

STONY CORAL COMMUNITY STRUCTURE AND
SPECIES DIVERSITY AT SELECTED PATCH
REEFS WITHIN BISCAYNE NATIONAL MONUMENT

Walter C. Jaap
Florida Department of Natural Resources
Marine Research Laboratory
100 Eighth Avenue SE
St. Petersburg, FL 33701

Results reported herein are a portion of an ongoing research project conducted by The Florida Department of Natural Resources Marine Research Laboratory and the U.S. National Park Service, Biscayne National Monument, to provide information for rational management of Florida's fragile coral reef resources.

Eight reefs are being studied with plot and plotless techniques. Four reefs, marked with mooring buoys and described in NPS visitor information brochures, receive heavy visitor use, and, for purposes of this project, are considered experimental reefs. Four unmarked reefs nearby are considered the controls; these are very similar in community structure to the experimental reefs. The hypothesis is that there will be significant changes in community structure, relative abundance of common species and species diversity between experimental and control reefs as a result of user pressure.

Plotless data acquisition was accomplished by setting 25 m long transects between locator stakes and censusing and measuring every coral lying along the transect. Eighteen transects were sampled in 1977 and 20 during 1978.

Plot data were acquired by setting a PVC grid at the ends of each transect in 1977 and within randomly placed locator stakes in 1978. In 1977 each plot was one m^2 , but in 1978 each plot was increased to 4 m^2 . A total of 32 m^2 was sampled in 1977 and 96 m^2 in 1978. The 4 m^2 plots will be censused and photographed during future years.

reefs losing cover. Apparently, cover may fluctuate as much as six percent per year due to natural causes, sampling error and human activity.

Size frequency distributions of the five most abundant species revealed two possible strategies. "Opportunistic" species consistently displayed high relative abundance in smaller size classes, indicating recent recruitment; Millepora alcicornis, Porites astreoides and P. porites are examples of this strategy. These species colonize recently disturbed, often unstable, substrates, hence existence is often transitory. For example, M. alcicornis (Fig. 2) commonly colonize dead octocoral axial elements, but waves may displace the colonies from the reefs into areas generally not suitable for M. alcicornis. The more substantial species such as Montastraea annularis have a trend of more equal distribution among size classes, indicating a more stable life history (Fig. 3). Growth is slow, but, once established, M. annularis can attain considerable mass and size.

Growth rate investigations of western Atlantic stony corals have been limited to short-term, in situ studies or X-ray studies of banding which usually examined only vertical growth. Since data reported here is horizontal and Vaughan (1916) reported a difference in vertical and horizontal growth, the more precise X-ray rates are not appropriate. Vaughan's studies, conducted at Dry Tortugas, Florida, were of five year's duration and provide a good estimate of annual growth. Porites astreoides had an annual horizontal increase of 1.22 ± 0.27 cm, and Montastraea annularis increased 0.74 ± 0.11 cm per year. Extrapolating this information, a 50 cm colony of P. astreoides would be about 41 years old and a similar-sized M. annularis would be about 67 years old. This implies that most P. astreoides colonies encountered in the plotless study were less than eight years old. Conversely, M. annularis colonies were spread over a wide age grouping, and many were 100 or more years old.

Comparison of dispersion patterns of the five most abundant species between plot and plotless enumeration techniques gave differing results. Most plotless species exhibited contagious patterns during 1977 and 1978, but several of the same species in plots indicated random distribution patterns (Table 7). Intuitively, contagious patterns are more compatible with normal zonal patterns that are observed on the reefs.

Baseline data base forms a good comparison for the future. Some expansion and improvement are anticipated which will add to the validity of the investigation. Current parallel studies include octocorals, algae, fish, other macro-invertebrates, damage surveys, and reproductive histological studies of the stony corals and octocorals.

Table 1 Systematic Account, Stony Corals Known from Biscayne National Monument

Class HYDROZOA Owen, 1843

Order MILLEPORINA Hickson, 1901

Family Milleporidae Fleming, 1828

Millepora alcicornis Linne, 1758

* M. complanata Lamarck, 1816

Class ANTHOZOA Ehrenberg, 1834

Subclass HEXACORALLIA Haeckel, 1896

Order SCLERACTINIA Bourne, 1900

Suborder ASTROCOENIINA Vaughan and Wells, 1943

Family Astrocoeniidae Koby, 1890

* Stephanocoenia michelinii H. Milne Edwards and Haime, 1849

Family Pocilloporidae Gray, 1842

* Madracis decactis (Lyman, 1857)

Family Acroporidae Verrill, 1902

Acropora cervicornis (Lamarck, 1816)

A. palmata (Lamarck, 1816)

Suborder FUNGIINA Verrill, 1902

Superfamily Agariciidae Gray, 1847

Family Agariciidae Gray, 1847

Agaricia agaricites (Linne, 1758)

* A. lamarcki H. Milne Edwards and Haime, 1851

* A. fragilis Dana, 1846

* Helioseris cucullata (Ellis and Solander, 1768)

Family Siderastreidae Vaughan and Wells, 1943

Siderastrea radians (Pallas, 1766)

S. siderea (Ellis and Solander, 1786)

Superfamily Poriticae Gray, 1842

Family Poritidae Gray, 1842

Porites astreoides Lamarck, 1816

P. porites (Pallas, 1766)

* P. branneri Rathbun, 1887

Suborder FAVIINA Vaughan and Wells, 1943

Superfamily Faviidae Gregory, 1900

Family Faviidae Gregory, 1900

Favia fragum (Esper, 1795)

Diploria labyrinthiformis (Linne, 1758)

D. clivosa (Ellis and Solander, 1786)

D. strigosa (Dana, 1846)

Manicina areolata (Linne, 1758)

Colpophyllia natans (Houttyn, 1772)

Cladocora arbuscula (LeSueur, 1821)

Montastraea cavernosa (Linne, 1758)

M. annularis (Ellis and Solander, 1786)

Solenastrea hyades (Dana, 1846)

* S. bournoni H. Milne Edwards and Haime, 1850

Family Oculinidae Gray, 1847

Oculina diffusa Lamarck, 1816

Family Meandrinidae Gray, 1847

Meandrina meandrites (Linne, 1758)

* Dichocoenia stellaris H. Milne Edwards and Haime, 1849

D. stokesii H. Milne Edwards and Haime, 1849

Family Mussidae Ortmann, 1890

Mussa angulosa (Pallas, 1766)

* Scolymia sp.

All D. cylindrus from E Cont.

Table 2

Summary of stony coral density and diversity

Biscayne National Monument

	1977 Transects (25mL)	1978 Transects (25mL)	1977 Quadrats (m ²)	1978 Plots (m ²)
N (samples)	18	20	32	96
Number species	22	22	18	27
Number of colonies	451	532	241	592
Density (overall)				
species $\bar{X}$	6.8*	7.2*	3.4	3.3
S	1.9	1.8	1.8	1.44
range	4-9	4-11	0-8	1-7
colonies $\bar{X}$	25.1	27.0	7.53	6.2
S	11.0	8.2	5.9	3.5
range	7-49	16-43	0-23	2-16
Diversity Indices**				
Shannon-Weiner				
H'n (range)	0.59 - 2.80	1.48 - 3.33	1.89 - 2.92	2.22 - 3.23
H'n max (range)	1.00 - 3.00	2.32 - 3.46	2.00 - 3.59	3.00 - 3.81
J'n (range)	0.65 - 0.96	0.56 - 0.96	0.74 - 0.95	0.62 - 0.85
H'c (range)	0.41 - 2.68	1.38 - 2.92	-	-
H'c max (range)	1.00 - 3.17	2.32 - 3.17	-	-
J'c (range)	0.40 - 0.95	0.47 - 0.88	-	-

*Density for transects: species or colonies per 25 linear meters

**Index values for transects and sets of plots per each reef

Table 3

Comparison of Species Diversity for Plotless Line Transects and Plots

1977

Reef	N		No. species		H'_n		H'_n max.		J'_n	
	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.
	(25m)	m ²								
Elkhorn	3	4	10	7	2.67	2.46	3.32	2.81	.80	.88
E. Control	3	4	10	8	2.78	2.23	3.32	3.00	.84	.74
Schooner	2	4	7	8	2.52	2.24	2.81	3.00	.90	.75
Sc. Control	2	4	7	8	2.21	2.40	2.81	3.00	.79	.80
Star	2	4	11	12	2.84	2.92	3.46	3.59	.82	.81
St. Control	2	4	8	4	2.42	1.89	3.00	2.00	.81	.95
Dome	2	4	10	6	2.20	2.08	3.32	2.59	.66	.80
D. Control	2	4	11	7	2.88	2.55	3.46	2.81	.87	.91
Total	18	32	22	18	3.48	3.27	4.39	4.17	.79	.79

1978

Reef	N		No. species		H'_n		H'_n max.		J'_n	
	T.	P.	T.	P.	T.	P.	T.	P.	T.	P.
	(25m)	m ²								
Elkhorn	3	16	13	12	2.76	2.99	3.70	3.59	.75	.64
E. Control	3	16	11	12	3.05	2.22	3.46	3.58	.38	.74
Schooner	3	8	11	8	2.58	2.24	3.46	3.00	.75	.75
Sc. Control	3	8	9	11	2.24	2.68	3.17	3.46	.71	.77
Star	2	12	10	14	2.53	3.23	3.32	3.81	.76	.85
St. Control	2	12	9	14	2.54	2.71	3.17	3.81	.80	.71
Dome	2	12	12	13	2.51	3.08	3.58	3.70	.70	.83
D. Control	2	12	10	11	2.84	2.77	3.46	3.46	.86	.80
Total	20	96	22	27	3.65	3.34	4.52	4.75	.81	.70

T: Transect, 25 m in length.

P: Plot

Table 4
Comparison of Stony
Coral Cover (Plotless Technique)

Study	Location	Range % Cover
Loya, 1972	Eilat Red Sea	22.1 - 86.4
Loya, 1976	Punta Ostiones, Puerto Rico	30.3 - 81.4
Benayahu & Loya, 1977	Eilat Red Sea	5.5 - 49.1
Jaap, unpub.	Grand Bahama	0 - 60.2
Jaap, unpub.	Dry Tortugas	0.5 - 55.5
Jaap	Biscayne National Monument	4.8 - 42.4

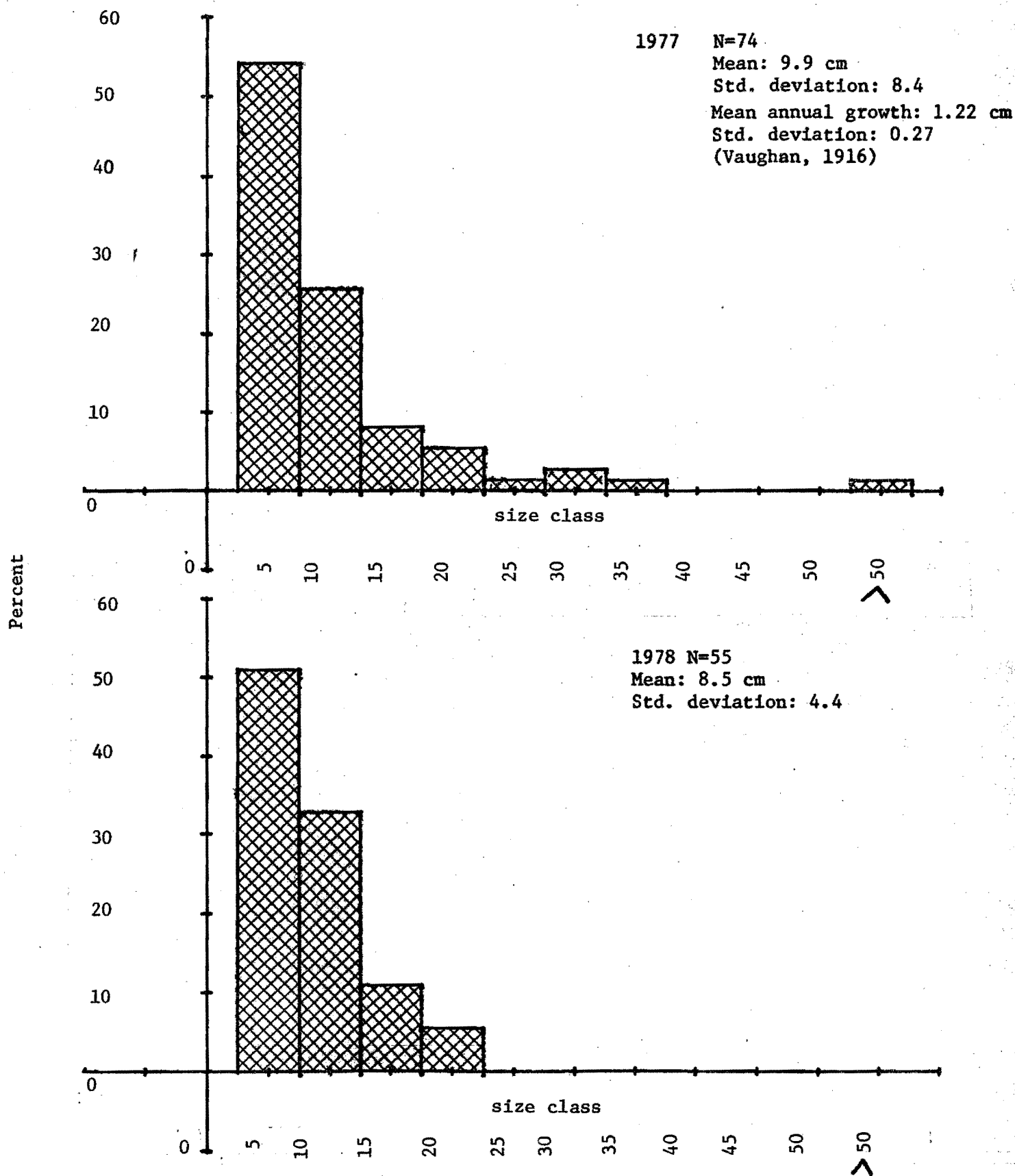
Comparison of Stony
Coral Diversity

Study	Location	Species/ Transect (range)	Colonies/ Transect (range)	H'n (range)	H'c (range)
Loya, 1972	Eilat, Red Sea	5-34	27-106	1.70-4.15	1.91-4.13
Porter, 1972	San Blas, Panama	3-18	-	0.00-3.50	-
Ott, 1975	Barbados, Antilles	-	-	2.30-3.50	-
Loya, 1976	Punta Ostiones, Puerto Rico	9.3-13.2*	23-47.6*	2.64-3.17*	-
Jaap, unpub.	Dry Tortugas	0-19	0-90	0.00-3.43	0.00-3.05
Jaap, BNM	Elliott Key, Florida	2-11	7-42	0.59-2.97	0.41-2.92
Jaap, unpub.	Grand Bahama, Bahamas	1-18	1-97	0.81-3.71	0.39-3.39

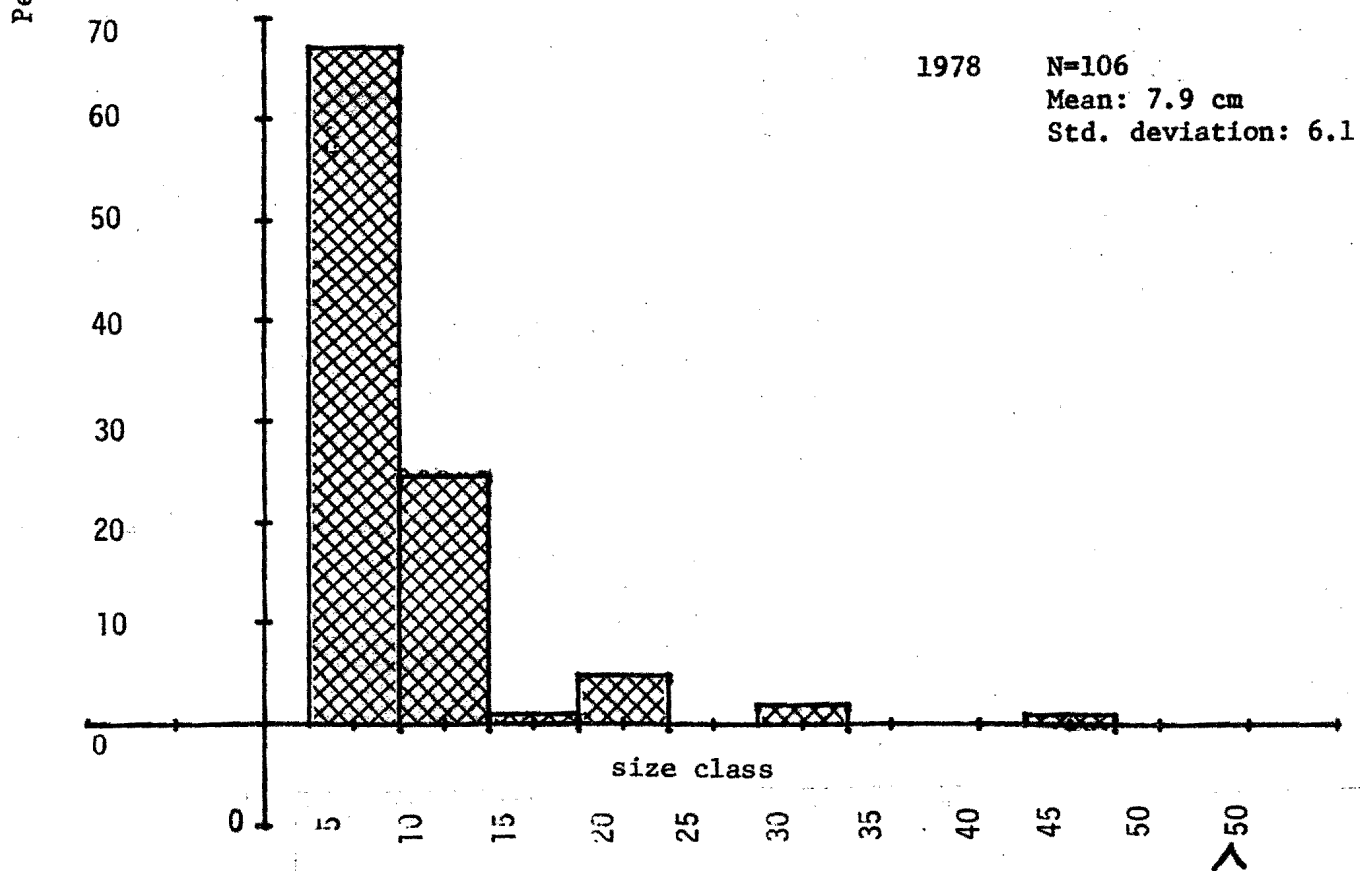
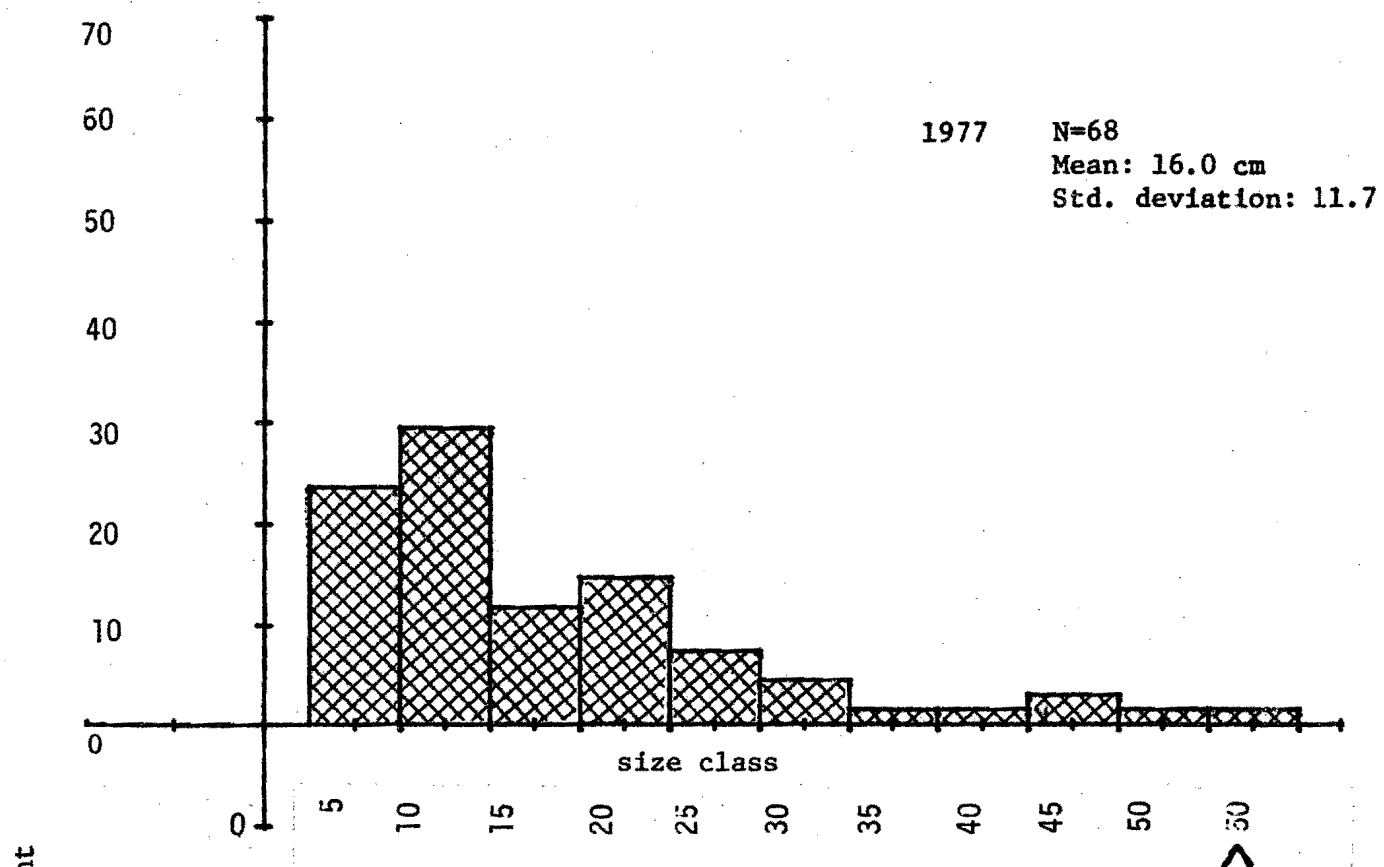
Loya and Porter used 10 m long transects; Jaap unpub. and BNM used 25 m transects; Ott did not specify transect length. H' values computed with $\log_2$. Jaap unpub. Grand Bahama used 10 m transects.

