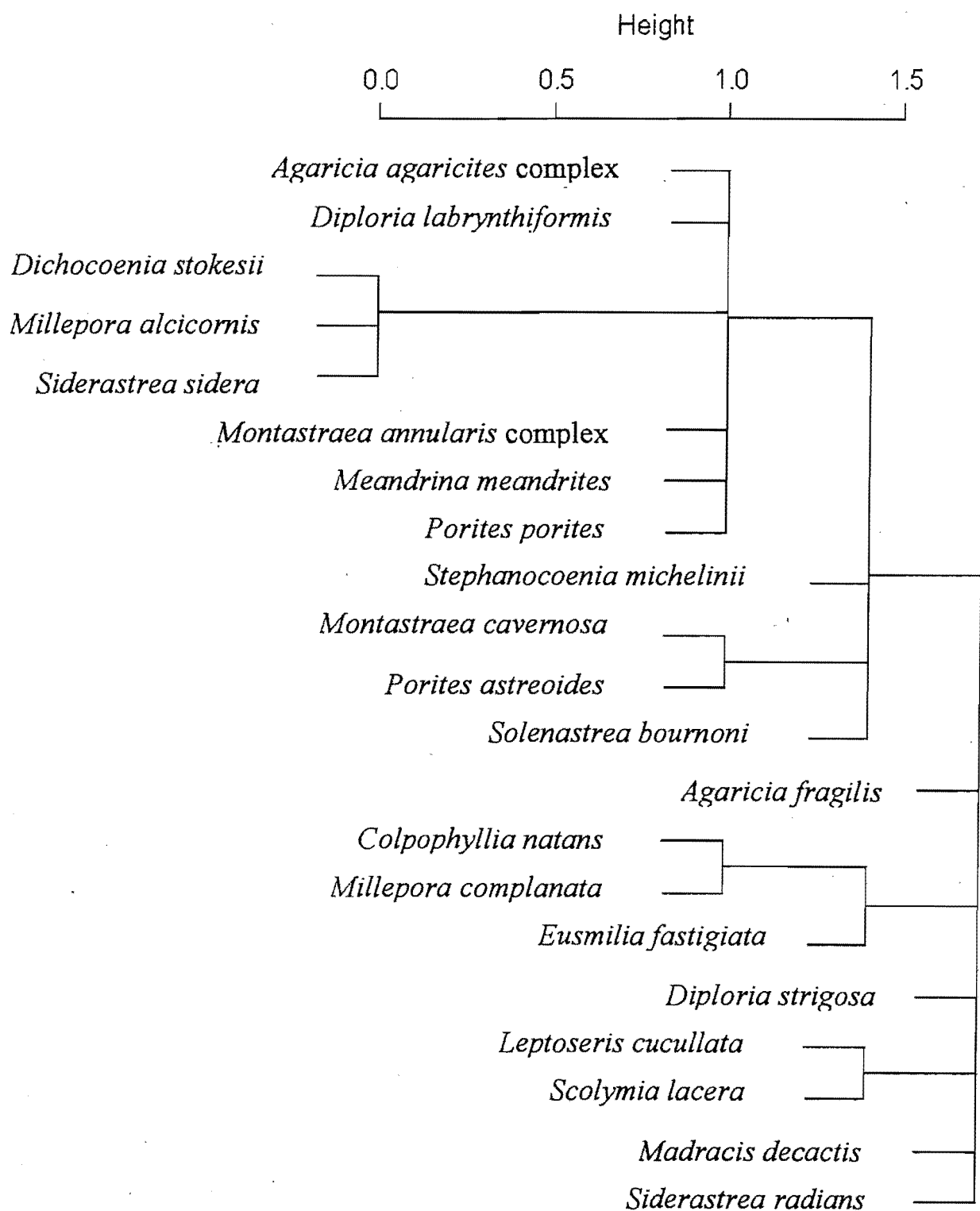
Bache Shoal Stony Coral, 2000



