TOWARDS THE DEVELOPMENT OF A SPATIO-TEMPORAL ATLAS OF THE 'HIGH ISLAND' FRINGING REEFS FOR THE SOUTHERN SECTION OF THE GREAT BARRIER REEF MARINE PARK: The application of a new technique for the assessment of fringing reef communities

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ABSTRACT

An integrated technique has been developed to provide a possible standard methodology for the assessment of the distribution and abundance of fish and benthic communities on fringing reefs. To date this technique has been applied to four Islands in The Whitsunday region and maps with colour overlays have been prepared. The overlays describe the community location, the vertical and horizontal distribution of communities, the distribution of substrate types, the distribution and abundances of fish species and the distribution of seagrasses.

An accompanying description of each "site" has been prepared which includes

a) A stylized 3-dimensional profile.

b) A pie diagram providing information on the absolute abundance of hard corals, soft corals, dead standing corals, macroalgae, turf algae, sponges and sand/rubble.

c) Relative abundance, tables for The Order Scleractinia, Subclass Alcyonaria, Phylum Porifera and Macroalgae.

In addition, broad scale patterns of distribution and composition of fish assemblages are discussed and anticipated work outlined. Maps of Brampton, Carlisle, Cockermouth and Goldsmith Islands can be obtained from the G.B.R.M.P.A in an Atlas, form after 31st January, 1987.

INTRODUCTION

Pressure on fringing reef communities from such diverse human activities as fishing, agriculture, industrial development and tourism (resort development) are steadily increasing. An informative data base is necessary to provide adequate information to assess the effects of these activities on the marine environment. Initial research providing a base-line by which to monitor community changes through time is essential for management policies to be applied. This report describes a technique designed to provide a suitable data base to act as a base-line for the continued monitoring and management of the 'High Island' fringing reefs in the southern section of The Great Barrier Reef Marine Park.

The processes leading to understanding the major factors defining the spatial distribution of coral reef communities will ensue only by expanding the scales and perspectives of observation. Therefore an integrated approach was adopted in this study, surveying both fish and benthic communities simultaneously. This approach firstly allows the examination of the nature of the different fish communities and subsequently a comparison of these communities with various biotic and abiotic factors. Secondly, the technique aiiows the examination of possible interactions (e.g. herbivory) between the fish and benthic communities by monitoring these communities on a temporal scale. Recent insight into the

organization of coral, reef benthic 'communities, was 'provided by Glynn, (1976), Connell (1979), Hay (1981a), Sammarco (1982a,b), Wellington (1982), Hixon and Brostoff (1983) and Lewis (1985) indicating that physical and biological disturbancesmay be major forcing functions in shaping community structure.

TOWARDS A BENTHIC METHODOLOGY

The complexity of the reefal system and their structural and taxonomic heterogeneity makes the task of describing communities to species level particularly difficult and time consuming. Furthermore, morphological plasticity of certain coral species are evident when subjected to diverse hydrodynamic, photic and sedimentary environments (Veron and Pichon, 1976). Coral community patterns have been demonstrated in quantitative studies of taxonomic groupings above the species level by Done (1982) and Bradbury et al (1985). Their 'visually dominant organisms' and 'life form' attributes were designed in view of these difficulties in taxonomic identification.

Considering the 'typically' adverse water transparency conditions around the Whitsunday Islands (pers. obs.), accurate benthic recording by such methods as manta towing (Done et al., 1982) would be insufficient. After reviewing other methodologies for collecting accurate ecological information 'it was concluded that a new

integrated sampling technique be employed with the aid of aerial photographs to analyse -the communities on these fringing reefs. This techniqe is an expansion of the method employed by Veron and Done in 1979 on Lord Howe Island to include the entire benthic community.

Classification to genera and morphological types were adopted after reviewing previous community studies on fringing reefs by G. Bull (1982) and T.J. Done (1982). it was observed that the results of these separate studies in similar areas classified communities varying in species composition, however genera frequently corresponded in both classifications for areas with similar abiotic parameters.

TOWARDS A METHOD OF RECORDING FISH ASSEMBLAGES

In considering a method to monitor coral reef fish assemblages the following questions need to be addressed.

Do all fringing reefs have similar assemblages? If not, can these assemblages be objectively characterised?

