The Oligocene Corals Had Circumtropical Distribution



Patrali Sinha and Kalyan Halder

Abstract An analysis of the palaeobiogeographic distribution of the Oligocene corals of the world reveals strong specific endemism whereas large generic pandemism. Four palaeobiogeographic provinces are identified here based on this distribution: the Western Indian Province (WIP) represented by Kutch, the Mediterranean-Iranian Province (MIP) consisting of Greece, Italy and Iran, the Caribbean-Northern South American Province (CNSAP) composed of Antigua, Puerto Rico and Venezuela, and the Northwestern American Province (NAP) represented by the state of Washington, USA. Different basins within a province show some specific similarity whereas specific provincialism is nearly absolute. Genera show wide distribution—the WIP shows 82% similarity with the MIP and 36% with the CNSAP; the CNSAP has 69% similarity with the MIP. However, the NAP shows significant generic endemism. The tropical affinity, and wide and rapid dispersability of the Oligocene corals are evident from this distribution pattern. Dispersal beyond tropics was apparently limited. This explains the relatively higher endemism of the NAP. Generic exchange between the WIP and the MIP, both belonging to the Tethys Realm, has been known for gastropods. Affinity of these provinces with the CNSAP is worth noticing. This similarity reflects the presence of a trans-Atlantic current during the Oligocene. The circumtropical distribution of the coral genera also evinces protracted planktotrophic larval ontogeny. However, endemism in the species level indicates rapid evolution. This distribution pattern having tropical yet wide longitudinal extent of genera and provincialism of species resembles the present day distribution of corals. It reflects that the scleractinian coral biology had already attained modern aspects in the Oligocene.

Keywords Coral \cdot Oligocene \cdot Kutch \cdot Palaeobiogeography \cdot Tethys \cdot Tropic

P. Sinha · K. Halder (⊠)

Department of Geology, Presidency University, 86/1, College Street, 700073 Kolkata, India e-mail: kalyan.geol@presiuniv.ac.in

P. Sinha e-mail: patralisinha.geol@gmail.com

[©] Springer International Publishing AG, part of Springer Nature 2018

S. Bajpai et al. (eds.), *The Indian Paleogene*, Society of Earth Scientists Series, https://doi.org/10.1007/978-3-319-77443-5_12

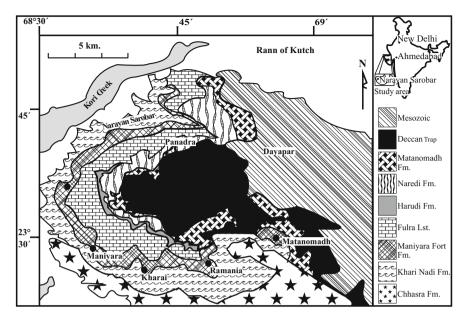


Fig. 1 Geological map of the Cenozoic of Kutch with coral collection sites marked by solid black circles

Introduction

The Oligocene marine sedimentary deposits of Kutch, Gujarat are known to house a diverse coral fauna (Biswas 1992). However, the composition of this fauna largely remains unknown to the palaeontological fraternity till date. We intend to make a rigorous systematic study of this coral fauna. Towards this goal we have collected corals from five localities that are dispersed along the entire transect of a narrow arcuate exposure of the Oligocene rocks at Kutch (Fig. 1).

The systematic study of our collection from one of the localities, which is exposed near village Ramania, has so far been completed. It has been observed during this study that almost all the species from Kutch are new whereas nearly all the genera to which they belong were reported from other parts of the world. The genera are known mainly from the Middle-East, southern European countries and the Caribbean archipelago. This strong specific endemism and large generic pandemism of the Kutch fauna prompted us to analyse global distribution patterns of the Oligocene reef corals. We would like to see through this analysis:

- (1) whether this pattern of specific endemism and generic pandemism is true for other contemporaneous coral faunas from different areas of the world,
- (2) if formal palaeobiogeographic units can be erected based on coral faunas, and
- (3) if the units can be compared to the existing palaeobiogeographic units, mainly based on molluses.