*Range of mean values presented on p. 457.

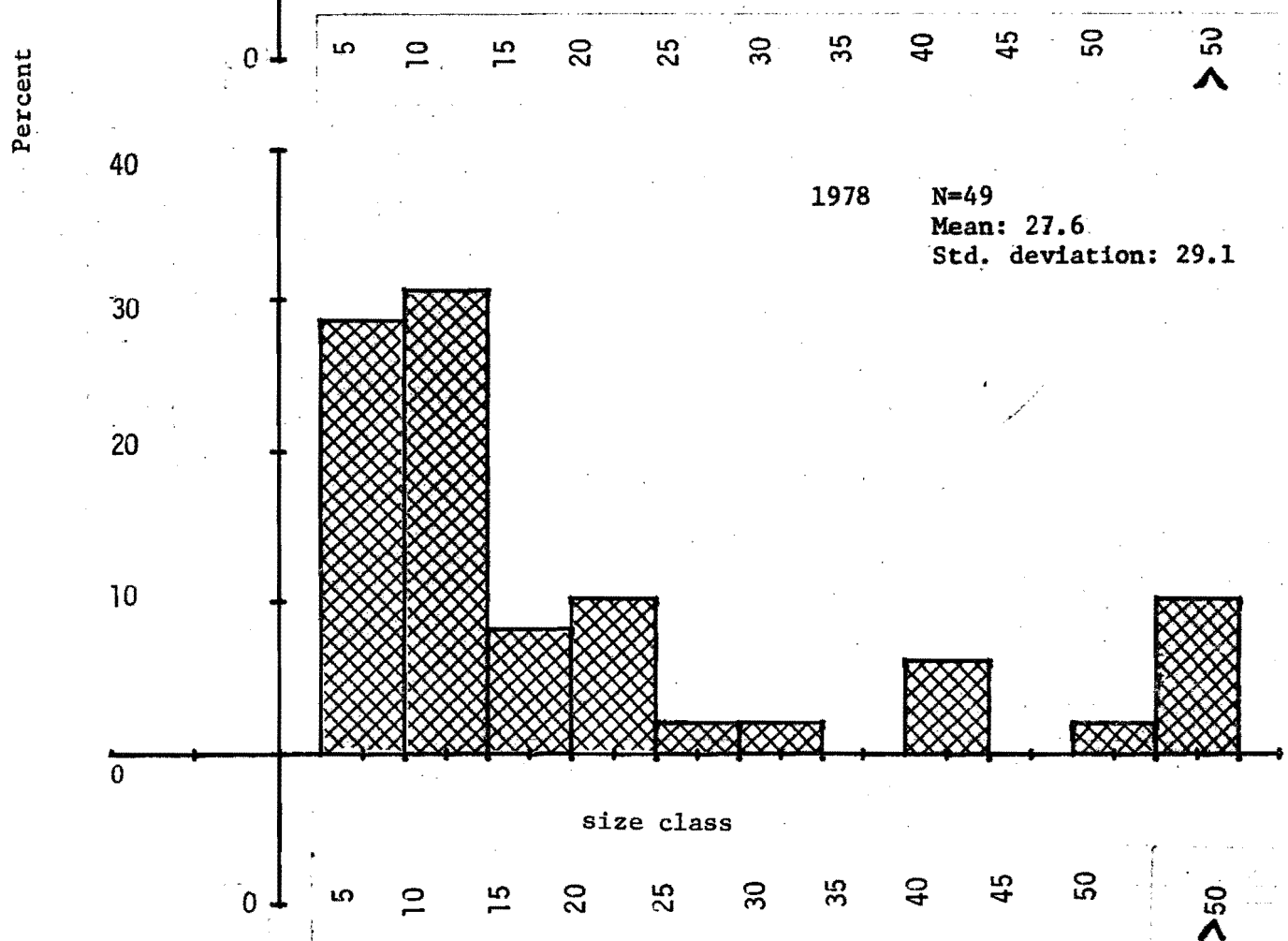
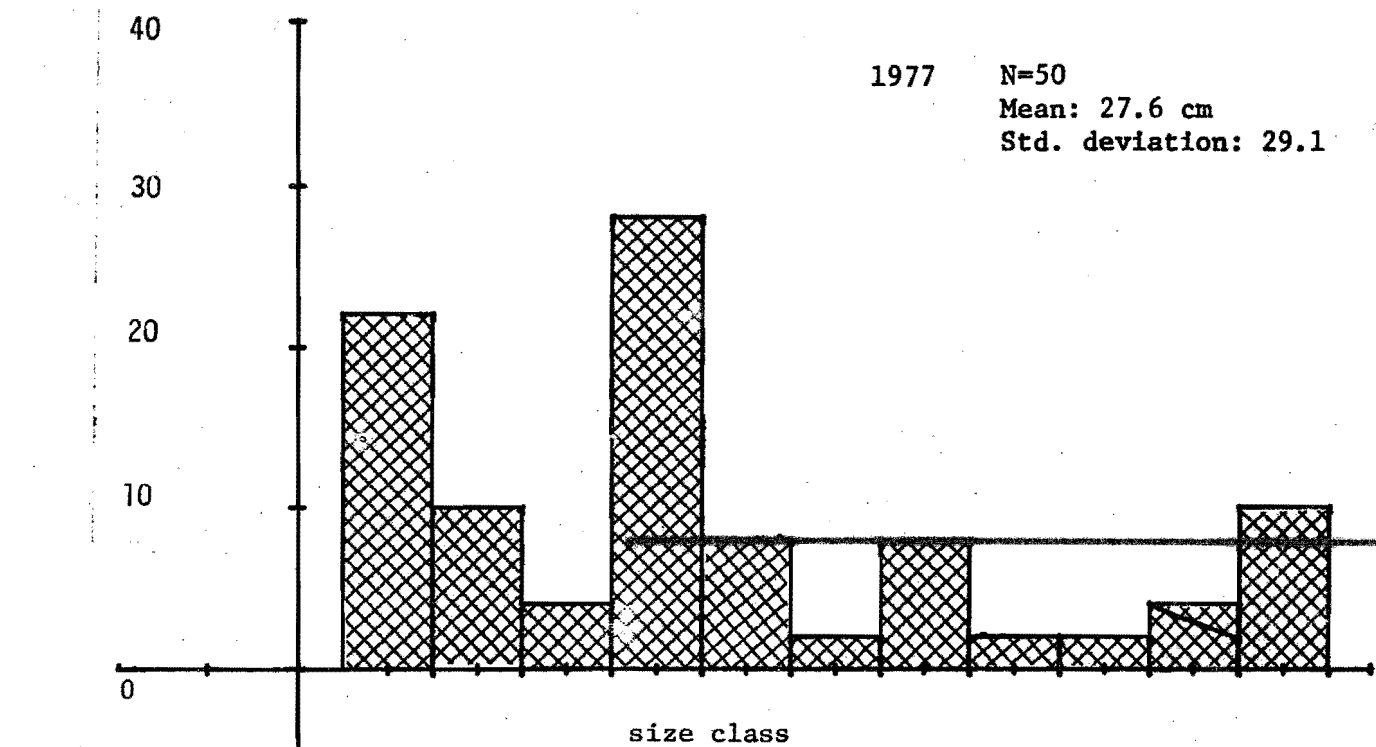
Porites astreoides size frequency distribution



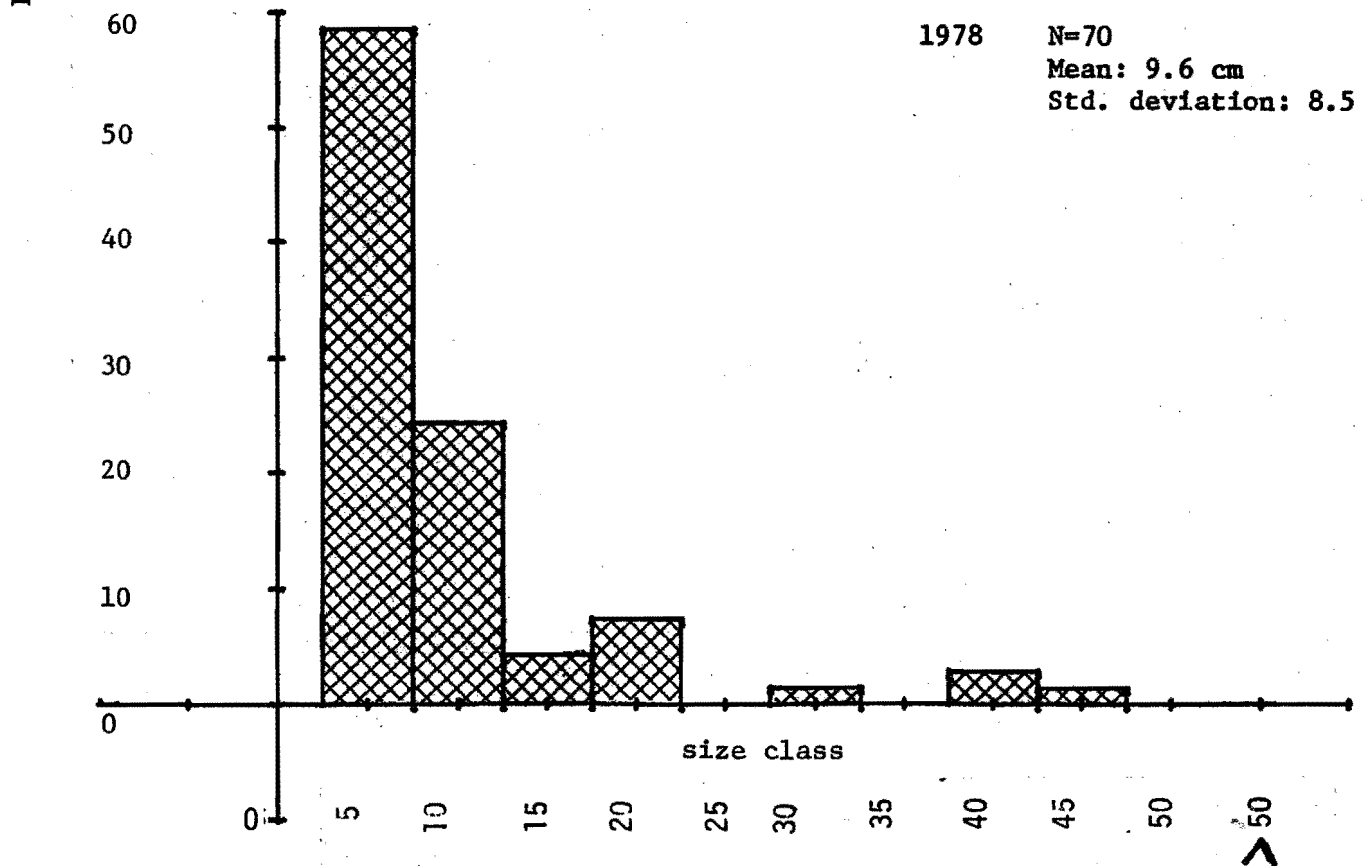
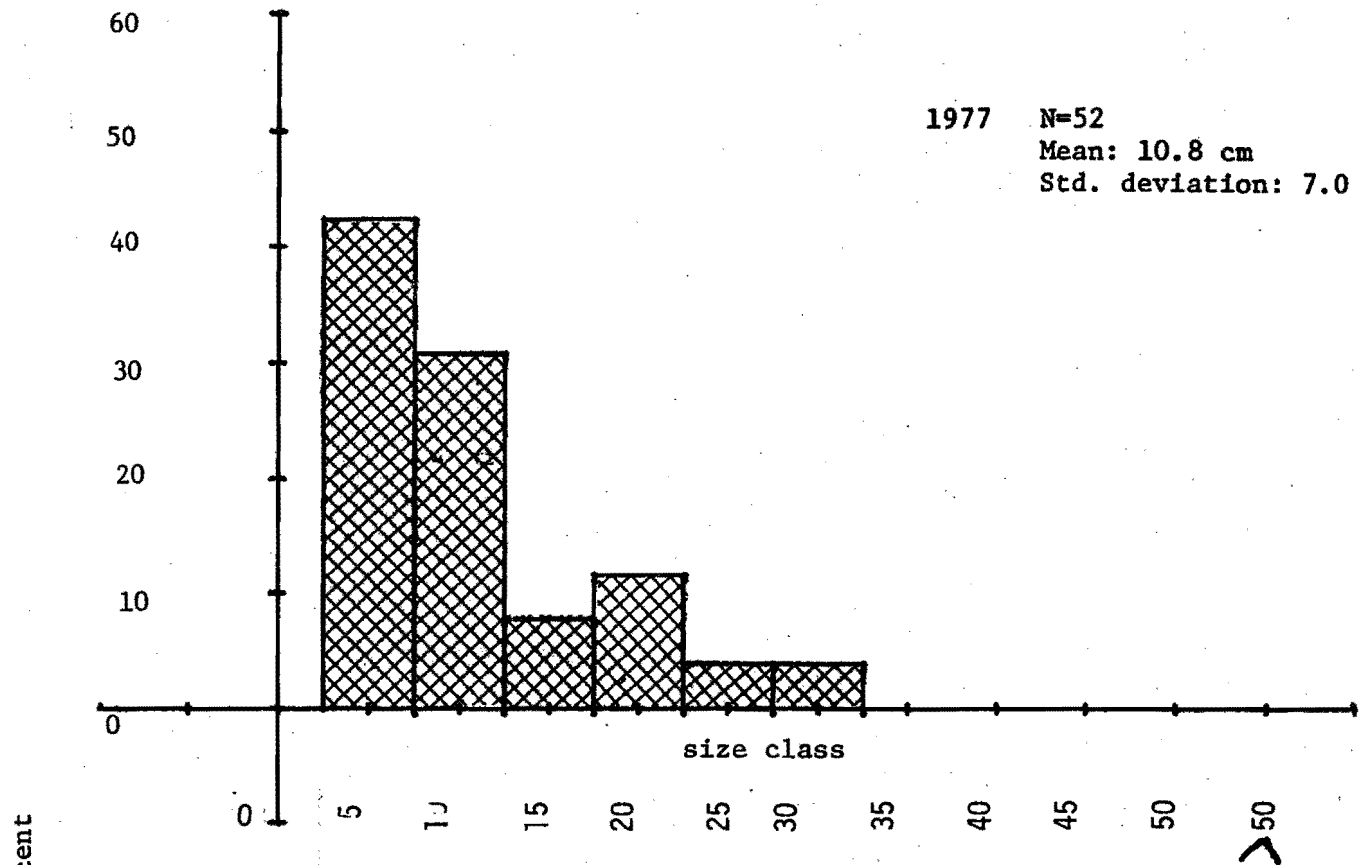
Millepora alcicornis size frequency distribution



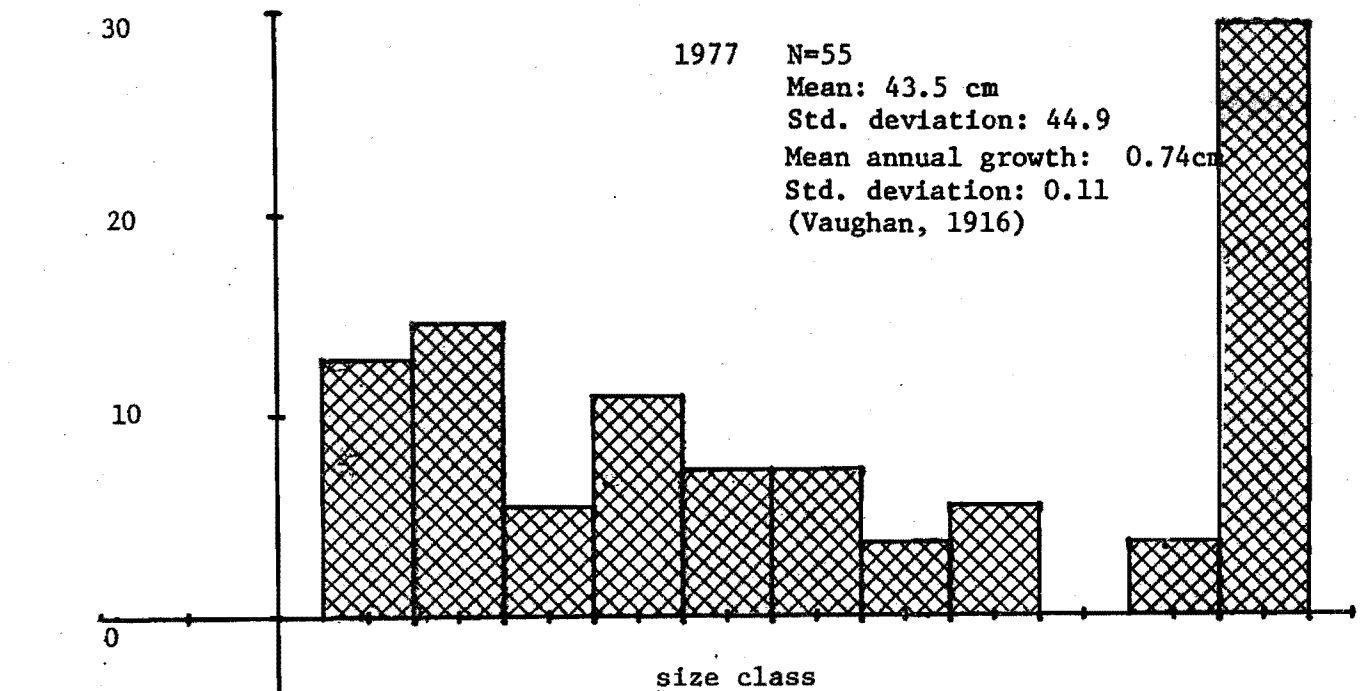
Acropora cervicornis size frequency distribution