Any suitable sampling technique is governed by certain constraints. These include the speed with which the survey can be conducted, and safe working limits for S.C.U.B.A. divers, as well as minimum man power and equipment. As a result a semiquantitative technique has been developed which discriminates the differences in coral reef fish assemblages within and between reefs: Simultaneously the technique provides base-line data to

assess the level of fishing **pressure on** these fringing **reefs** by 'using the commonly fished coral trout **(*Plectro-pomus* spp.)** as an indicator species.

The sampling technique, which use's a 50x20 inetre transect, is derived from the standardized rapid visual, **technique** developed at the Workshop on Reef Fish Assess-, ment and Monitoring, convened by G.B.R.M.P.A. **in** 1978. This technique is 'modified due to the constraints encountered when assessing reefs of a largely **indistinct** nature **(i.e.** reef flat and reef slope are frequently indistinguishable) and the. generally poor visibility typically encountered while undertaking surveys on fringing **reefs** in the Whitsunda'y area.

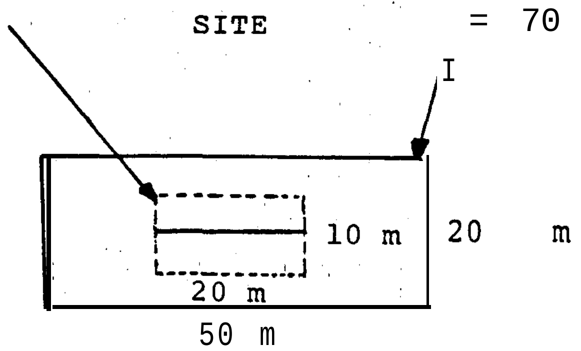
FIELD METHODS

Person 1. Benthos assessment (transect area = **200m^2)**

Average duration for collection of data, = 60 minutes

Person 2. Fish assessment (transect area = **1000m^2)**

Average duration for **collection of** data = 70 minutes



PERSON 1

SITE, SELECTION AND SAMPLING STRATEGY

1) Preliminary observations were made by distinguishing areas where community boundaries may occur using high resolution aerial photographs as tools for defining topographic features. "Sites" were selected on the basis of visible differences in benthic topography and exposure.

2) A search in the vicinity of the selected sites was made in order to' determine if the selected sites had a relatively homogeneous community and to determine the visible extent of the community. If--considerable. variance was detected in a neighbouring area an additional site was selected and surveyed accordingly. "Sites" were mapped using standard navigation techniques i.e. determining the angles between three reference points easily distinguished on the Islands, and subsequently plotting the "site" location.

3) To determine the abundance of the major benthic components a 20 metre line transect using the intercept method (Loya, 1972) was laid along the reef community at a uniform depth. The cover of macroalgae, hard coral, soft coral, dead standing coral, sand/rubble, turf algae, sponges and other major benthic components were recorded (see Appendix 1 for attribute list). A permanent line transect would provide additional insight when monitoring these sites by providing

information on mortality, recruitment and, information on significant changes in growth, rates.

4) A 5 metre search either side of the line transect was 'undertaken. The relative abundance of coral genera within the Order Scleractinia and Subclass Alcyonaria were derived by recording every individual encountered in the $200m^2$ transect area. Similar recordings were undertaken for the Phylum Porifera and the Order Zoanthidea, which varied in taxonomic resolution in accordance with the authors' capabilities in taxonomy.

A special column was set aside for conspicuous macrofauna such as. the giant clams Tridacna, Tunicates and Echinoderms.

All recordings were marked on a large Perspex board which had the Operational Taxonomic Units listed (see Appendix II). Data were obtained through visual assessment and size estimates, the benthic components were assigned a graded score depending on their'maximum diameter.

A broad scale indication of population structures were obtained using four size categories. However, resolution of population dynamics is variable when considering that coral colonies vary in porosity' and growth rates.

'Field recording criteria on Perspex board:

1-50cm 50-100cm + 1-3metres >3 metres

5) An in-situ mapping technique was employed to determine the relative abundance and generic type of macroalgae.

Ten random $1m^2$ quadrats were placed in the site area. For permanent transects, quadrats are placed at specified distances along the line. The quadrats were subdivided by wire mesh into sixteen squares for simplified and more accurate data recording. The macroalgae within each quadrat were identified and traced out in the appropriate recording blocks on the large perspex board.

If seagrasses were present in the quadrats, species type were identified and their relative cover per metre square were estimated.