Name of the Area	No. of species	No. of genera
Kutch	24	11
Iran	61	38
Greece	38	27
Italy	20	18
Antigua	45	26
Venezuela	32	18
Puerto Rico	25	13
Washington	46	35
California	14	7

 Table 1
 Geographic areas from where taxonomic data have been gathered along with number of species and genus known from each

Further, we intend to investigate the factors that were responsible for the development of paleobiogeographic distribution patterns of the Oligocene corals and possible routes and mechanism of their dispersal.

Materials and Methods

The Oligocene deposits of Kutch are included in the Maniyara Fort Formation (Biswas 1992). It is composed of claystone, foraminiferal limestone and thick coral biostrome. This formation is underlain by a thick foraminiferal limestone formation (Fulra Limestone) and overlain by the Khari Nadi Formation, which is composed of shale, siltstone and sandstone. The rocks of the Maniyara Fort Formation outcrop in a nearly continuous arc, roughly paralleling the present day coastline (Fig. 1).

Our systematic study revealed that the coral fauna from Ramania (Fig. 1) is constituted of 24 species belonging to 11 genera. We have gathered systematic and geographic information of the Oligocene corals from some major publications pertaining to different areas of the world. The sources of information used in this study are: Vaughan (1900), Durham (1942), Geister and Ungaro (1977), Schuster and Wielandt (1999), Budd (2000), Schuster (2002), Kolodziej and Marcopoulou-Diacantoni (2003), Johnson (2007), Johnson et al. (2009), Champagne (2010) and López-Pérez (2012).

The areas for which taxonomic data could be gathered are Iran, Italy, Greece, USA, Puerto Rico, Antigua and Venezuela (Table 1). All the data were analysed in specific and generic levels to see the degree of compositional similarities between different geographic areas (Tables 2, 3 and 4). The data were plotted in palaeogeographic maps of Smith et al. (1994) (Figs. 2 and 3). Formal palaeobiogeographic units are erected based on the global distribution of corals.

	Iran	Greece	Italy	Antigua		Venezuela Puerto Rico Kutch	Kutch	Washington California	California
Iran	61	11	4	1	0	m	2	1	0
Greece		38	7	0	0	S	1	1	0
Italy			20	0	0	e	0	0	-
Antigua				45	17	5	0	0	0
Venezuela					32	6	0	0	0
Puerto Rico						25	0	e	0
Kutch							24	0	0
Washington								46	
California									14

	rix showing specific similarities among different geographic areas
	ong different
• • •	arities am
:	Simil
	specific
	showing
•	matrix
	Similarity matr
	able 2

	California	1	1	1	2	2	2	1	6	7
	Washington California	10	5	4	9	8	9	1	35	
		7	3	8	4	ю	2	11		
	Puerto Rico	12	6	6	12	10	13			
aphic areas	Antigua Venezuela Puerto Rico Kutch	13	6	6	16	18				
different geogra	Antigua	19	14	11	26					
Table 3 Similarity matrix showing generic similarities among different geographic areas	Italy	12	11	18						
ving generic sin	Greece	19	27							
rrity matrix shov	Iran	38								
Table 3 Simil		Iran	Greece	Italy	Antigua	Venezuela	Puerto Rico	Kutch	Washington	California

nt geographic areas
different geo
s among
aritie
wing generic simil
showing
y matrix
Similarit
able 3

	Western	Mediterranean-	Caribbean	Northwestern	California
	Indian	Iranian	Northern	American	
	Province	Province	South	Province	
	(WIP)	(MIP)	American	(NAP)	
			Province (CNSAP)		
WIP	24/11	2/9	0/4	0/1	0/1
MIP		98/49	8/20	1/11	1/2
CNSAP			76/29	3/9	0/3
NAP				46/35	1/6
California					14/7

 Table 4
 Similarity matrix showing specific/generic similarities among different provinces