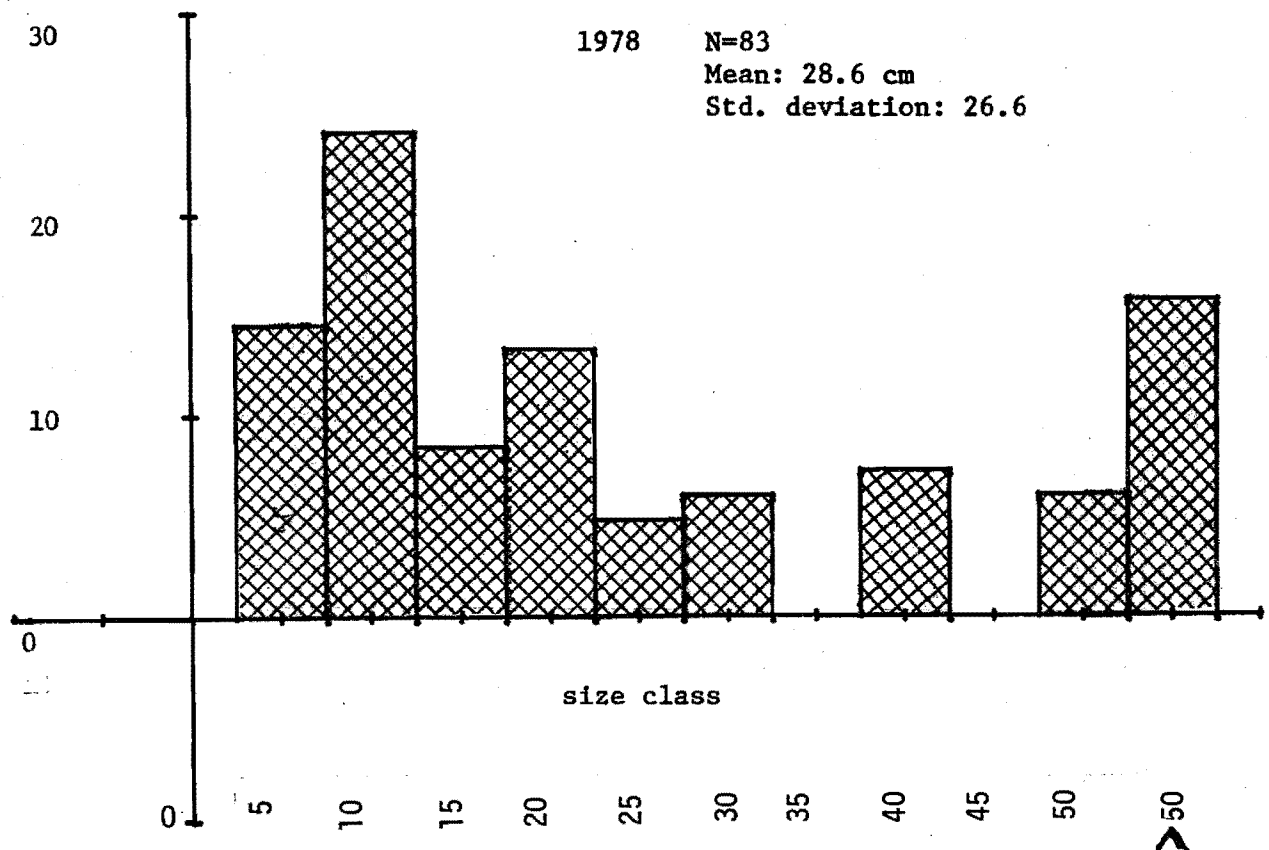
Porites porites size frequency distribution



Montastraea annularis size frequency distribution



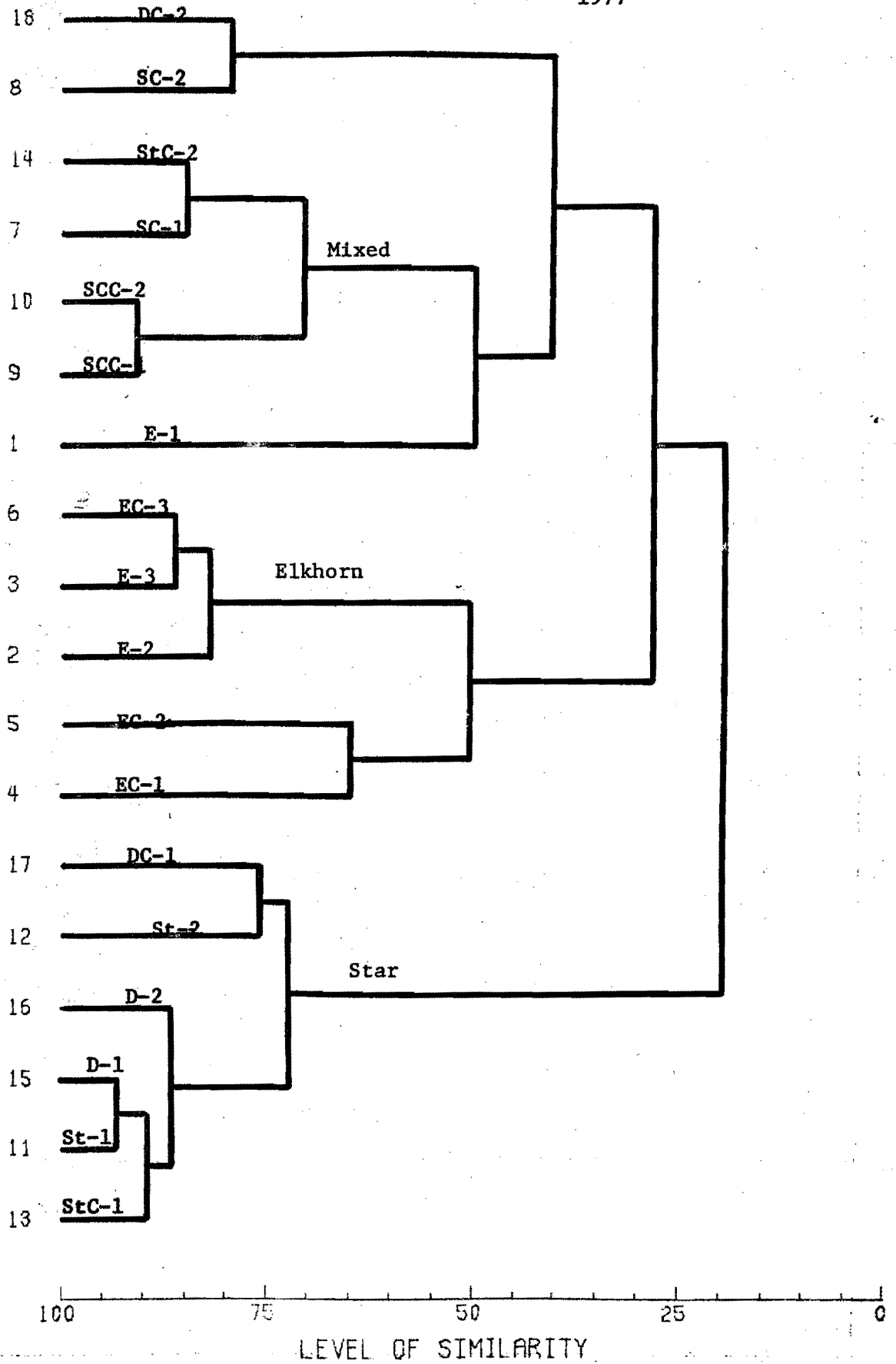
Percent



size class

GA(Q) MORISITA - TRANSECTS (STONY) 1977

DENDROGRAM SEQUENCE OF OTUS



Elkhorn Association
Species Abundance

		BI Value	Colonies	Cover (cm)	Weighted Abundance Index
1	<u>Porites astreoides</u>	97.5	59	605	0.27
2	<u>Acropora cervicornis</u>	87	44	1300	0.44
3	<u>A. palmata</u>	80.5	22	830	0.14
4	<u>Millepora alcicornis</u>	68	16	150	0.02
5	<u>Diploria clivosa</u>	65	12	325	0.03
6	<u>P. porites</u>	64.5	12	100	0.09
7	<u>Agaricia agaricites</u>	48.5	8	100	0.01
8	<u>M. complanata</u>	31	7	95	0.01
9	<u>Siderastrea siderea</u>	29.5	2	75	0.001
10	<u>Dichocoenia stellaris</u>	15	2	25	0.0004
11	<u>S. radians</u>	15	1	5	0.00004
12	<u>Madracis decactis</u>	14.5	1	5	0.00004
Total			186	3615	

H'n 2.79
H'c 2.57
H'max 3.58
J'n 0.78
J'c 0.72

Weighted abundance index:

$$\frac{\text{colonies} \times \text{cover}}{\sum \text{colonies} \times \text{cover}}$$

McCloskey's Index frequency of
occurrence ranking, BI max. in
this association: 100

Table 5

STONY CORAL
COMMUNITY ASSOCIATIONS
BISCAYNE NATIONAL MONUMENT

Association	ELKHORN	STARCORAL	MIXED
Transects	E 2, 3, EC 1, 2, 3: 5 transects	St 1, 2, StC 1, D 1, 2 DC 1: 6 transects	E 1, Sc 1, 2, ScC 1, 2 StC 2, DC 2: 7 transects
Dominant Species	<u>Acropora cervicornis</u> <u>Acropora palmata</u> <u>Porites astreoides</u>	<u>Montastraea annularis</u>	<u>Porites porites</u> <u>Millepora alcicornis</u>
% of Colonies	67.2	44.2	48.2
Unique Species	<u>Millepora complanata</u> <u>Siderastrea radians</u>	<u>Stephanocoenia michelinii</u> , <u>Colpophyllia natans</u> , <u>Mycetophyllia ferox</u> , <u>Mycetophyllia lamarckiana</u>	<u>Diploria labyrinthiformis</u>
No. Sp.	12	16	14
No. Colonies	186	124	140
H'n	2.79	2.89	2.84
H'c	2.57	2.14	2.91
H' max	3.58	4.00	3.81
J'n	0.78	0.72	0.75
J'c	0.72	0.54	0.76
% Cover ($\bar{x} \pm s$)			
Algae	0.3 ± 0.3	1.7 ± 2.7	2.0 ± 2.5
Sponge	0.7 ± 0.8	1.1 ± 1.4	2.7 ± 3.3
Octocoral	25.2 ± 12.8	23.2 ± 11.4	38.3 ± 15.3
Stony coral	28.9 ± 15.1	25.7 ± 10.6	14.3 ± 9.7
Abiotic substrate (sand, + rubble + rock)	46.7 ± 9.3	48.4 ± 12.1	42 ± 19.0

E: Elkhorn Reef
D: Dome Reef

Sc: Schooner Reef
St: Star Reef

C: Control Reef

i.e. StC: Star Control Reef

Star Coral Association
Species Abundance

		BI Value	Colonies	Cover (cm)	Weighted Abundance Index
1	<u>Montastraea annularis</u>	117.5	54	2395	0.92
2	<u>Millepora alcicornis</u>	106	18	325	0.04
3	<u>Siderastrea siderea</u>	82	8	320	0.02
4	<u>Porites porites</u>	75.5	6	70	0.003
5	<u>Agaricia agaricites</u>	69	9	85	0.01
6	<u>Mycetophyllia ferox</u>	49.5	5	110	0.004
7	<u>Dichocoenia stellaris</u>	46.5	3	85	0.002
8	<u>P. astreoides</u>	45	5	35	0.001
9	<u>Acropora cervicornis</u>	35	6	90	0.004
10	<u>Colpophyllia natans</u>	33	3	250	0.01
11	<u>M. lamarckiana</u>	17	2	20	0.0003
12	<u>Favia fragum</u>	16	1	5	0.00004
13	<u>Diploria clivosa</u>	16	1	15	0.0001
14	<u>Stephanocoenia michelinii</u>	14	1	20	0.0001
15	<u>M. cavernosa</u>	13	1	20	0.0001
16	<u>Eusmilia fastigiata</u>	13	1	5	0.00004
Total			124	3850	

H'n 2.89
H'c 2.14
H'max 4.00
J'n 0.72
J'c 0.54

BI max. in this collection: 120

Mixed Association
Species Abundance

		BI Value	Colonies	Cover (cm)	Weighted Abundance
1	<u>Porites porites</u>	128	31	390	0.23
2	<u>Millepora alcicornis</u>	111	36	610	0.41
3	<u>P. astreoides</u>	105	20	170	0.06
4	<u>Siderastrea siderea</u>	93.5	27	430	0.22
5	<u>Montastraea cavernosa</u>	63.5	6	180	0.02
6	<u>Dichocoenia stellaris</u>	50	6	95	0.01
7	<u>Agaricia agaricites</u>	26.5	2	20	0.0008
8	<u>Acropora palmata</u>	19	5	465	0.04
9	<u>Diploria labyrinthiformis</u>	16.5	2	40	0.002
10	<u>Madracis decactis</u>	15.5	1	5	0.0001
11	<u>D. clivosa</u>	15.5	1	15	0.0003
12	<u>D. strigosa</u>	15.5	1	65	0.001
13	<u>Favia fragum</u>	13	1	5	0.0001
14	<u>Eusmilia fastigiata</u>	13	1	5	0.0001
Total			140	2495	

H'n 2.84
H'c 2.91
H'max 3.81
J'n 0.74
J'c 0.76

BI max. in this collection: 140

Table 6
Comparison of Cover (%) Stony Corals
1977 - 1978

	N	1977	N	1978	Change	
		%		%		
Elkhorn	3	40.3	3	35.9	-	4.4
E. Control	3	19.1	3	15.1	-	4.0
Schooner	2	10.1	3	12.8	+	2.7*
Sc. Control	2	14.4	3	9.9	-	4.5*
Star	2	26.1	2	20.5	-	5.6
St. Control	2	14.4	2	15.3	+	0.9
Dome	2	26.7	2	27.0	+	0.3
D. Control	2	18.3	2	13.3	-	5.0
Mean	18	21.2	20	18.7	3.4	**
Std. dev.		9.6		8.7	1.9	**

N: number of 25 m transects
*: different sample sizes
**: absolute value

Table 7

Dispersion Patterns, Stony corals determined from Elliott (1973),
 χ^2 variance to mean ratio test, and figure 8;
 5 most abundant species based on colonies

Species	Transects	
	Dispersion pattern	
	Transects 1977	Transects 1978
<u>Porites astreoides</u>	contagious	contagious
<u>Millepora alcicornis</u>	random-contagious	contagious
<u>Montastraea annularis</u>	random-contagious	contagious
<u>Porites porites</u>	contagious	contagious
<u>Acropora cervicornis</u>	contagious	contagious
Quadrats - Plots	Q	P
	1977	1978
<u>Porites astreoides</u>	contagious	contagious
<u>P. porites</u>	contagious	contagious
<u>Montastraea annularis</u>	contagious	random
<u>M. alcicornis</u>	random	random
<u>Siderastrea siderea</u>	random	random

Systematic account of stony coral fauna, Biscayne National Monument coral reef study

Species	Elkhorn		Elkhorn Control		Schooner		Schooner Control		Star		Star Control		Dome		Dome Control	
	77	78	77	78	77	78	77	78	77	78	77	78	77	78	77	78
1. <u>Stephanocoenia michelinii</u> Milne Edwards and Haime, 1849				0			0		0		T	P		Q		
2. <u>Madracis decactis</u> (Lyman, 1857)	T															
3. <u>Acropora palmata</u> (Lamarck, 1816)	TP	TP	T	T								0				
4. <u>Acropora cervicornis</u> (Lamarck, 1816)	TP	TP	TP	TP		T			T	TP		P				
5. <u>Agaricia agaricites</u> (Linne, 1758)		TP	TP	TP	TP	T	P	TP	TP	TP	TP	Q	P	TP	TP	T
6. <u>A. agaricites</u> forma <u>purpurea</u> (LeSueur, 1821)		0	0						Q	Q	0	0	Q	Q	Q	Q
7. <u>A. agaricites</u> forma <u>carinata</u> Wells, 1973																Q
8. <u>Helioseris cucullata</u> (Ellis and Solander, 1786)														P		
9. <u>Siderastrea siderea</u> (Ellis and Solander, 1786)	TP	TP	P	TP	TP	TP	TP	TP	TP	TP	0	TP	TP	TP	TP	TH
10. <u>Siderastrea radiana</u> (Pallas, 1766)			T			Q						P				
11. <u>Porites astreoides</u> Lamarck, 1816	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	Q	TP	TP	TP	TP	TP
12. <u>Porites branneri</u> Rathbun, 1887		0		P												
13. <u>Porites porites</u> (Pallas, 1766)	TP	TP	TP	P	TP	TP	TP	TP	TP	TP	TP	TP	T	TP	T	T
14. <u>Favia fragum</u> (Esper, 1795)		TP	P	TP	P	T				P			T	TP	TP	P
15. <u>Diploria labyrinthiformis</u> (Linne, 1758)		0		T		Q		P	P	P					T	P
16. <u>Diploria clivosa</u> (Ellis and Solander, 1786)	TP	TP	T	TP		TP	T	T		0		0	T	T		0
17. <u>Diploria strigosa</u> (Dana, 1846)	T	TP		0		TP				P		P		0		
18. <u>Manicina areolata</u> (Linne, 1758)		T		0			P	T		Q						
19. <u>Colpophyllia natans</u> (Houttyn, 1772)						0			P	T	T	T	TP	T		
20. <u>Cladocora arbuscula</u> (LeSueur, 1821)						0										
21. <u>Montastraea cavernosa</u> (Linne, 1758)	T			T	TP	P	TP	P	TP	0		TP	Q	TP	T	TP
22. <u>Montastraea annularis</u> (Ellis and Solander, 1786)		T				T		P	TP	TP	TP	TP	TP	TP	TP	TP
23. <u>Solenastrea hyades</u> (Dana, 1846)							P									
24. <u>Solenastrea bournoni</u> Milne Edwards and Haime, 1850				0						0		0		0		0
25. <u>Oculina diffusa</u> Lamarck, 1816												0		Q		
26. <u>Meandrina meandrites</u> (Linne, 1758)				T				0		0						Q
27. <u>Dichocoenia stellaris</u> Milne Edwards and Haime, 1849	P	TP	TP	TP	TP	TP	TP	TP	TP	TP		P	T	TP	TP	TP
28. <u>Dichocoenia stokesii</u> Milne Edwards and Haime, 1849						T								0		TP
29. <u>Mussa angulosa</u> (Pallas, 1766)														0		0
30. <u>Scolymia</u> sp.																
31. <u>Isophyllia sinuosa</u> (Ellis and Solander, 1786)									TP							0
32. <u>Isophyllastrea rigida</u> (Dana, 1846)														0		
33. <u>Mycetophyllia lamarckiana</u> Milne Edwards and Haime, 1849				0				0	P	0	T	TP		P		0
34. <u>Mycetophyllia ferox</u> Wells, 1973									T	T	T	T	T	0		
35. <u>Mycetophyllia aliciae</u> Wells, 1973														0		
36. <u>Eusmillia fastigiata</u> (Pallas, 1766)				0				P	TP	P		0		TP	T	TP
37. <u>Millepora alcicornis</u> Linne, 1758	T	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP	TP
38. <u>Millepora complanata</u> Lamarck, 1816	0	TP	T	TP												

T: transect data

P: quadrat data (1977), photo plot data (1978)

Q: ancillary observations

Table 1. Synopsis of Substrates and Benthos from 25m transects Sept. 1977 Biscayne National Monument patch reefs. September, 1977