If macroalgae *were* prolific and underlying benthic components could not be easily observed, 'a 11 the macroalgae were removed from each quadrat and the underlying corals identified. Each underlying coral colony was assigned a graded score according to size.

A	B	C	D	E	F	G
0-5cm	5-10cm	10-20cm	20-30cm	30-50cm	50-75cm	75-100cm

6) In addition to defining the composition and cover of communities the bottom types were recorded (i.e. mud, sand, rubble, igneous substrate, carbonate substrate). Furthermore, distinct morphological features were noted (e.g. spur and groove systems) as were the local currents. The exact depth of the benthic communities were determined by preparing tidal curves and interpolating the recorded time and depth for each community using L.W.D. as datum. The relief and the slope angles were also sketched for each "site".

7) In order to'determine intra-community variation replicate "site" surveys were occasionally undertaken'.

Note: In order to determine any major temporal community changes the survey technique can be employed by persons with only elementary knowledge in taxonomy by "scaling-up" the taxonomic categories and by diagramatic assistance on the prepared underwater board.

PERSON 2

SITE SELECTION - similar as person 1, steps 1) and 2) employed.

SAMPLING STRATEGY

A 50 metre tape was placed along the reef'slope at a uniform depth. The observer, to ensure consistency, swam using S.C.U.B.A. in a zig zag (sinusoidal) pattern 10 metres either side of the tape i.e. Belt' transect = $1000m^2$.

The presence of species and their abundance were recorded on a prepared underwater slate as the diver swam along the transect.

Numerically dominant species such, as Pomacentrids and, some Labrids (Haliocheres spp.) and Lutjanids (Caesio spp.) were recorded on a log 5 abundance scale, whilst 'other,, more solitary, demersal, fish species were recorded in absolute numbers.

The log 5 abundance categories follow Sale and' Williams, (1982).

Category

1 fish,= 1	26-125 fish = 4
2-5 fish = 2	126-625 fish = 5
6-25 fish = 3	626-3250 fish = 6
	> 3250 fish = 7

Rare or exceptional species not on the proforma list are also recorded as well as an aesthetic appeal rating made at each site.

Coral trout {*Plectropomus spp.*) are recorded under the following size categories when encountered:.

Juvenile < 40cm

Medium sub-adult 40-60cm

Large adult > 60cm.

The information provided by size frequency data is far more **sensitive** in indicating 'stress in a fished population.

RESULTS

These results refer to the fringing reefs of four Islands in the southern section of the Marine Park, namely Brampton, Carlisle, Goldsmith and Cockermouth Islands. The benthic survey data are stored in the form of maps with plastic colour overlays indicating the vertical and horizontal distribution of communities, distribution of seagrasses and substrate types. This graphic representation makes access and interpretation of data relatively easy. Additional descriptions and stylized profiles have been prepared for each "site"..

An agglomerative hierarchical classification (Williams, 1971) using Bray-Curtis similarity, coefficients identified broad scale patterns in the composition of fish assemblages. This analysis was run for 32 "sites" using the Numerical Taxonomy Package '(N.T.P.) developed by the C.S.I.R.O. The results indicate that differences in fish assemblages are greater between Islands than within Island "sites". Goldsmith Island was found to be most dissimilar from Islands further off-shore. "Sites" on' the windward slopes were found to be more similar than those on the more sheltered slopes. Where strong currents were persistent on leeward "sites" the fish assemblages showed similarity to those sites on the windward side of the Islands.

Due to the complex nature of the benthic communities any taxonomic classification': has yet to be undertaken. However distinct 'patterns in the benthic communities are

apparent by "eyeballing" the data.

The changes in benthic communities and fish assemblages between Islands appear to follow the broad cross shelf trends identified by Done (1982) and Williams (1982). However fringing reef variability maybe greater than previously thought. The inter-Island variability may mask these cross shelf trends resulting in the need to focus on a smaller scale.

Comparing the benthic communities on the exposed indistinctly developed Goldsmith Island reefs with the well developed reefs on Cockermouth Island, obvious differences in benthic components were observed. Sargassum assemblages with minimal coral cover of encrusting morphologies dominated Goldsmith Island in comparison with the Acropora robusta - hyacinthus - palifera variants on Cockermouth Island. Similarly the fish assemblages on Cockermouth, Brampton and Carlisle Island have species which are described as being more midshelf in distribution than those on Goldsmith (Williams, 1982).