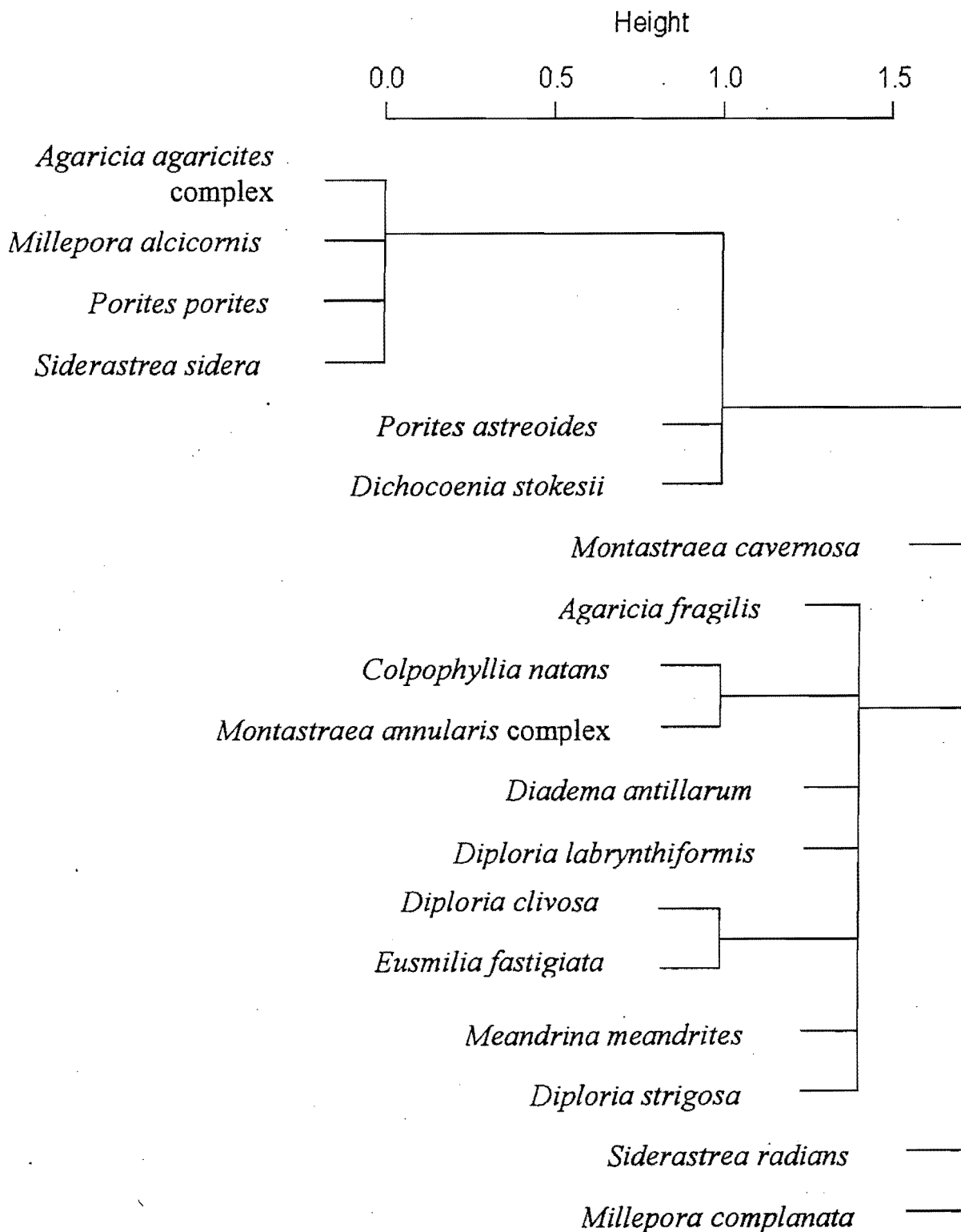
Ball Buoy Reef Stony Coral, 2000



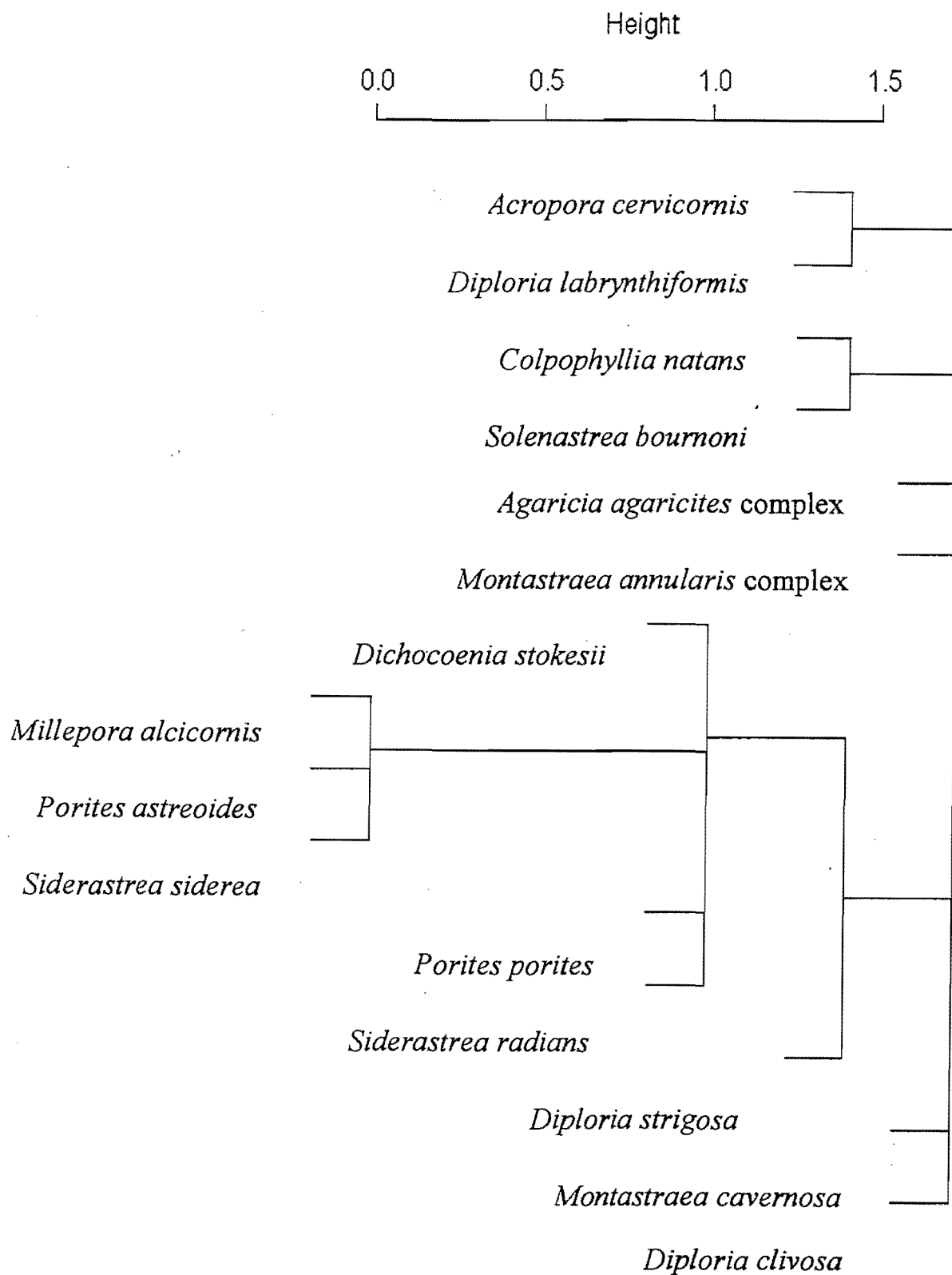