Reef & Transect Numbers	Depth (m)	Substrates								Benthos									
		Rock		Rubble		Sand		Total Substrates		Algae		Sponge		Octocoral		Stony Coral		Total Benthos	
		cm	%	cm	%	cm	%	cm	%	cm	%	cm	%	cm	%	cm	%	cm	
Schooner 1-1	2.1	1055	42.20	-	-	-	-	1055	42.20	130	5.20	95	3.80	1100	44.00	120	4.80	1445	5
1-2	2.1 - 2.7	1050	42.00	-	-	-	-	1050	42.00	35	1.40	230	9.20	795	31.80	385	15.40	1450 *	5
Schooner 2-1	2.1 - 2.7	735	29.40	75	3.0	45	1.80	855	34.20	40	1.60	35	1.40	1220	48.80	340	13.60	1645 **	6
Control 2-2	1.8 - 2.1	755	30.20	-	-	5	0.20	760	30.40	150	6.00	100	4.00	1110	44.40	380	15.20	1740	6
Elkhorn 3-1	1.8 - 2.1	1305	52.20	50	2.00	5	0.20	1360	54.40	20	0.80	5	0.20	195	7.80	920	36.80	1140	45
3-2	1.2 - 1.5	985	39.40	30	1.20	40	1.60	1055	42.20	-	-	-	-	405	16.20	1260	50.40	1665	66
3-3	2.4 - 3.0	685	27.40	260	10.40	-	-	865	34.60	-	-	15	0.60	775	31.00	845	33.80	1635	65
Elkhorn 4-1	1.5 - 1.8	1205	48.20	-	-	-	-	1205	48.20	-	-	5	0.20	815	32.60	475	19.00	1295	51
Control 4-2	1.5 - 1.8	730	29.20	-	-	100	4.00	830	33.20	10	0.40	25	1.00	975	39.00	660	26.40	1670	66
4-3	3.0 - 3.7	1080	43.20	310	12.40	-	-	1390	55.60	5	0.20	50	2.00	755	30.20	300	12.00	1110	44
Dome 5-1	0.9 - 4.5	815	32.60	-	-	95	3.80	910	36.40	-	-	-	-	540	21.60	1050	42.00	1590	63
5-2	1.5 - 2.7	750	30.00	95	3.80	70	2.80	915	36.60	175	7.00	90	3.60	1035	41.40	285	11.40	1585	63
Dome 6-1	1.8 - 4.0	905	36.20	-	-	170	6.80	1075	43.00	40	1.60	30	1.20	745	29.80	610	24.40	1425	57
Control 6-2	2.1 - 3.4	560	22.40	120	4.80	80	3.20	760	30.40	-	-	-	-	1435	57.40	305	12.20	1740	69
Star 7-1	1.2 - 4.3	1195	47.80	50	2.00	35	1.40	1280	51.20	15	0.60	-	-	385	15.40	815	32.60	1220***	48.8
7-2	2.4 - 2.7	760	30.04	600	24.00	10	0.40	1370	54.80	20	0.80	45	1.80	555	22.20	490	19.60	1130****	45.2
Star Control 8-1	2.3 - 6.1	1475	59.00	210	8.40	-	-	1685	67.40	-	-	-	-	215	8.60	600	24.00	815	32.6
8-2	2.7	1970	78.60	-	-	-	-	1970	78.60	-	-	-	-	270	10.80	120	4.80	530 *****	21

* 5 cm of Palythoa not indicated
 ** 10 cm of Palythoa not indicated
 *** 5 cm of Palythoa not indicated
 **** 20 cm of Palythoa not indicated
 ***** 140 cm of Palythoa not indicated

2.82 ± 2.48

~~22.17 ± 12.12~~ 22.17 ± 12.12

29.61 ± 14.51

Comparison of Biota, Reef Communities
Eilat Red Sea, Biscayne Natl. Monument, Florida

	Eilat, Loya 1977	Biscayne Natl. Mon.
Percent cover algae	RF: 28.99 $\pm$ 24.39 UFR: 10.43 $\pm$ 6.16	2.32 $\pm$ 2.48
Percent cover octocorals	RF: 5.28 $\pm$ 4.78 UFR: 6.83 $\pm$ 4.29	29.61 $\pm$ 14.51
Percent cover stony corals	RF: 19.27 $\pm$ 10.75 UFR: 30.70 $\pm$ 10.70	22.13 $\pm$ 12.12
Percent Total Benthos	RF: 53.54 UFR: 47.96	55.18

Eilat data from Loya Tables 2, 5^{and} 8
9 sets of transects sampled

RF: Reef flat

UFR: Upper fore-reef

Biscayne data from 18 transects
sampled during 1977, 8 reefs

Rank abundance of stony corals enumerated in photo plots, 1978

Species	Number	Percentile
P. astreoides	162	.2736
M. alcicornis	116	.1959
P. porites	70	.1182
S. siderea	54	.0912
A. agaricites	40	.0675
A. cervicornis	26	.0439
D. stellaris	24	.0405
M. annularis	19	.0320
D. clivosa	19	.0320
M. cavernosa	9	.0152
A. palmata	6	.0101
F. fragum	6	.0101
D. strigosa	6	.0101
E. fastigiata	4	.0067
D. labyrinthiformis	3	.0050
S. radians	3	.0050
M. complanata	2	.0033
M. lamarckiana	2	.0033
I. sinuosa	2	.0033
C. natans	1	.0016
D. stokesii	1	.0016
S. michelinii	1	.0016
H. cucullata	1	.0016
P. branneri	1	.0016
S. hyades	1	.0016
Scolymia sp.	1	.0016
26 sp.	580	

N = 96

m²

COMPARISON OF STONY CORAL COLONIES AND COVER, 20 (25 m) TRANSECTS, 1978

Species	(colonies)	Pi	Cover(cm)	Pc
<u>M. alcicornis</u>	100	.1879	800	.0871
<u>M. annularis</u>	83	.1560	2450	.2669
<u>P. Porites</u>	71	.1109	675	.0735
<u>P. astreoides</u>	59	.1334	460	.0501
<u>A. cervicornis</u>	55	.1033	1055	.1149
<u>S. siderea</u>	35	.0675	955	.1040
<u>A. palmata</u>	25	.0469	1280	.1394
<u>A. agaricites</u>	22	.0413	170	.0185
<u>D. clivosa</u>	21	.0394	355	.0387
<u>D. stellaris</u>	16	.0300	200	.0218
<u>M. complanata</u>	12	.0225	155	.0169
<u>E. fastigiata</u>	8	.0150	60	.0065
<u>F. fragum</u>	6	.0112	30	.0033
<u>C. natans</u>	4	.0075	250	.0272
<u>M. cavernosa</u>	3	.0056	35	.0038
<u>D. stokesii</u>	3	.0056	20	.0022
<u>M. ferox</u>	2	.0037	30	.0033
<u>D. strigosa</u>	2	.0037	140	.0153
<u>M. areolata</u>	2	.0037	20	.0022
<u>D. labyrinthiformis</u>	1	.0018	15	.0016
<u>M. lamarckiana</u>	1	.0018	20	.0022
<u>I. sinuosa</u>	1	.0018	5	.0005
	532		9180	

26.6/T (25 m)

459 cm/T (25 m)

COMPARISON OF STONY CORAL COLONIES AND COVER, 18 (25 m) TRANSECTS, 1977

Species	(colonies)	Pi	Cover(cm)	Pc
<u>P. astreoides</u>	90	.1995	1570	.1581
<u>M. alcicornis</u>	69	.1529	1085	.1093
<u>M. annularis</u>	54	.1197	2395	.2412
<u>P. porites</u>	51	.1130	560	.0564
<u>A. cervicornis</u>	44	.0975	600	.0604
<u>S. siderea</u>	37	.0820	825	.0831
<u>A. palmata</u>	27	.0598	1295	.1304
<u>A. agaricites</u>	19	.0421	205	.0206
<u>D. clivosa</u>	14	.0310	355	.0358
<u>D. stellaris</u>	11	.0243	205	.0206
<u>M. complanata</u>	7	.0155	95	.0096
<u>M. cavernosa</u>	7	.0155	200	.0201
<u>M. ferox</u>	5	.0110	110	.0111
<u>C. natans</u>	3	.0066	250	.0252
<u>F. fragum</u>	2	.0044	10	.0010
<u>E. fastigiata</u>	2	.0044	10	.0010
<u>D. labyrinthiformis</u>	2	.0044	40	.0040
<u>M. lamarckiana</u>	2	.0044	20	.0020
<u>M. decactis</u>	2	.0044	10	.0010
<u>D. strigosa</u>	1	.0022	65	.0065
<u>S. michelinii</u>	1	.0022	20	.0020
<u>S. radians</u>	1	.0022	5	.0005
	451		9930	

25.1 colonies/T (25 m)

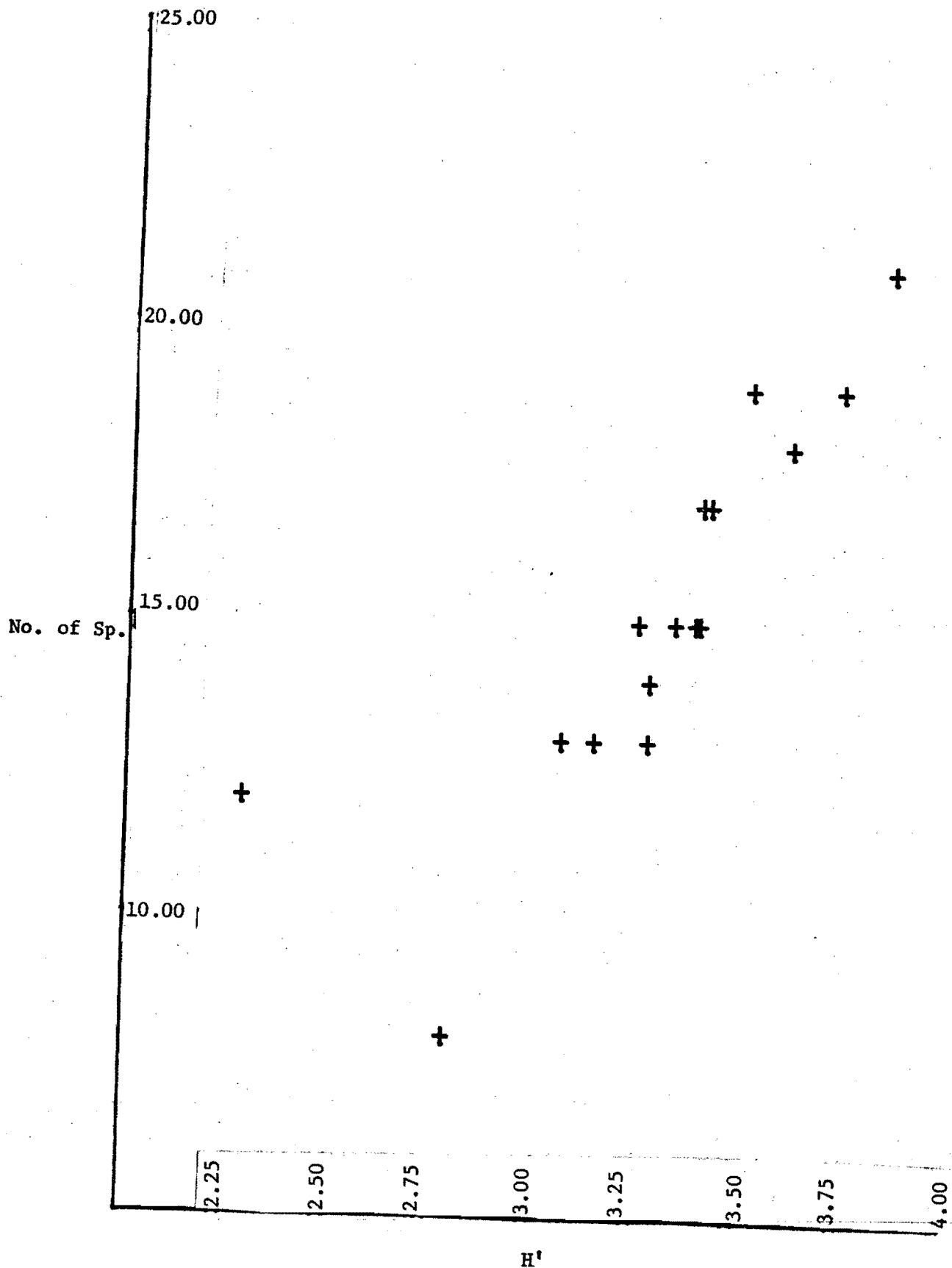
551.7 cm cover/T (25 m)

TABLE CORRELATION OF NUMBER OF SPECIES AND SHANNON-WEINER (H') DIVERSITY

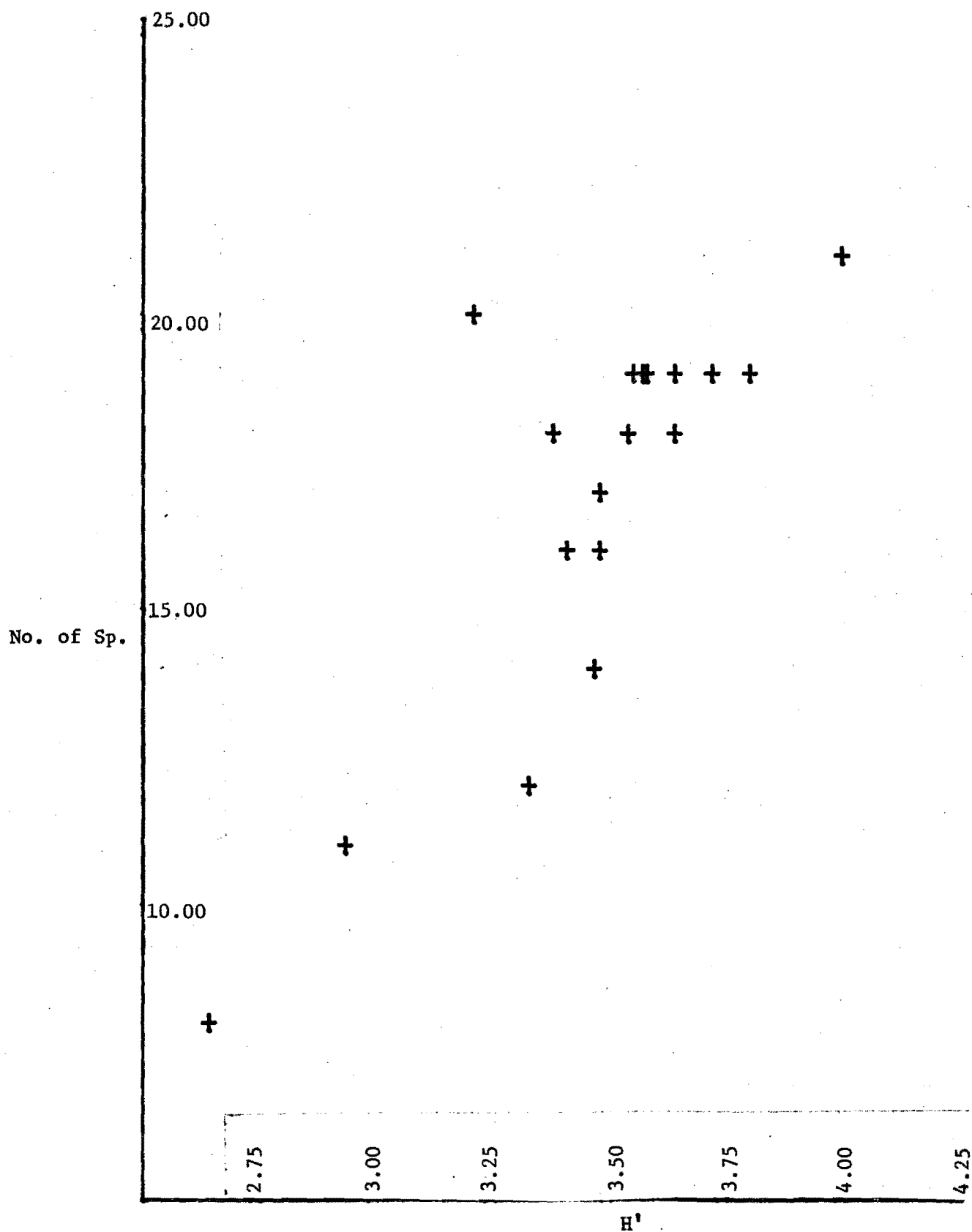
Unit	N	No. sp.		1977		H'		Correlation coefficient
		mean	Std. dev.	mean	Std. dev.	mean	Std. dev.	
Octocoral	16	15.25	3.21	3.28	0.36			0.8256 *
Stonycoral	18	6.06	1.47	2.11	0.49			0.8297 *
Combined corals	16	21.31	3.18	3.75	0.28			0.7358 *
1978								
Octocoral	18	16.83	3.47	3.46	0.31			0.8235 *
Stonycoral	20	7.00	1.78	2.29	0.53			0.9120 *
Combined corals	18	24.06	4.08	3.87	0.22			0.7068 *

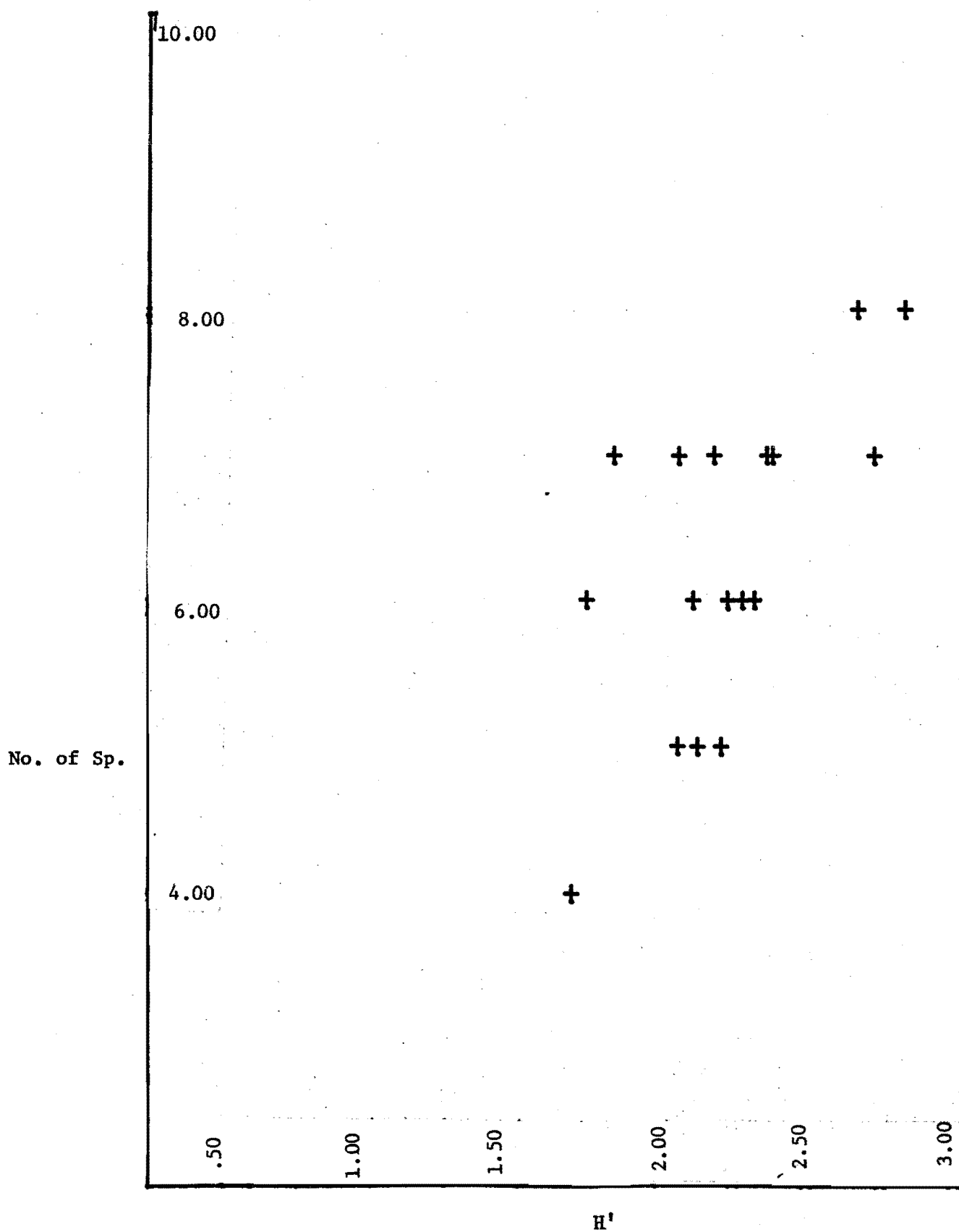
* Correlation coefficient tested significant, 0.01 level, table Y, Rohlf and Sokal, 1969, p. 225