A good example of the fish species distribution patterns is the pomacentrid Abudefduf whitleyi which is absent on Goldsmith Island, moderately common on Brampton and Carlisle, becomes a numerically dominant species on Cockermouth Island. An interesting anomaly is the virtual absence of Scarids on Goldsmith Island where macroalgae were most prolific, whilst a few kilometres to the south east an increasing abundance and diversity of these fishes were observed.

DISCUSSION

The work to date has helped to elucidate broad scale patterns in distribution and abundance of fish assemblages and benthic communities on fringing reefs on southern 'High Islands'.

Further work will involve numerical clustering of benthic communities by coral genera, families and various coral population sizes. Separate clustering on 'macro-" algae - coralcommunities will be divided temporally due to the seasonal nature of macroalgae.

Perhaps the most important analysis yet to be undertaken is the correlation of various biotic and abiotic factors. This will involve multivariant analysis providing information on the possible associations of these various parameters. Further work will also focus on small scale variability and the examination of detailed differences between assemblages within Island reefs.

It is considered by the authors that the communities recorded could represent stages in succession. Therefore fine scale temporal monitoring is of prime importance in determining not only'the effect of infrequent large scale perturbations on the communities but also continuous seasonal perturbations. Insightinto the extent of coral - algae interactions needs to be gained and the possible extent to which they may be mediated by the herbivorous fish guild for any effective long-term management of these reefs.

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REFERENCES

Bradbury, R.H., Loya, Y., Reichelt, R.E., Williams, W.T. (1986) Patterns in the structural typology of benthic communities on two coral reefs of the central Great Barrier Reef. Coral Reefs 4: 161-167.

Bull, G.D. (1982) Scleractinian Coral Communities of two Inshore High Island fringing reefs at Magnetic Island, North Queensland. 'Marine Ecology Progress Series Vol 7: 267-277.

Connell, J.H. (1979) Tropical rain forests and coral, reefs as open non-equilibrium systems. Pages 141-163 in R.M. Anderson, B.D. Turner and L.R. Taylor, editors. Population dynamics. Blackwell Scientific, Oxford, England.

Done, T.J. (1982) Patterns in the distribution of'coral communities across the central Great Barrier Reef. Coral Reefs 1, 95-107.

Done, T.J., Kenchington, R.A., Zell, L. (1982) Rapid, Large' Area, Reef Resource Surveys using a manta board. Proceedings of the Fourth International Coral Reef Symposium, Manila, 1981(1). 299-308.

G.B.R.M.P.A. (1978) Great Barrier Reef Marine Park Authority workshop on reef fish assessment and monitoring. Workshop series No. 2, G.B.R.M.P.A., Townsville, Australia.

G.B.R.M.P.A. (1979) Great Barrier Reef Marine Park Authority workshop'on Coral Trout assessment techniques. Workshop series No. 3, G.B.R.M.P.A., Townsville, Australia.'

Glynn, P.W. (1976) Some physical and'biological determinants of coral community structure in the eastern Pacific. Ecological Monographs 46: 431-456.

Hay, M.E. (1981a). Herbivory, algal distributions and the maintenance of between-habitat diversity on a tropical fringing reef. American Naturalist 118: 520-540.

Hixon, M.A. and W.N. Brostoff. (1983) Damselfish as keystone species in reverse : intermediate , disturbance and diversity of reef algae. *Science'220: 511-513.*

Lewis, S.M. (1985) Herbivore abundance and grazing, intensity on a Caribbean coral reef. J. Exp. Mar. Bio,l. Ecol. Vol. 87, pp. 215-228.

Loya, Y. (1972) Community structure and species diversity of hermatypic corals at Eilat, Red Sea. Marine Biology 13: 100-123.

Russ, G.R. (1984) The distribution and abundance of herbivorous grazing fishes in the central Great Barrier Reef. I. Levels of variability across the entire continental shelf. Mar. Ecol. Prog. Ser. 20: 23-24.

Russ, G.R. (1984) Distribution and abundance of herbivorous grazing fishes in the central Great, Barrier Reef. II. Patterns of zonation of mid-shelf and centre-shelf reefs. Mar. Ecol. Prog. Ser. 20: 35-44.