Brewster Reef Stony Coral, 2000



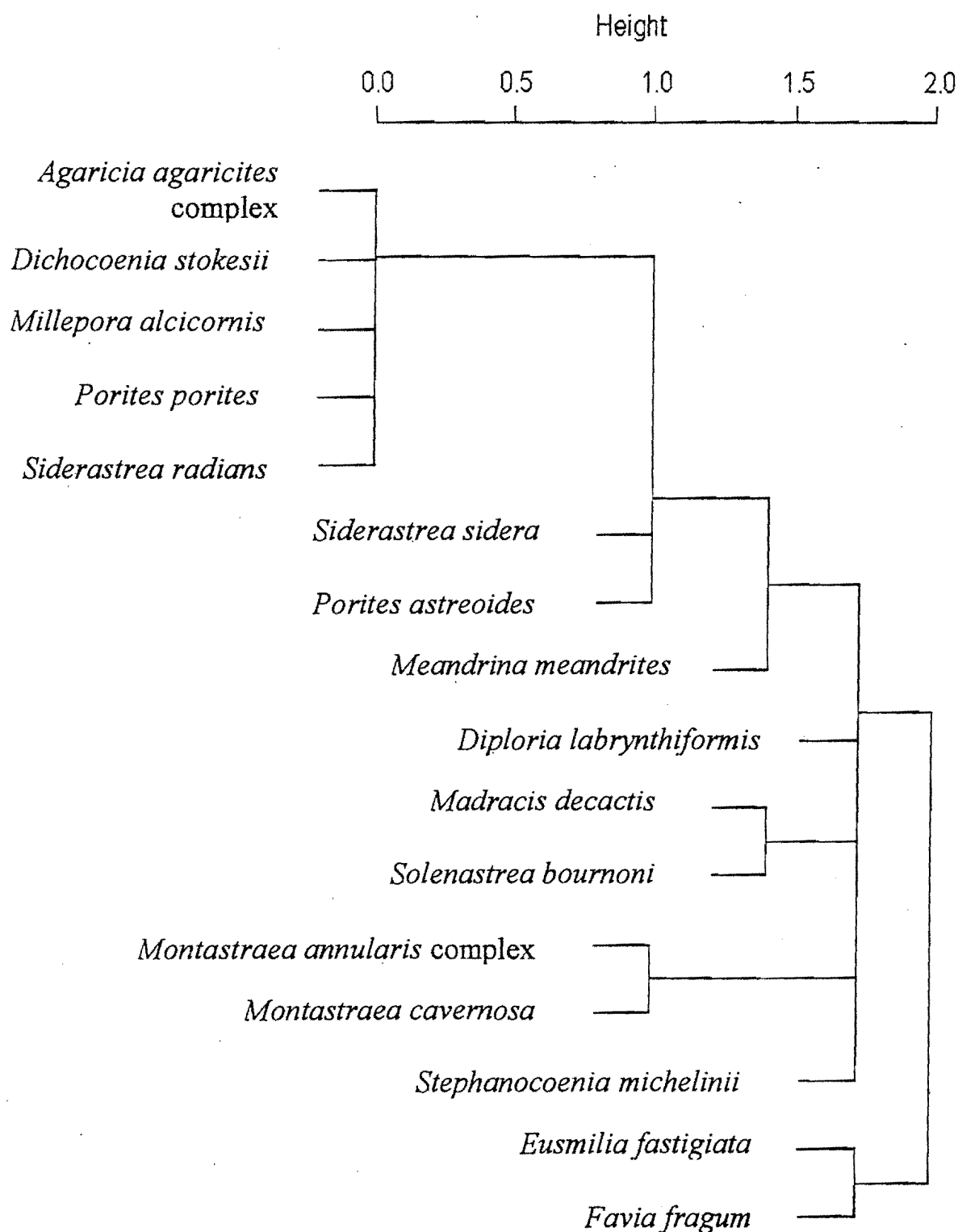