Octocorals, 1978

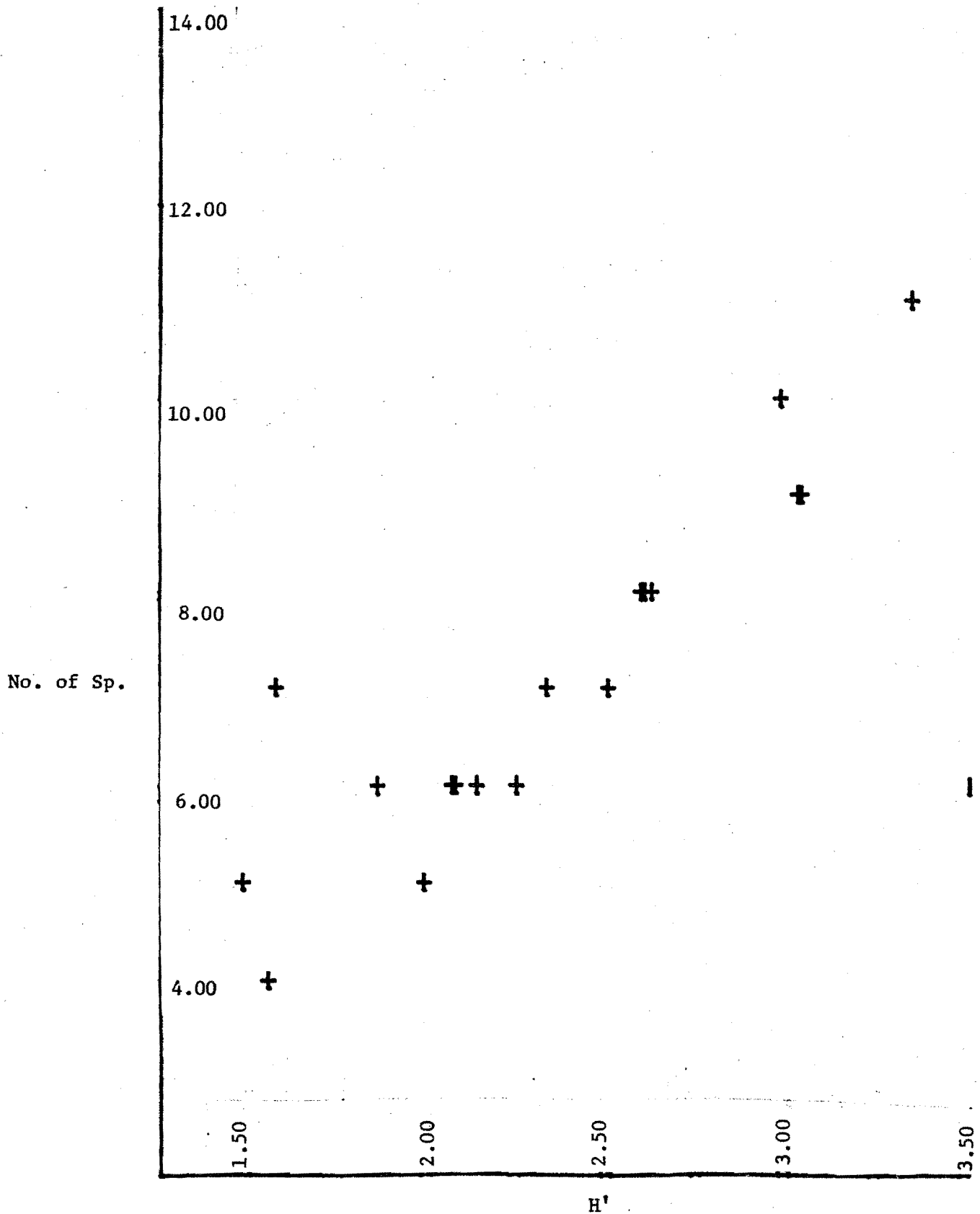


Transect Diversity Values
Octocorals, 1978

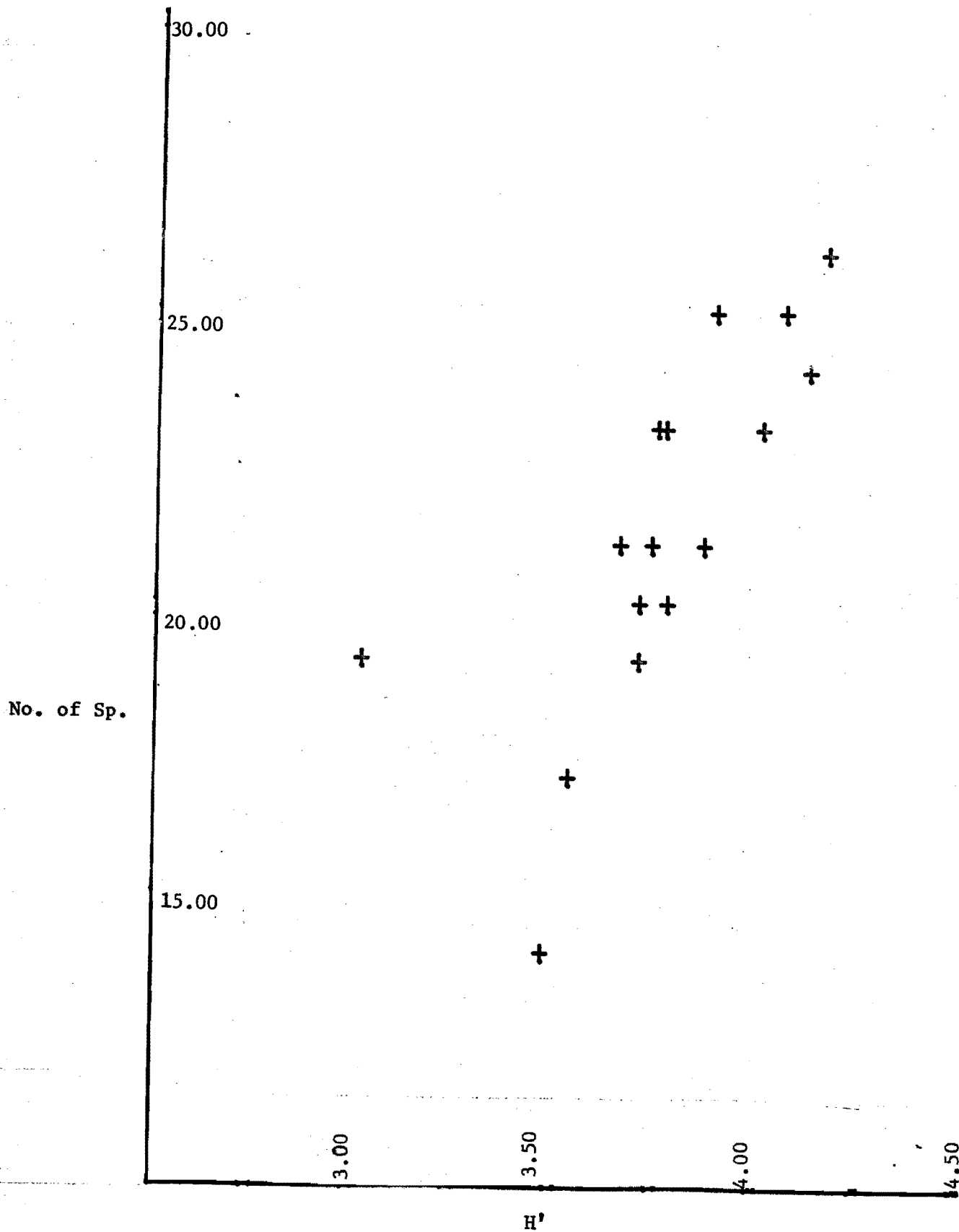


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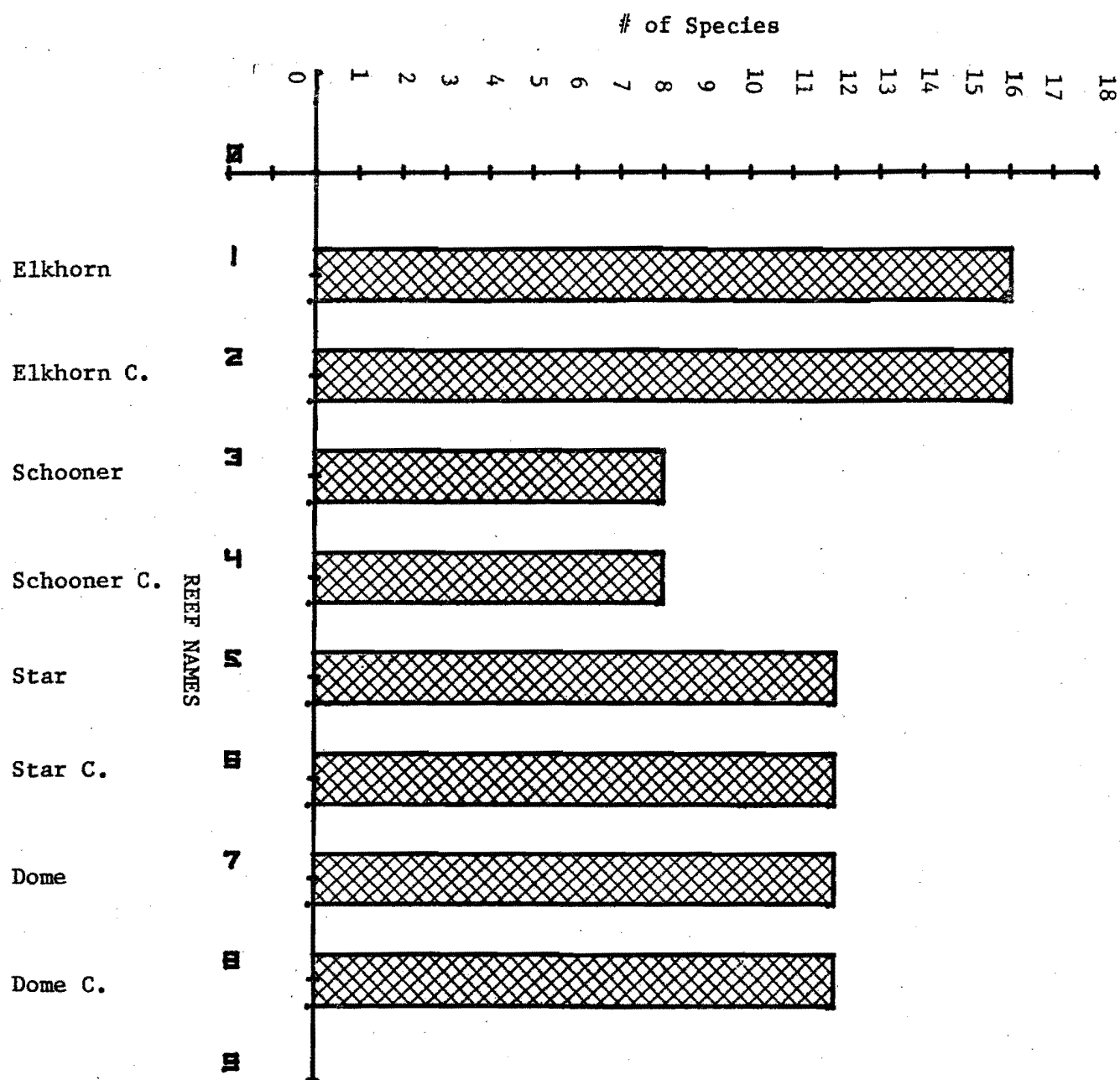
Stony Corals, 1978