Sammarco, P.W. (1982a) Effects of grazing by Diadema antillarum Philippi (Echinodermata: Echinoidea) an algal diversity and community structure. J. Exp. Mar. Biol. Ecol. 65: 83-105.

Sammarco, P.W. (1982b) Echinoid grazing as a structuring force in coral communities : whole reef manipulations. J. Exp. Mar,. Biol. Ecol. 61: 31-55.

Veron, J.E.N. and M. Pichon. (1976) Scleractinia of Eastern Australia. (Part 1) Families Thamnasteriidae, Astrocoeniidae, Pocilloporidae. A.I.M.S. 'Monograph Series Vol. 1, Australian National University Press, Canberra.

Wellington, G.M. (1982) Depth zonation of corals in the Gulf of Panam : control and facilitation by resident reef fishes; Ecological Monographs 52: 223-241.

Williams, D. McB. (1982) Patterns in the distribution of fish communities across the central Great Barrier Reef. Coral Reefs 1: 35-43.

Williams, D. McB., Hatcher, A.I. (1983) Structure of fish communities on outer slopes of inshore, mid-shelf and outer shelf reefs on the Great Barrier Reef. Mar. Ecol. Prog. Ser. 10: 239-250.

APPENDIX I

List of Attributes 'and respective Recording Codes employed for Line Transects'

Attribute	Description	Field Code
Scleractinian Corals:		
Acropora	"fine branching"	AFB
	"thick open-branching"	ACB
	"stout shrub-like"	ASS
	"fine shrub-like"	AFS
	"tabulate"	ACT
	"stout"	ACS
	Palifera-type	ACP
	"encrusting"	ACE
	Astreopora	ACM
non-Acropora	identified to genera, with separate recordings for morphologies	
	M - Massive, F - Foliose, E - Encrusting, B - Branching, c - Columnar	
Other Fauna:		
Alcyonacea	identified to genera where possible	SC
Gorgonacea		G
Zoanthidea		Z
Actinaria, Antipatharia, Hydroids		A
Echinoderms, Mollusc, etc.		O
Millepora		M
Algae:		
Turf Algae		TA
Coralline Algae		CA
Macroalgae		MA
Abiotic Components:		
Sand		S
Rubble		R
Sand/Rubble Mixture		S/R
Silt		Si
Mud		Mu
Recently dead, standing coral		DC
Water (cracks deeper than 50 cm)		WA

APPENDIX II

(Operational Taxonomic Units, **OTU's)**

Organism's maximum diameter: **a** **1-50** cm; b 50-100 cm; **c** **100-300** cm; **d** greater than 300 cm

Code	Taxon	a	b	c	d
200	Familv Faviidae	**a**	b.	**c**	**d**
	Cauiastrea	**201**	202	**203**	**204**
	Favia	210	211	212	213
	Favites	216	217	218	219
	Goniastrea	220	221	222	223
	Platygyra	226	227	228	229
	Leptoria	230	231	232	233
	Oulophyllfa	236	237	238	239
	Hydrophora	240	241	242	243
	Montastrea	250	251	252	253
	Plesiastrea	260	261	262	263
	Diploastrea	266	267	268	269
	Leptastrea	270	271	272	273
	Cyphastrea	276	277	278	279
	Echinopora	280	281	282	283
	Uoseleya	290	291	292	293
300	**Family** Acroporidae				
	"Fine branching"	301	302	303	304
	"Thick **open-** branchins"	306	307	308	309
	"Stout shrub-like"	310	311	312	313
	"Pine shrub-like"	316	317	318	319
	"Tabulate"	320	321	322	323
	"Stout" **(gemmifera type**)	330	**331**	**332**	333
	"Palifera-type"	336	337	338	339
	"Encrusting",	340	341	342	343
	Astreopora	350	351	352	353
360	Montipora **"foliose"**	361	362	363	364
	"Encrusting **free-lip"**	**366**	**367**	**368**	**369**
	"Encrusting no free-lip"	370	371	372	373
	"Encrustinq with vertical projections"	376	377	378	379
	"Submassive"	380	381	382	383
	Anacropora	390	**391**	392	393
400	Family Poritidae				
	Porites "Massive"	401	402	403	404
	"Encrusting"	410	411	412	413
	"Branching"	420	421	422	423
	"Lichen-type"	430	431	432	433
	Goniopora	440	441	442	443
	Alveopora	450	451	452	453
460	Familv Pocilloporidae				
	Pocillopora	461	462	463	464
	Seriatopora	466	467	468	469
	Stylophora	470	471	472	473
	Palauastrea	480	481	482	483
	Madracis	484	485	486	487
500	Family Aqariciidae				
	Pavona "Foliose"	501	502	503	504
	"Massive"	506	507	508	509
	"Stout"	510	511	512	513
	Leptoseris	520	521	522	523
	Gardineroseris	530	531	532	533
	Coeloseris	536	537	538	539
550	Pachyseris ruqosa	551	552	553	554
	speciosa	556	557	558	559
560	Family **Siderastreidae**				
	Pseudosiderastrea	561	562	563	564
	Coscinaraea	566	567	568	569
570	Family Oculfnidae				
	Galaxea	571	572	573	574
	Archelia	576	577	578	579
580	Family Trachyphylliidae				
	Trachyphyllia	581	582	583	
590	Family Thamnasteriidae				
	Psammocora	591	592	593	594
595	Family Astrocoeniidae				
	Stylocoeniella	596	597	598	599