Elkhorn Reef Stony Coral, 2000



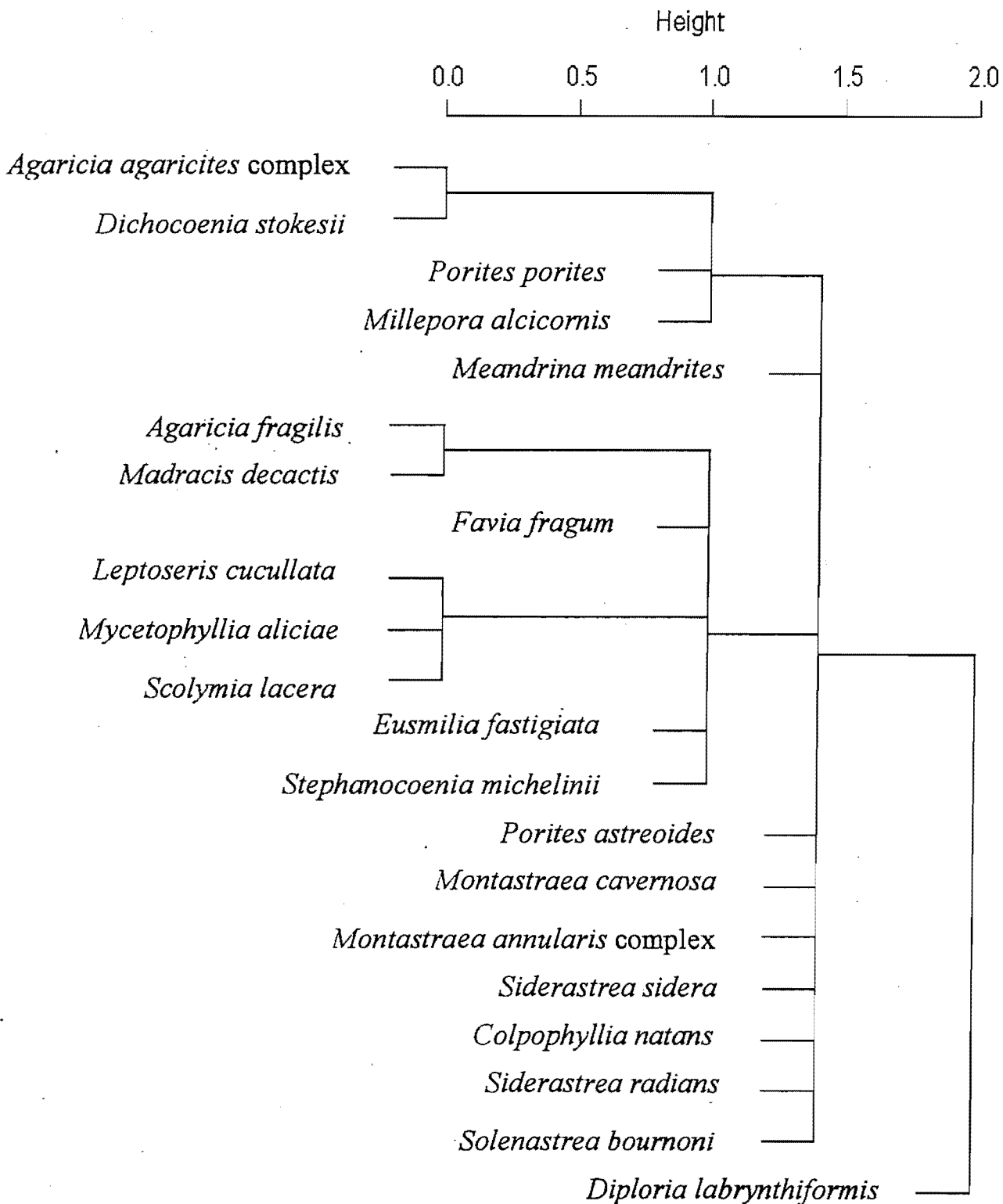
Marker "21" Stony Coral, 2000