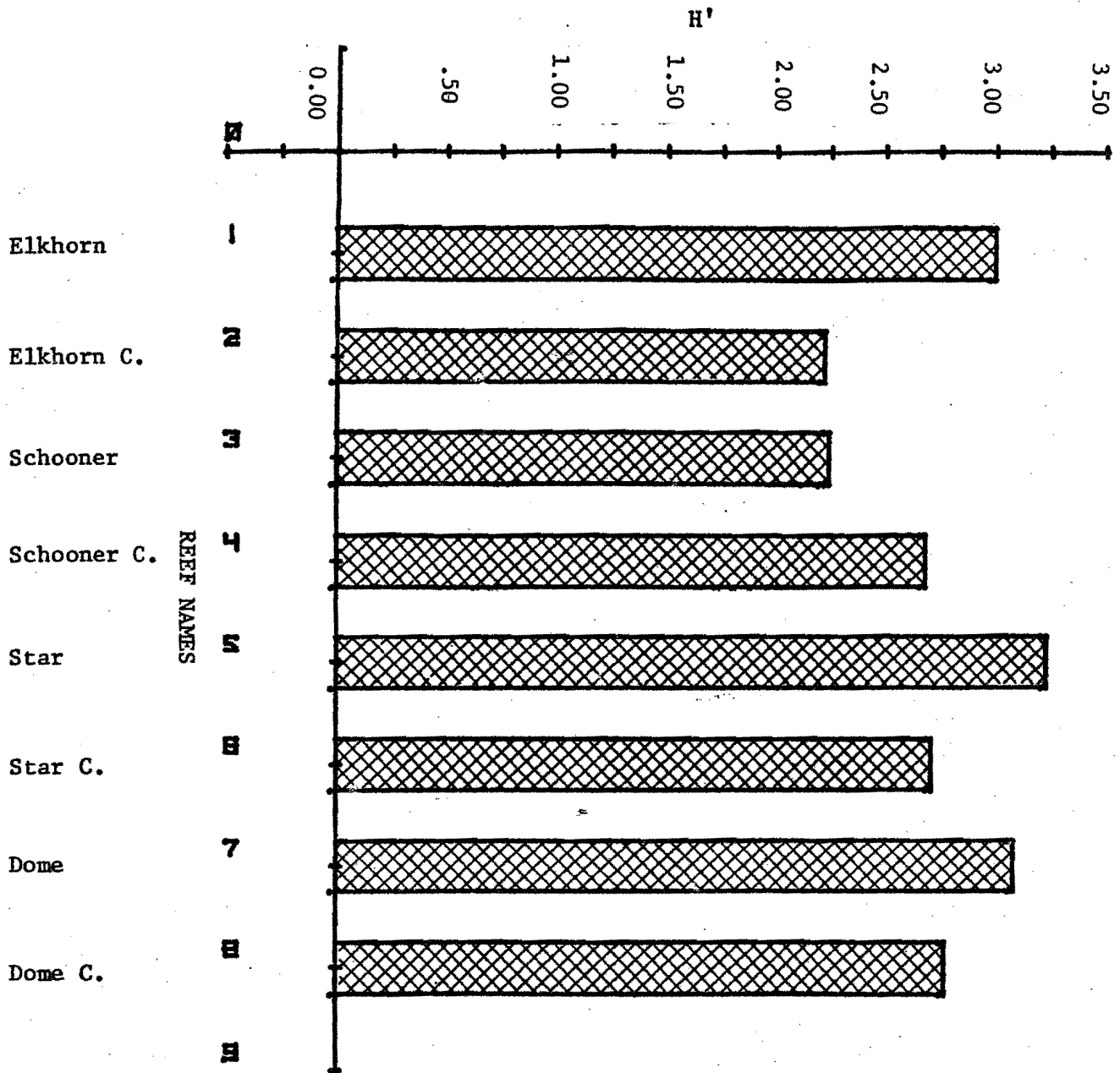
Combined Corals, 1977



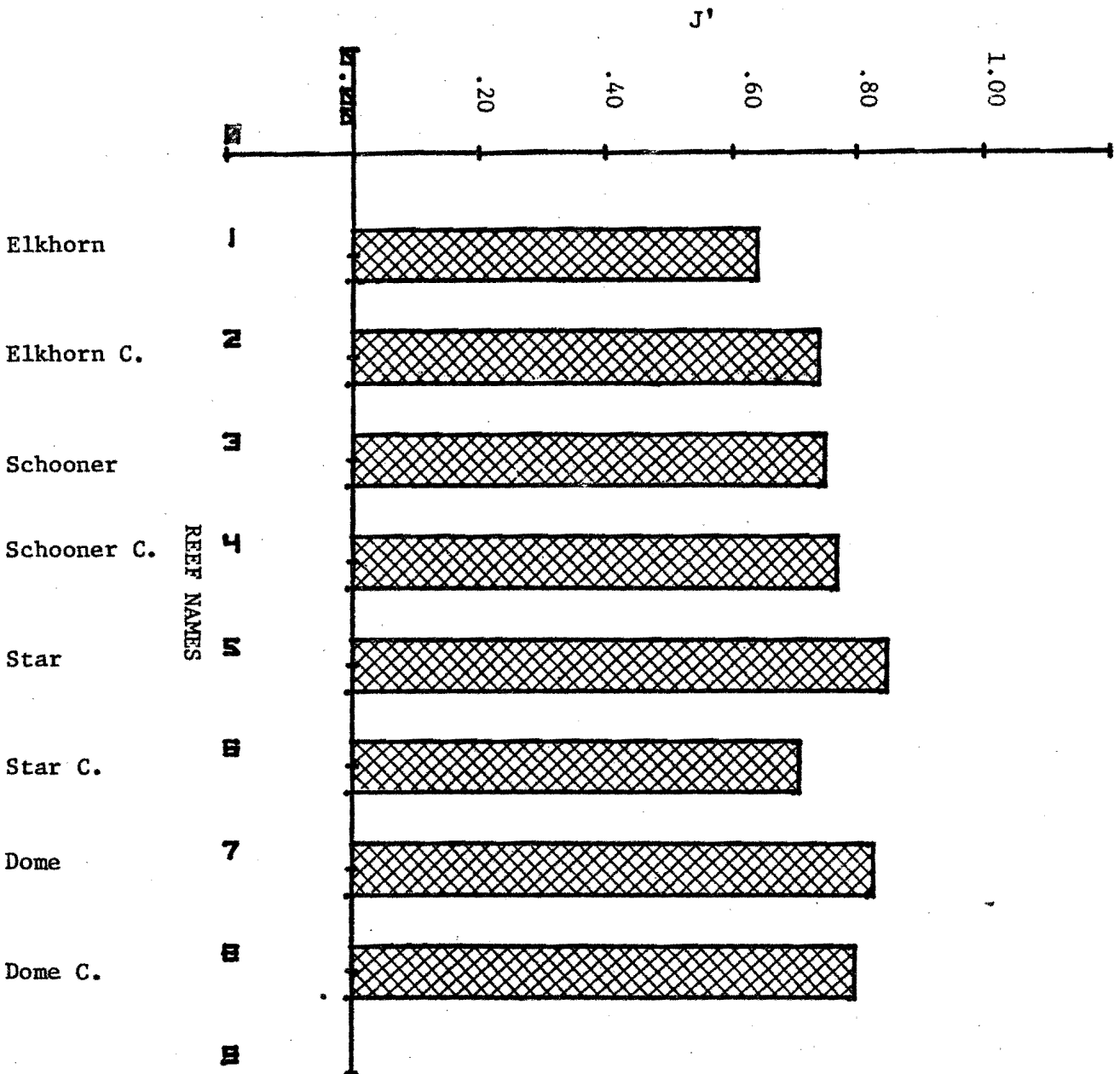
Diversity, 1978 Stony Corals
Plots



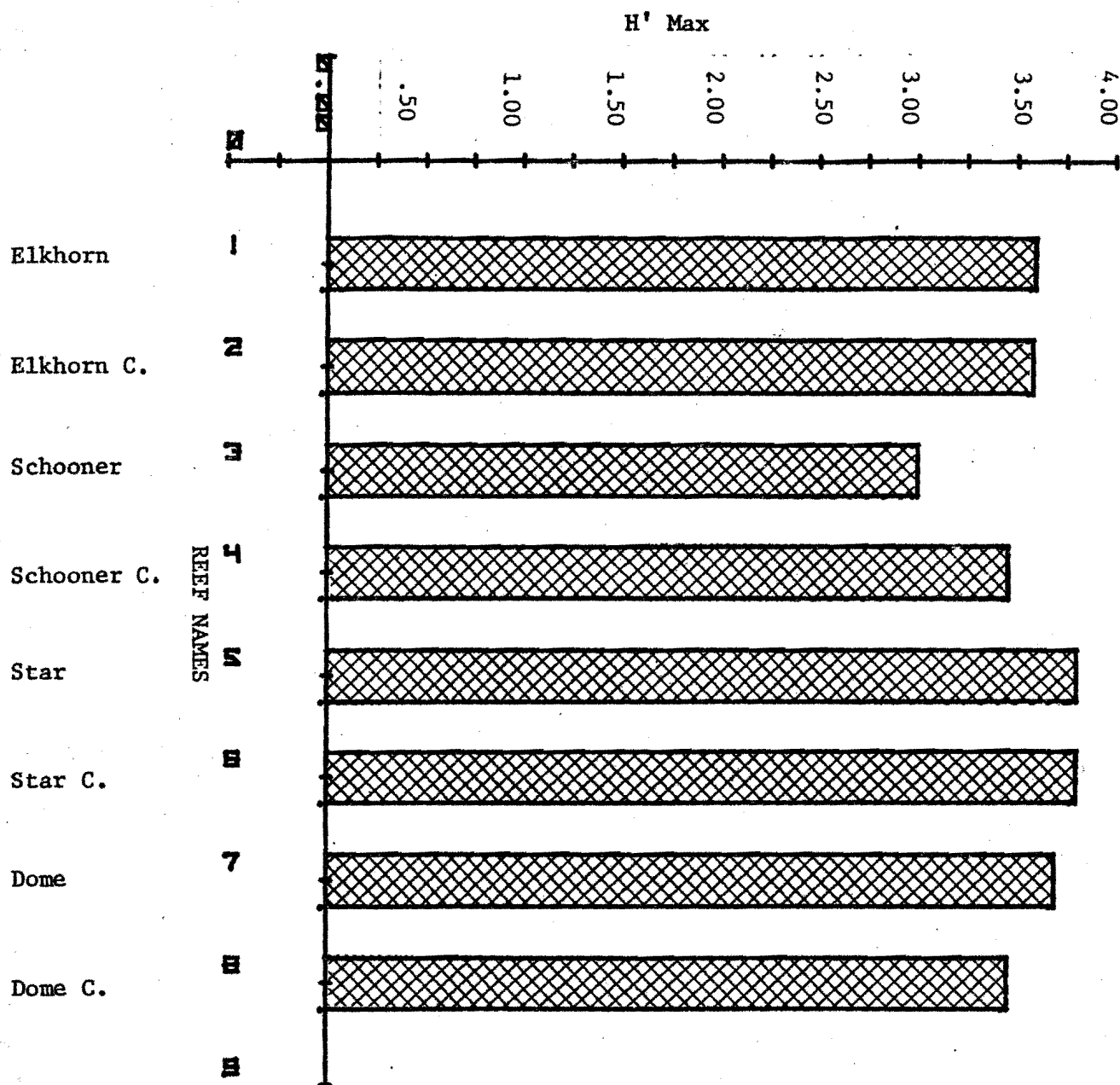
Diversity, 1978 Stony Corals
Plots



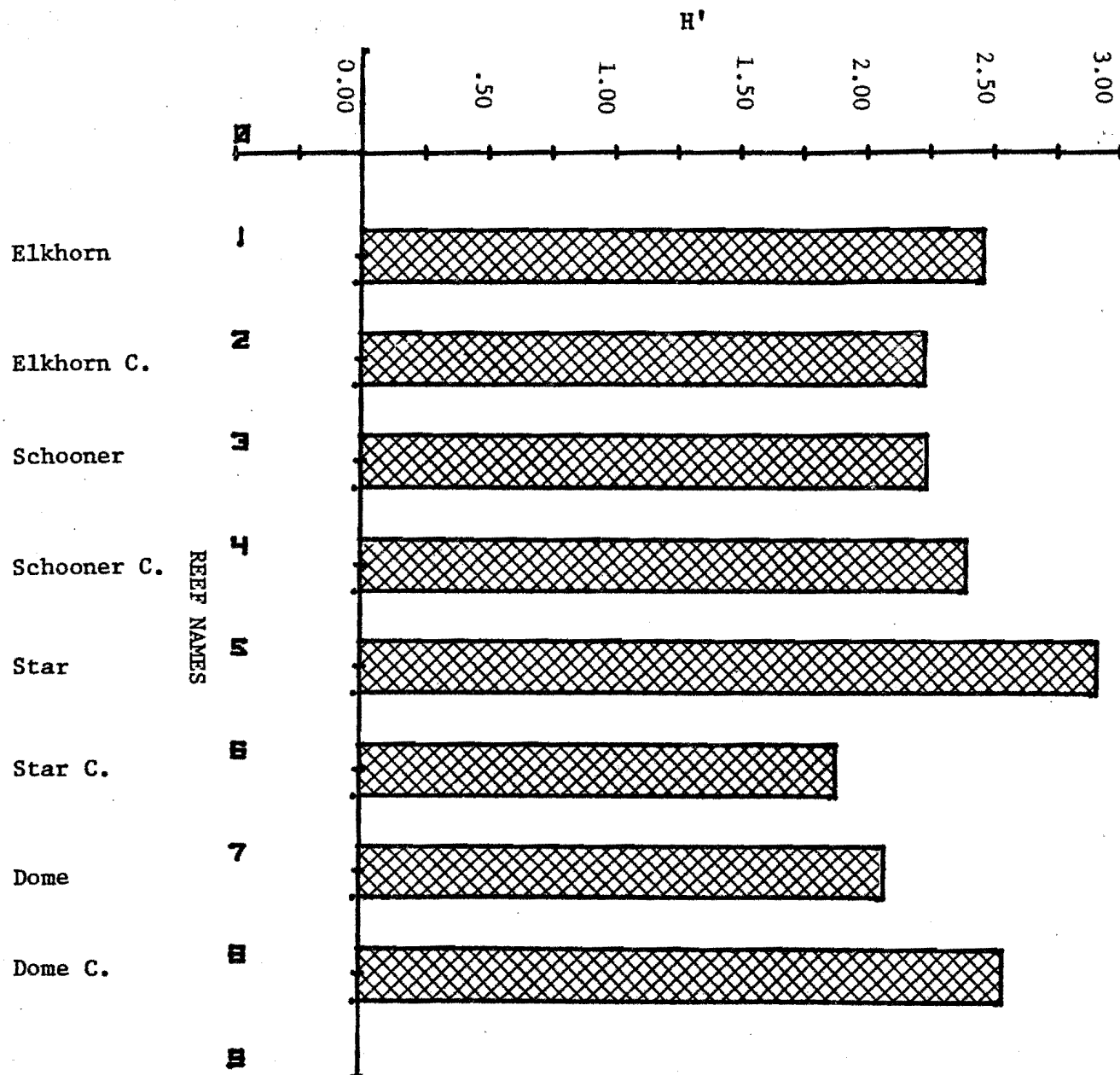
Diversity, 1978 Stony Corals
Plots



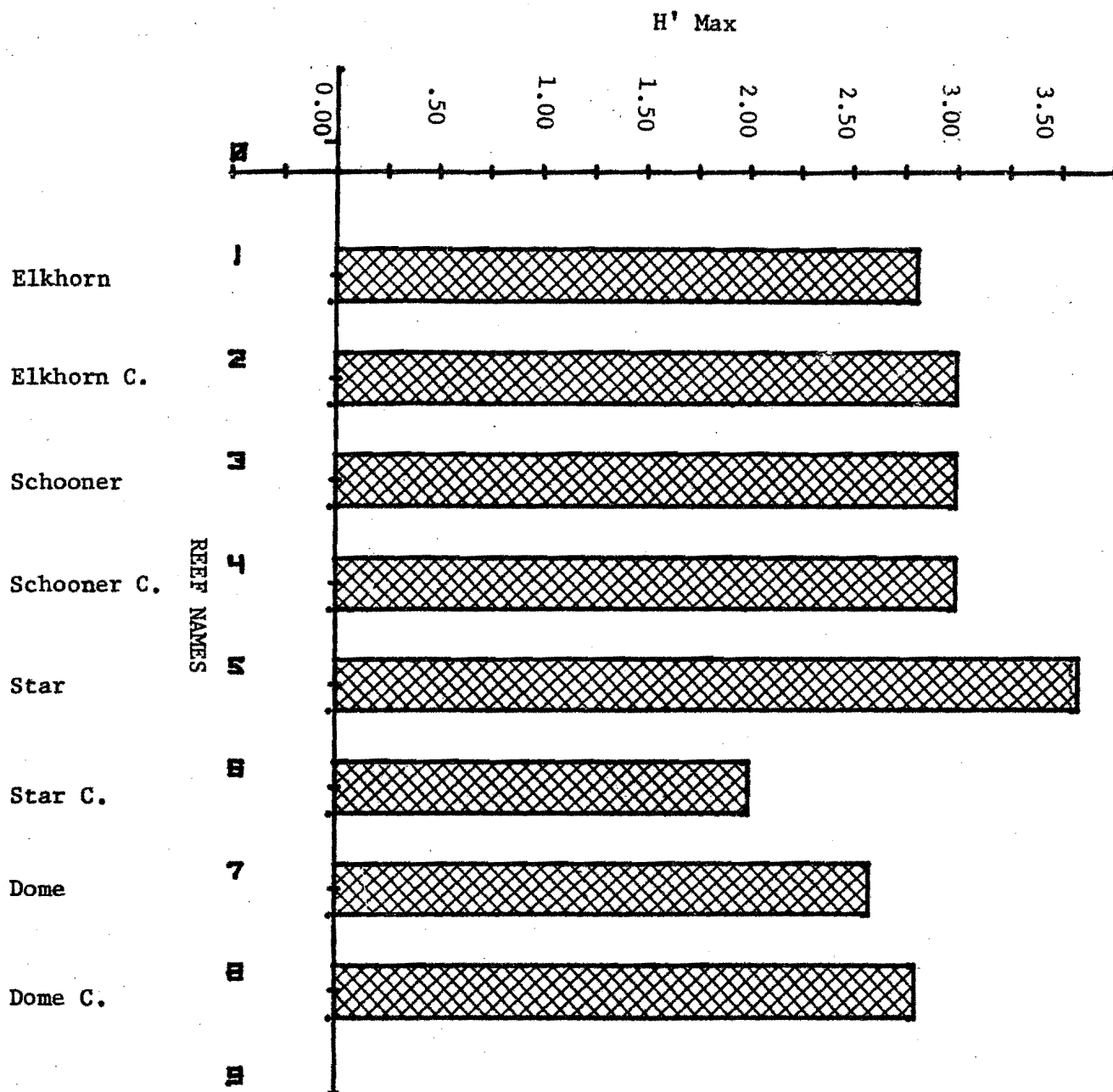
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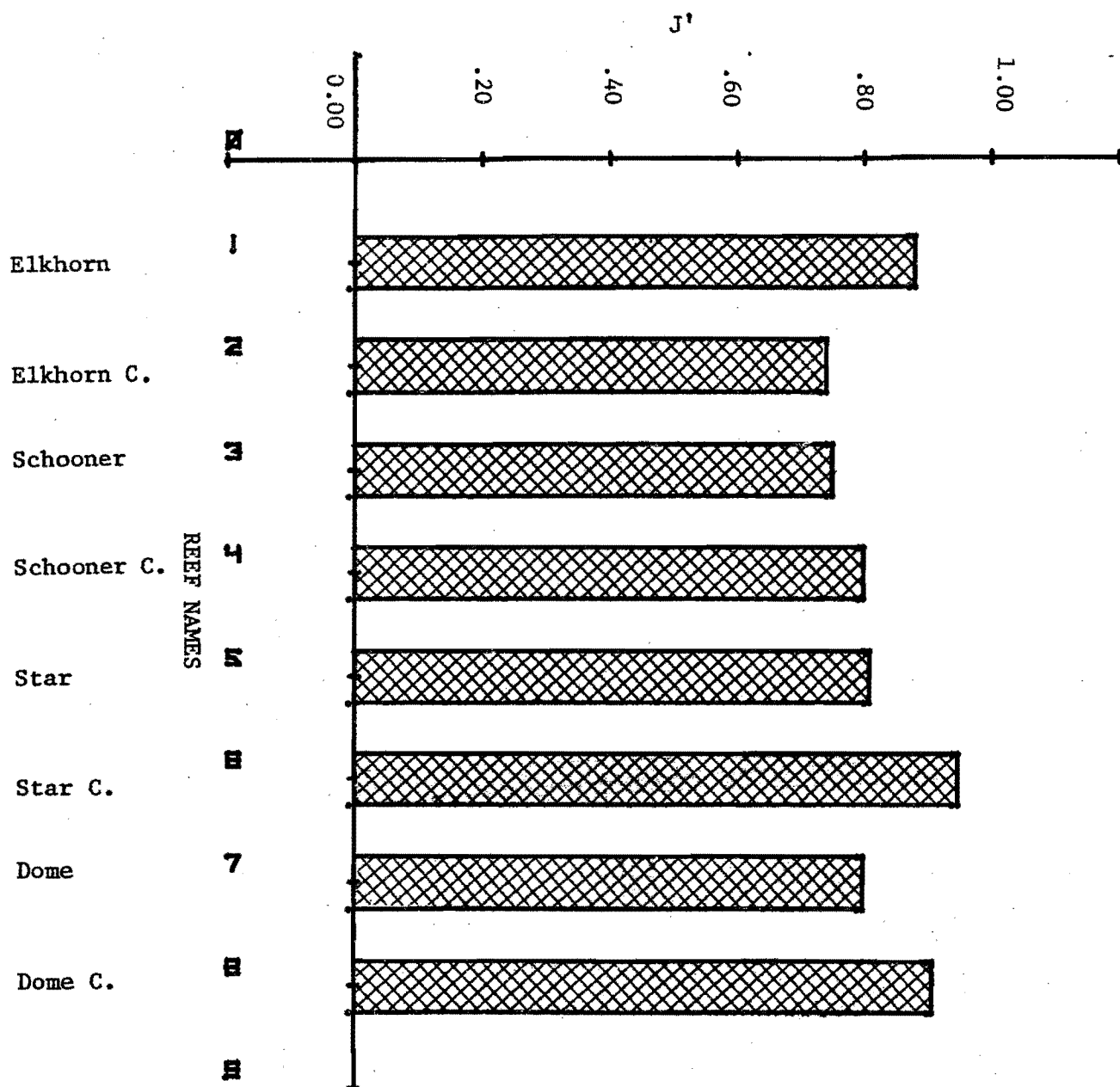
Diversity, 1977 Stony Corals
Quadrats



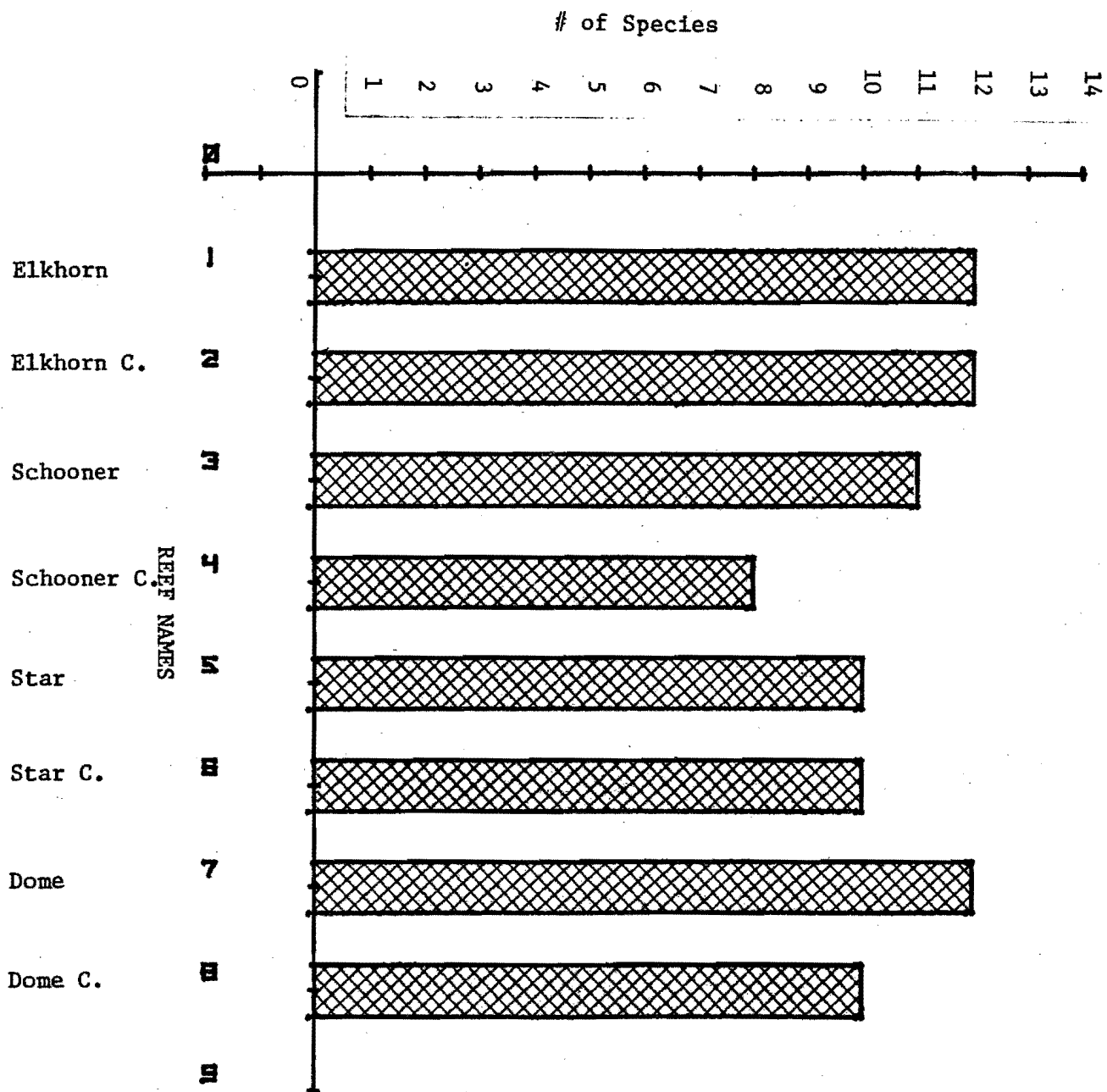
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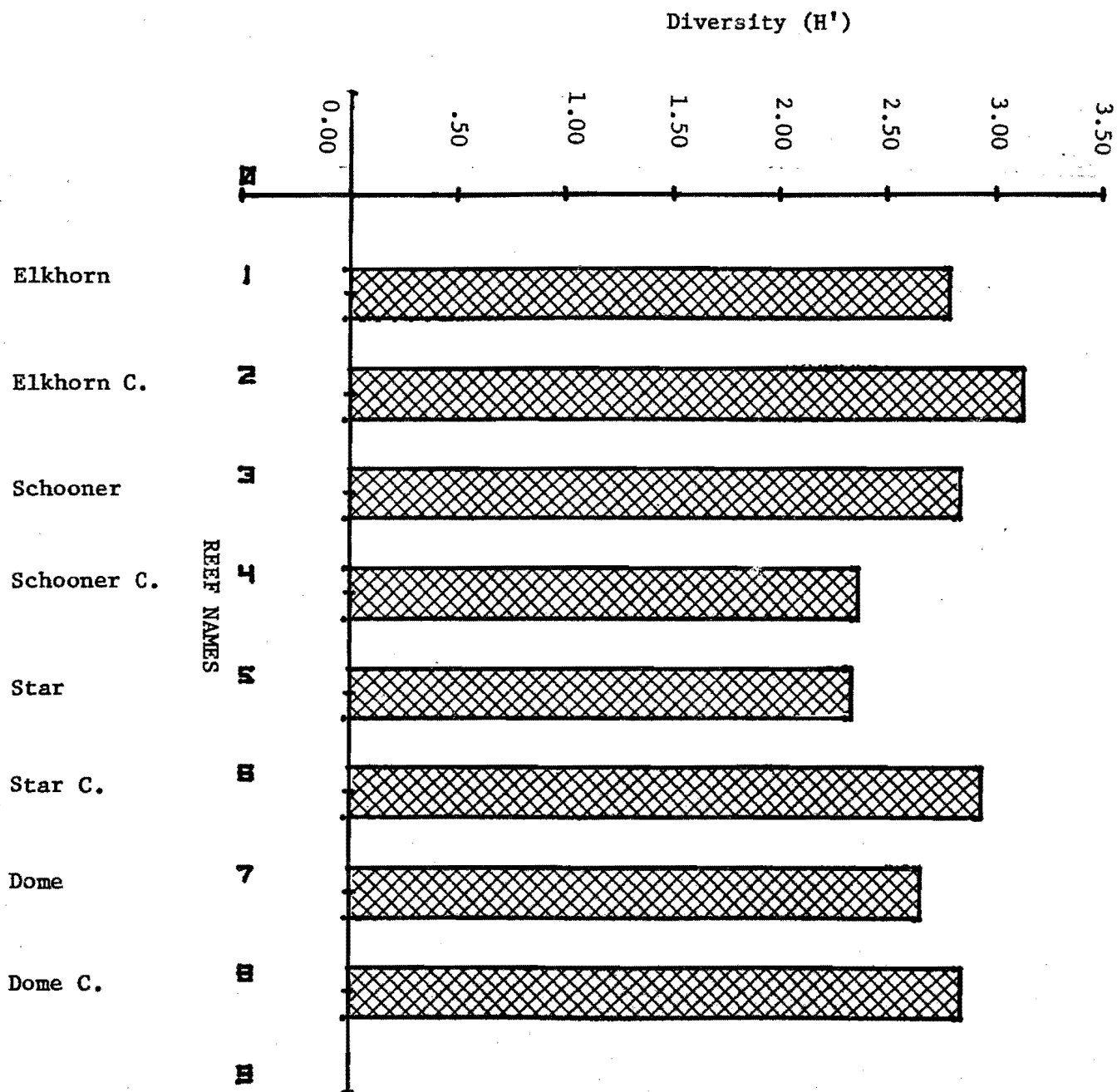
Diversity, 1977 Stony Corals
Quadrats