Code	Taxon	a	b	c	d
600	Family **Merulinidae**	**601**	b	**603**	d
	Merulina		602		604
	Clavarina	606	607	608	609
	Scapophyllia	610	611	612	613
620	Family **Mussidae**				
	Blastomussa	621	622	623	
	Cynaria	624	625		
	Scolymia	626	627		
	Acanthastrea	628	629	630	631
	Lobophyllia	632	633	634	635
	Symphyllia	636	637	638	639
640	Familv Pectiniidae				
	Echinophyllia	641	642	643	644
	Oxypora	646	647	648	649
	Mycedium	650	651	652	653
	Pectinia	656	657	658	659
660	Familv Carovhvlliidae				
	Euphyllia	661	662	663	
	Catalaphyllia	666	667	668	
	Plerogyra	670	671	672	
	Physoqyra	676	677	678	
680	Family Dendrophylliidae				
	Turbinaria **"Foliose"**	681	682	683	684
	"Encrusting **free-** lip"	685	686	687	688
	"Encrusting no free-lip"	689	690	691	692
	Duncanopsammia	693	694	695	
	Heteropsammia	696	697		
700	Family Funqia				
	Cycloseris	701.	**702**	**703**	
	Diaseris	706	707	**708**	
	Heliofunqia	710	711	712	
	Funqia	716	717	718	
	Herpolitha	720	72i	722	
	Herpetoqlossa	726	727	728	
	Polyphyllia	730	731	732	
	Halomitra	736	737	738	
	Sandolitha	740	741	742	
	Lithophyllon	746	747	748	
	Podabacia	750	751	752	
800	Subclass Alcyonaria				
	Tubiopora	801	802	803	
	Clavularia	804	805	806	
	Pachyclavularia	810	811	812	813
	Lobophytum	816'	817	818	819
	Alcvonium	820	821	822	823
	Briareum	826	827	828	829
	Cladiella	830	831	832	833
	Asterospicularia	835	836		
	Sarcophyton	837	838	839	
	Capnella	840	841	842	
	Sinularia	846	847	848	849
	Parenythropodium	850	851	852	853
	Stereonephthya	856	857	858	
	Nephthea	860	861	862	
	Dendronephthya	870	871	872	
	Paralemnalia	873	874	875	
	Cespitularia	876	877		
	Anthelia	878	879		
	Xenia	880	881	882	
	Efflatournaria	883	884	885	886
	Lemnalia	887	888	889	
890	Order Gorqonacea				
	Rumphella	891			
	Fan	892			
	Whip	893			
	comb	894			
	Order Pennatulacea	895			

APPENDIX II! (cont/d.)

900 Other: Order Zoanthidea	9 0 1
910 Order Actinaria	911
920 **Phyllum** Mollusca	
Class Bivalvia	
Tridacnidae	921 922 923
Hippopus	926 927
930 Phyllum Porifera	
"Foliose"	931
"Vase "	932
"Cup"	**933**
"Encrusting"	934
"Submassive"	935
"Cliona-type"'	'936 937 938 939
980 Phyllum Cnidaria	
Class Hydrozoa	
Millepora	
"Branching"	981 982 983 984
"Massive"	990 991 992 993
"Encrusting"	994 995 996 997