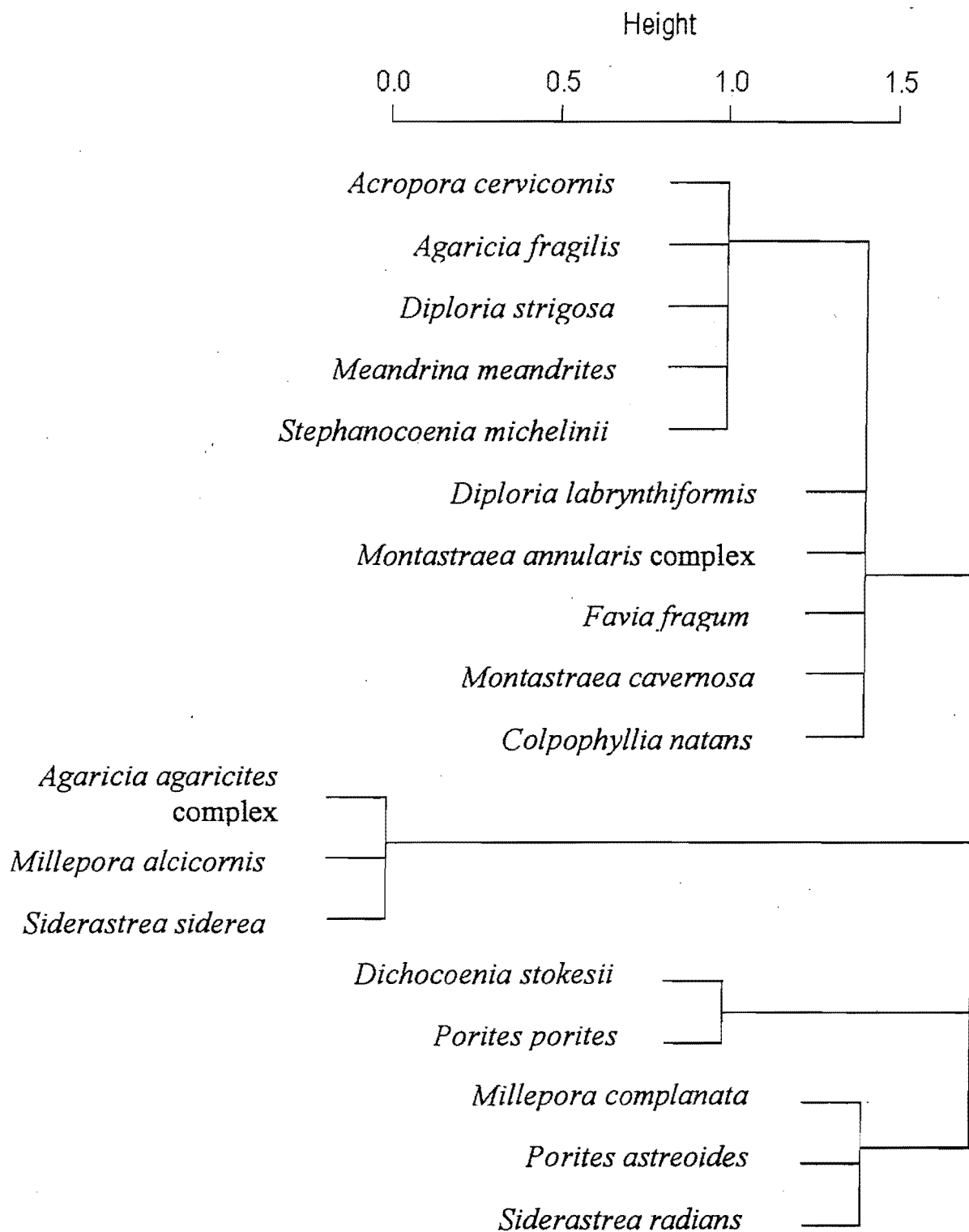
Pacific Reef Stony Coral, 2000



Star Reef Stony Coral,



Triumph Reef Stony Coral, 2000



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