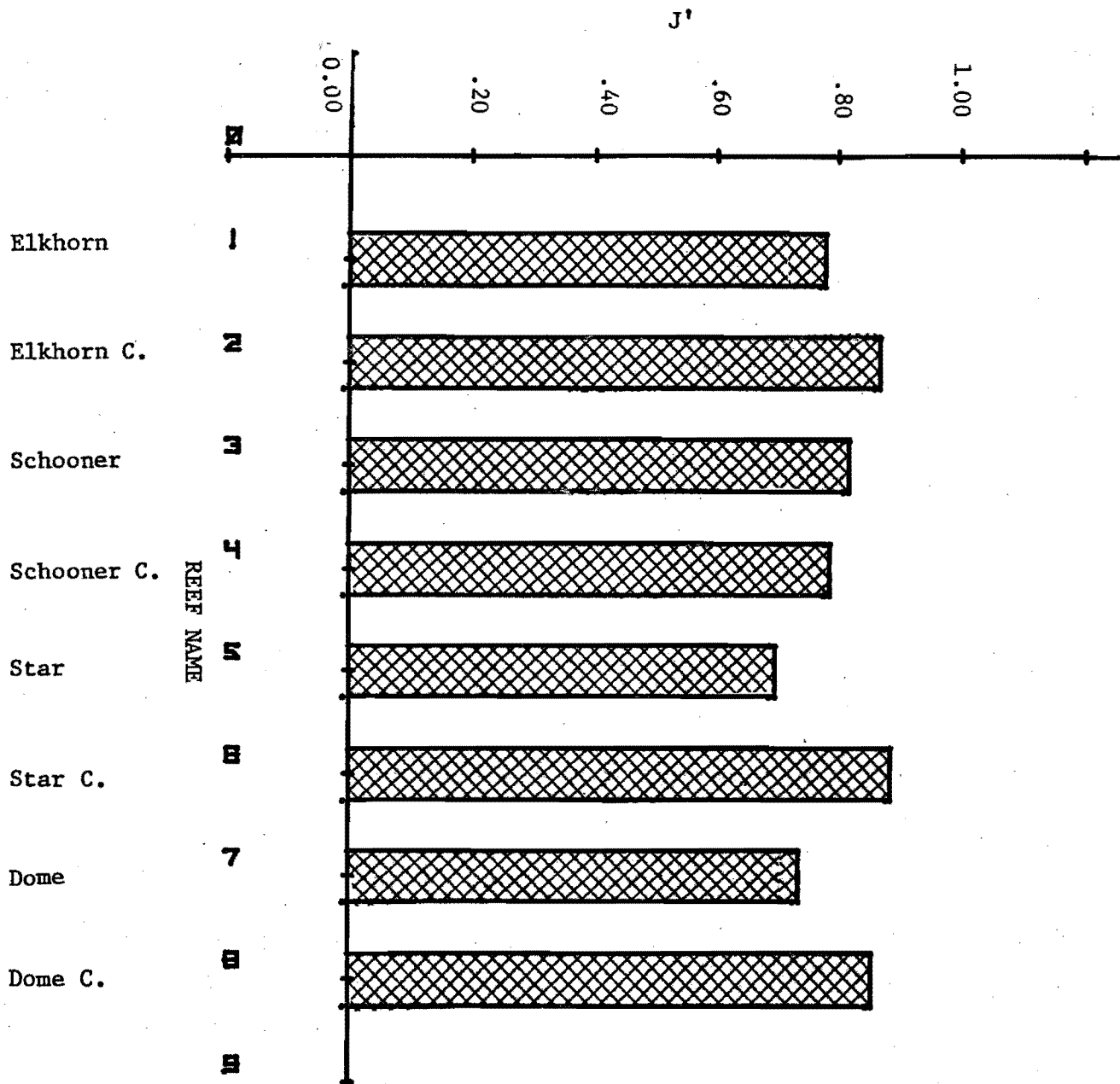
Diversity, 1978 Stony Corals
20m Transects



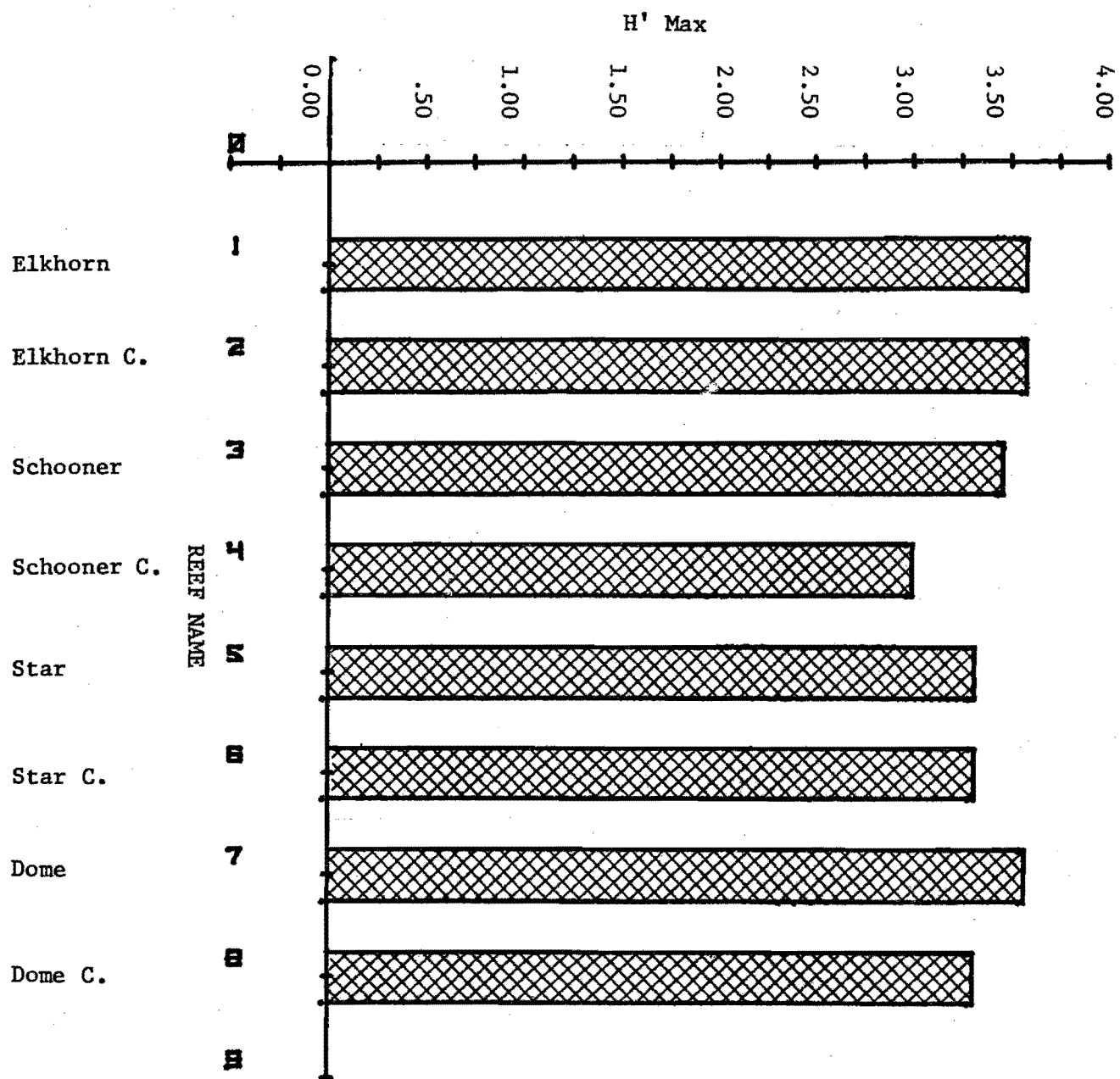
Diversity, 1978 Stony Corals
20m Transects



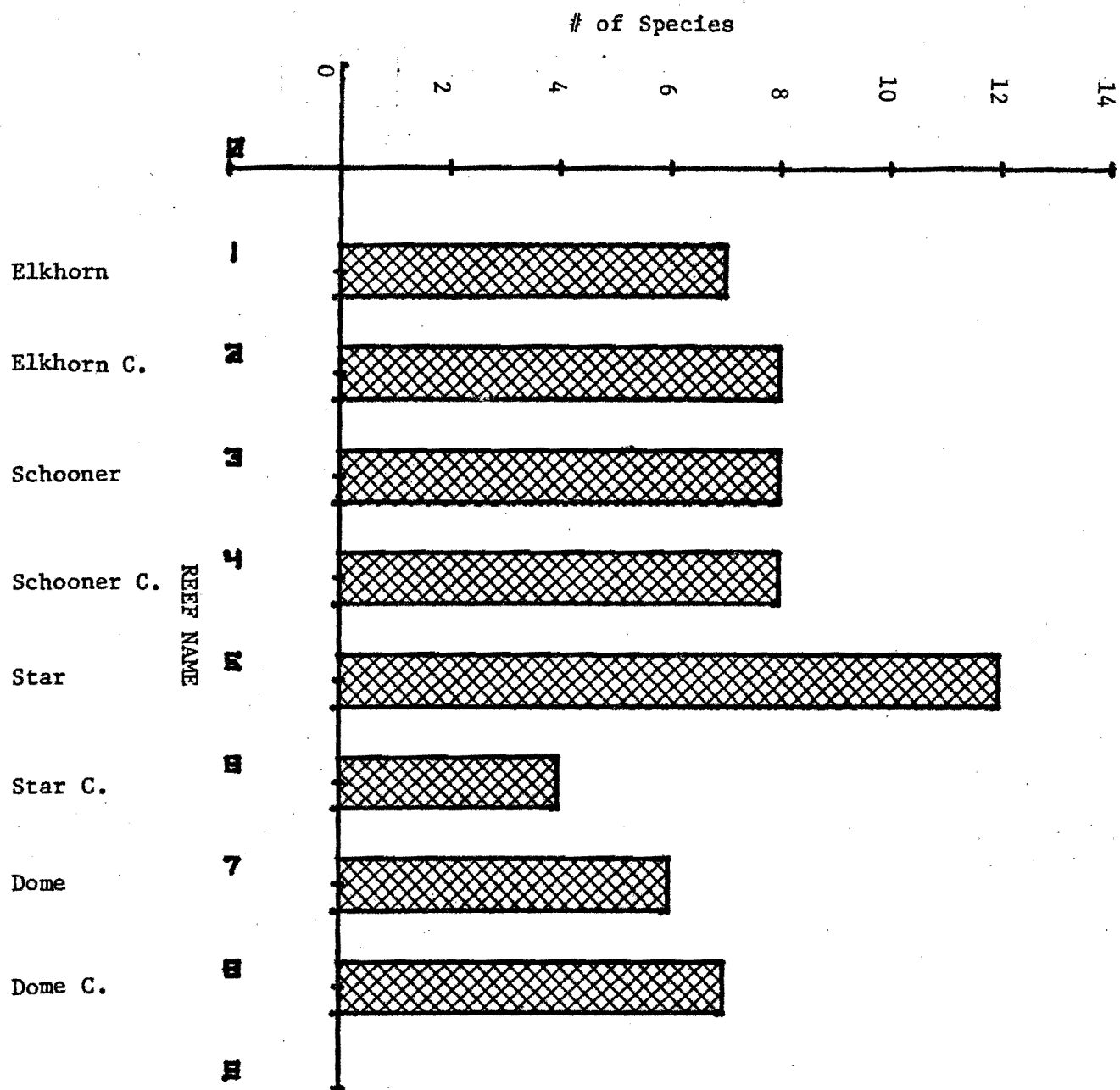
Diversity, 1978 Stony Corals
20m Transects



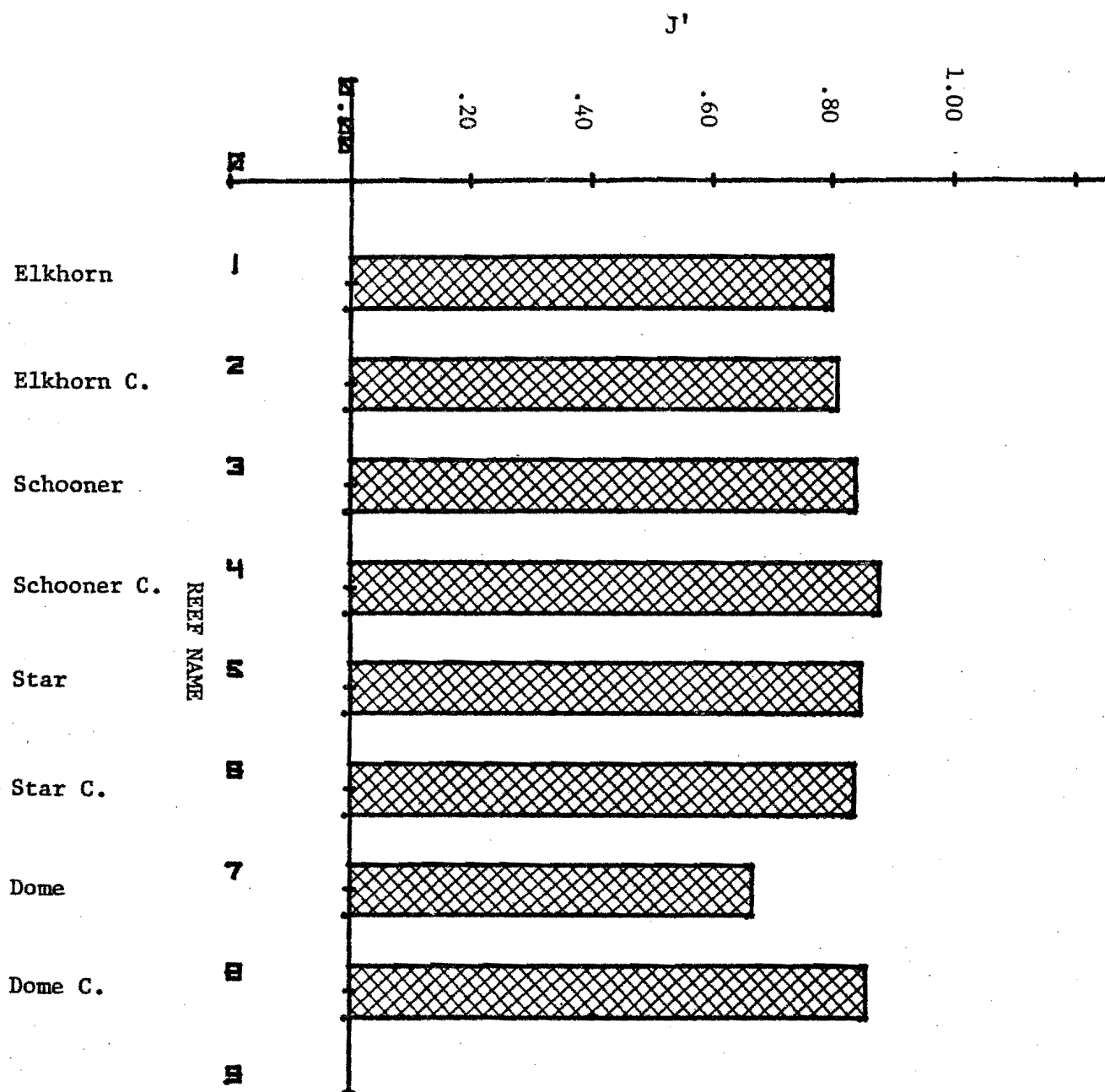
Diversity, 1978 Stony Corals
20m Transects



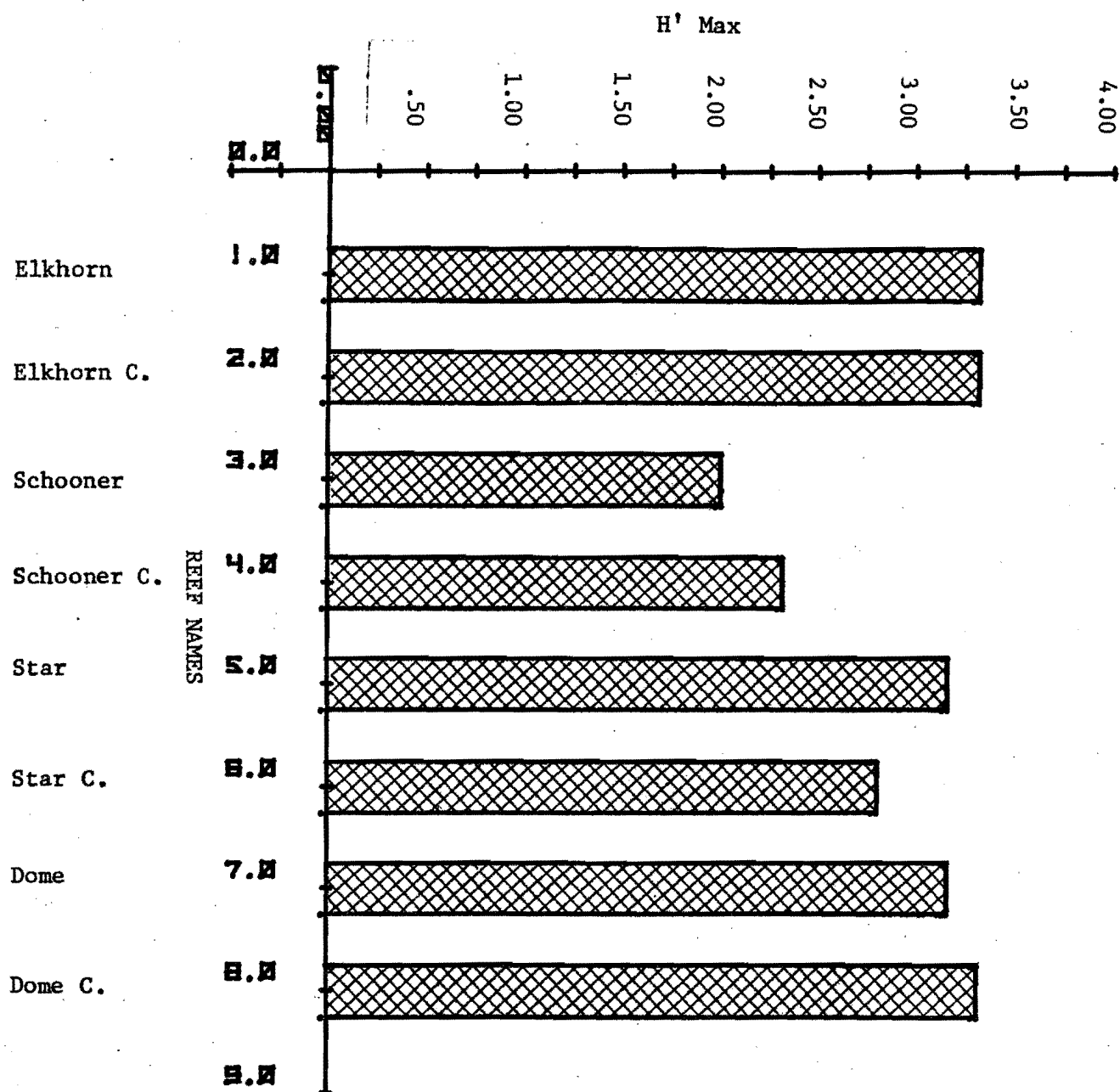
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Quadrats



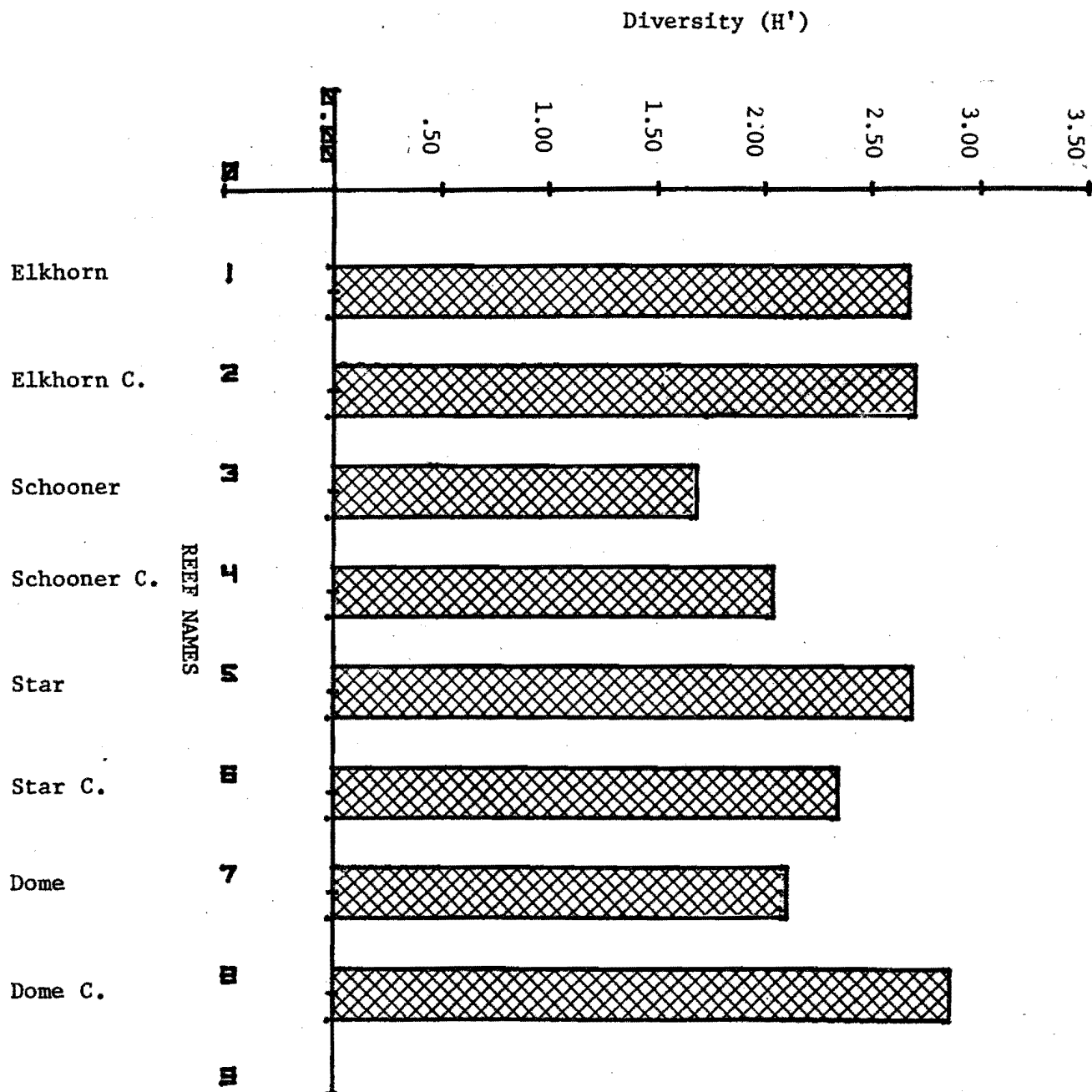
Diversity, 1977 Stony Corals
20m Transects



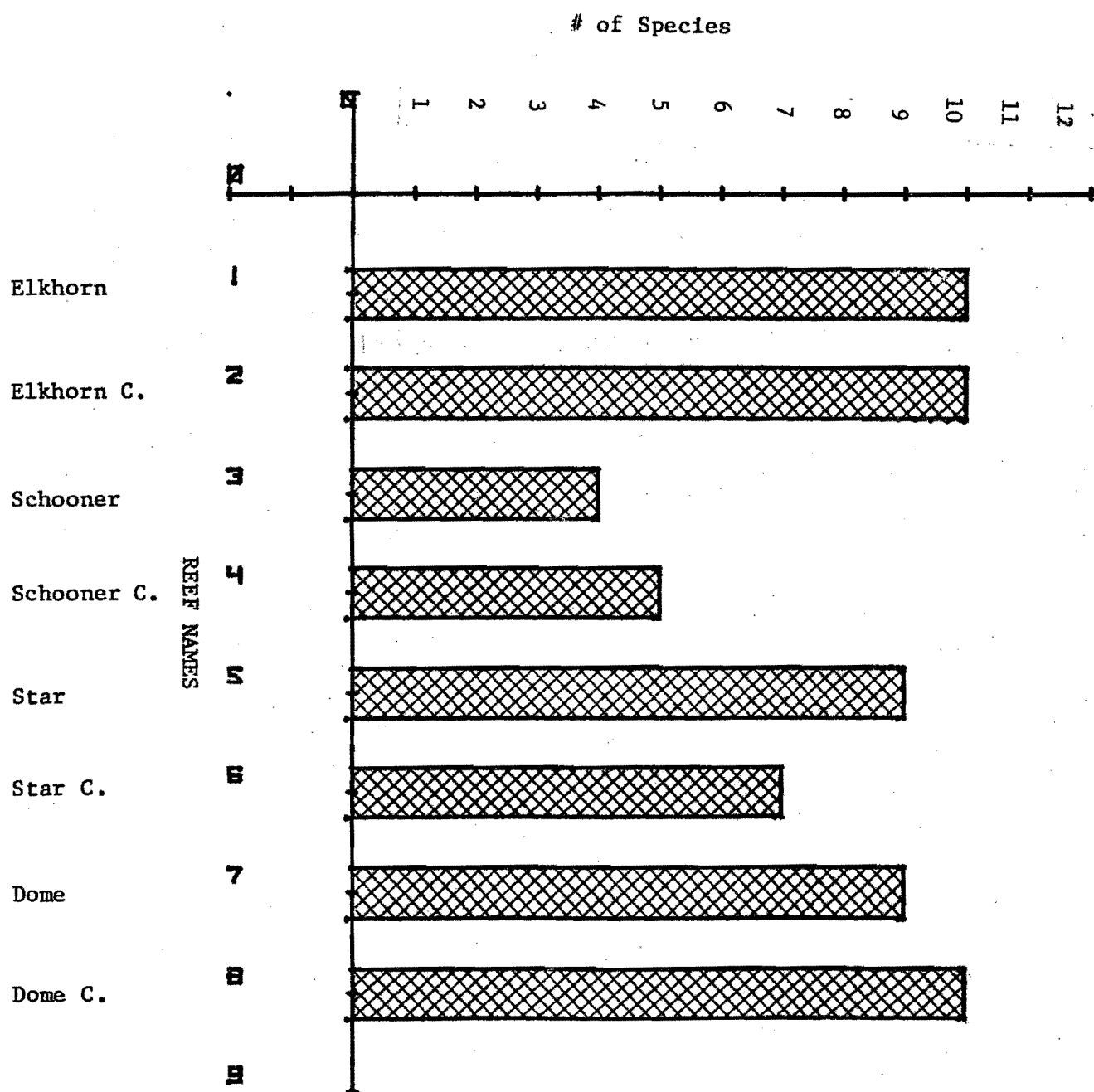
Diversity, 1977 Stony Corals
20m Transects

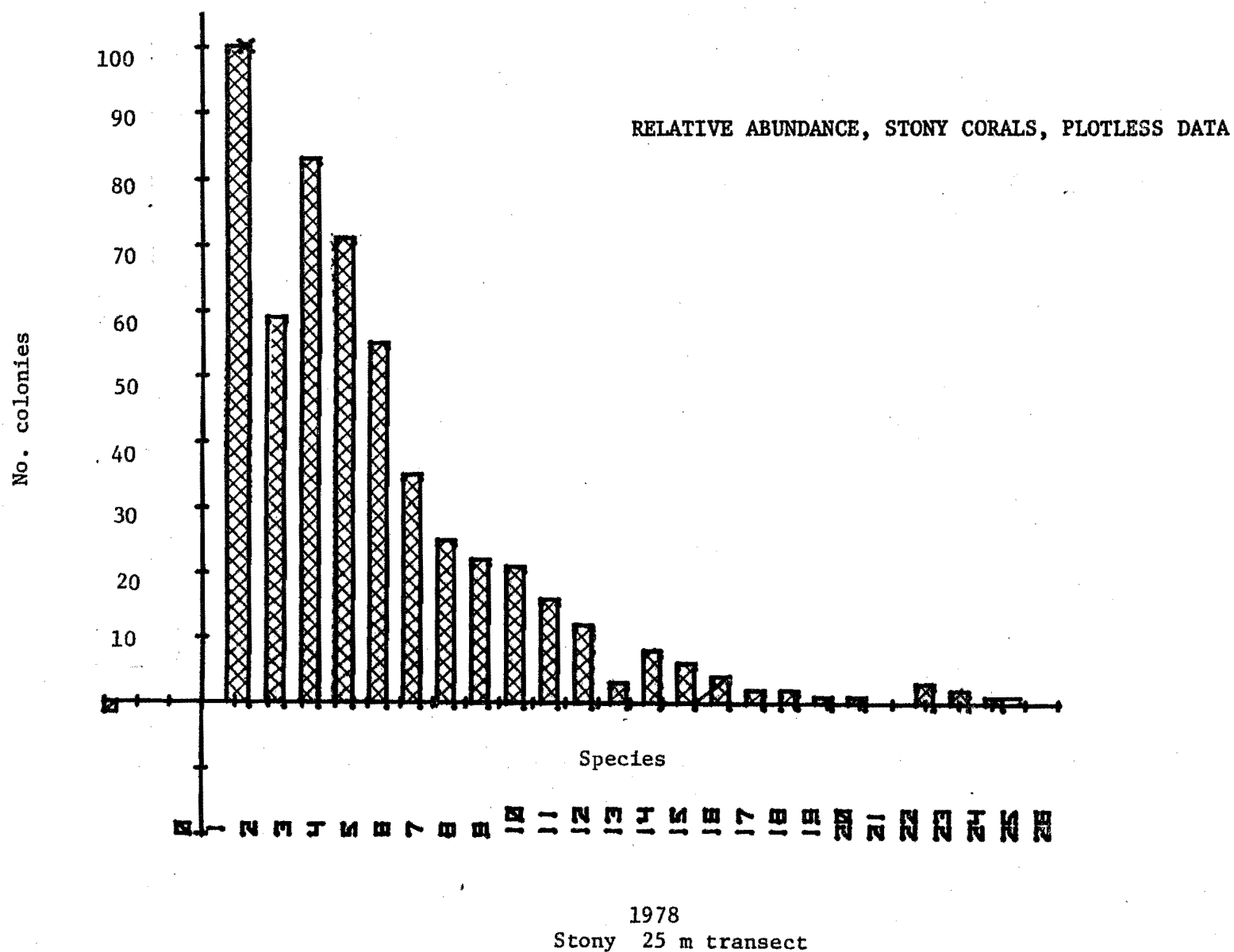


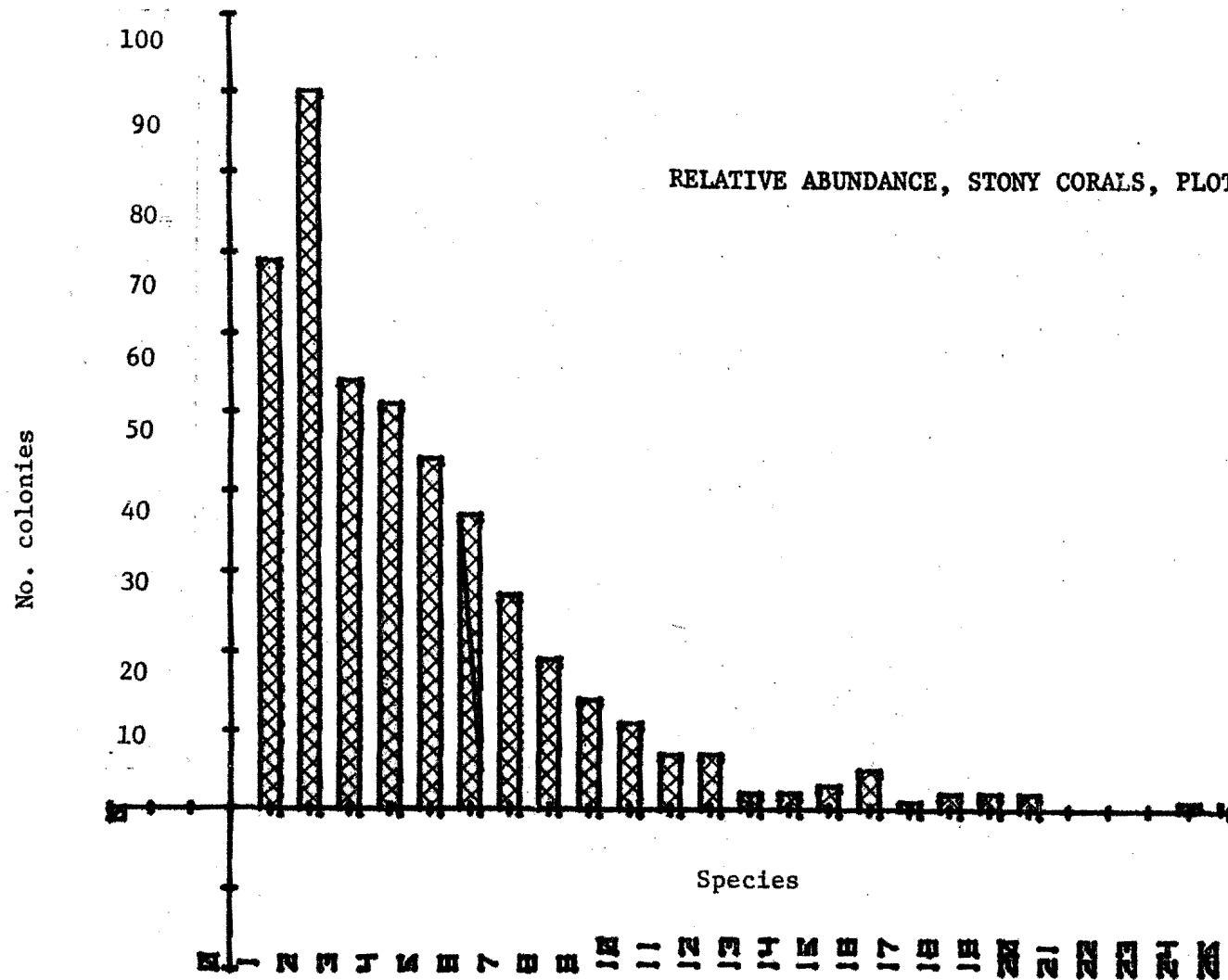
Diversity, 1977 Stony Corals
20m Transects



Diversity, 1977 Stony Corals
20m Transects







1977
Stony 25 m transect

J. W. Wells Plots, Tortugas 1933 Unpublished

Species	Site 1		Site 2		Site 3		Site 4		Site 5		Site 6	
	Col.	P _i	Col.	P _i	Col.	P _i	Col.	P _i	Col.	P _i	Col.	P _i
<u>. fragum</u>	107	.4179	-	-	5	.0458	158	.4425	133	.5236	2	.0073
<u>. annularis</u>	57	.2226	94	.7966	57	.5229	1	.0028	7	.0275	-	-
<u>. astreoides</u>	50	.1953	7	.0593	31	.2844	46	.1288	44	.1732	30	.1107
<u>. a. v. crassa</u>	21	.0820	4	.0338	1	.0091	-	-	-	-	-	-
<u>. porites</u>	13	.0507	4	.0338	7	.0642	1	.0028	16	.0629	4	.0114
<u>. siderea</u>	2	.0078	4	.0338	5	.0458	1	.0028	1	.0039	-	-
<u>. radians</u>	2	.0078	3	.0254	1	.0091	14	.0392	22	.0866	102	.3386
<u>. clivosa</u>	2	.0078	1	.0084	-	-	25	.0700	24	.0944	128	.4222
<u>. strigosa</u>	1	.0039	-	-	1	.0091	-	-	-	-	5	.0156
<u>. p. f. furcata</u>	1	.0039	-	-	-	-	110	.3081	5	.0196	-	-
<u>. cavernosa</u>	-	-	1	.0084	-	-	-	-	-	-	-	-
<u>. stokesii</u>	-	-	-	-	1	.0091	-	-	-	-	-	-
<u>. areolata</u>	-	-	-	-	-	-	1	.0028	2	.0078	-	-
Total Colonies	256		118		109		357		254		271	Total 1335
No. of Species	10		8		9		9		9		6	$\bar{X}=222$ 13
Density, m ²	6.56		3.02		2.79		9.15		6.51		6.94	$\bar{X}=5.83$ Std. Dev. 2.47
Min	2.21		1.25		1.92		1.97		2.14		1.64	
Max	3.32		3.00		3.17		3.17		3.17		2.58	
	0.67		0.42		0.60		0.62		0.67		0.64	

Plot size: 6'x 70' (39.0192m²)

DUPLICATE:
Original in
Museum Archives