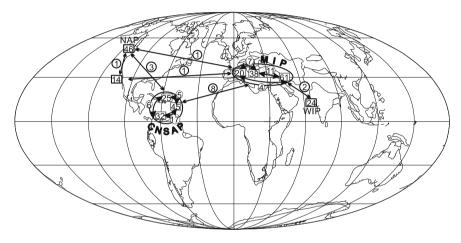


Fig. 2 Global distribution of coral species. Intra- and inter-provincial similarity in number of species are shown

Results and Discussion

Species Level Analysis

- 1. Twenty Four species have been identified from the locality of Ramania, Kutch, of which only 2 are already known—*Astrocoenia nana* Reuss, 1868 from Greece and Iran, and *Astrocoenia* cf. *bistellata* (Catullo, 1856) from Iran. The rest are new species (Table 2).
- 2. Data on the global distribution of coral species reveal high degree of similarity among faunas from Italy, Iran and Greece (Table 2; Fig. 2).
- 3. Substantial similarity also characterises the distribution of corals among Antigua, Venezuela and Puerto Rico, the three localities bordering the Caribbean Sea for which we could gather data (Table 2; Fig. 2). Puerto Rico shares some similarity

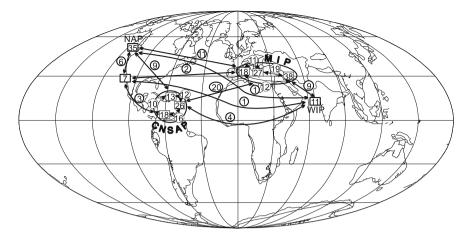


Fig. 3 Global distribution of coral genera. Intra- and inter-provincial similarity in number of genera are shown

with the areas of Europe and Middle East to which Antigua and Venezuela share almost nothing.

- 4. The state of Washington, USA is the only other area from where substantial number of Oligocene corals are known, almost all of which are endemic (Table 2; Fig. 2).
- The Oligocene corals are also known from a more tropical part of USA, i.e. California. Only 14 species are known, which also show strong endemism (Table 2; Fig. 2).

Strong specific endemism of the Oligocene corals from Kutch necessitates establishment of a palaeobiogeographic province. The Western Indian Province (WIP) was erected by Harzhauser (2007) based mainly on the Oligocene gastropods from Pakistan. Harzhauser et al. (2009) included the Oligocene gastropods from Kutch in this province based on faunal similarity. Contemporaneous mollusc faunas from Kutch and other adjoining areas of western India have long been known to bear strong similarity with the Pakistan fauna (Sowerby 1840; D'Archiac and Haime 1854; Vredenburg 1925, 1928) and were always considered together with the latter. Corals are not known from the Oligocene deposits of Pakistan. Here we designate the Oligocene corals from Kutch to the same palaeobiogeographic unit, i.e. the WIP in order to avoid multiplication of similar unit names.

Large sharing of species between Iran, Greece and Italy evinces close biogeographic relationship. Italy shares 35% of its coral species with Greece and Greece shares about 29% with Iran. This pattern of specific similarity of the coral faunas correspond to that of the Oligocene gastropods. Harzhauser et al. (2002) erected the Mediterranean Iranian Province (MIP) to include basins of northern Italy, Greece and central Iran based on the specific similarity of Oligocene gastropods. Here, we upheld the same province name for contemporaneous coral faunas. Significant specific similarity exists among Antigua, Venezuela and Puerto Rico. Puerto Rico shares 20% and 24% of its species with Antigua and Venezuela respectively. About 53% of Venezuelan coral species are also known from Antigua. We erect here the Caribbean-Northern South American Province (CNSAP) to include these three areas based on similarity of the Oligocene coral faunas.

Very strong endemism of the coral fauna from Washington necessitates erection of a new faunal province. We christen this province as the Northwestern American Province (NAP). Strong endemism of the Californian fauna also suggests the presence of a separate biogeographic province. However, the information from this area is relatively poor and only 14 species are known. Hence, we refrain from establishing a formal biogeographic unit based on such poor data and refer to the Californian fauna informally.

Genus Level Analysis

- 1. The 24 species that we have so far identified from Kutch, western India belong to 11 genera. Most of the genera are known from Italy, Iran and Greece. The Kutch assemblage also shows some generic similarity to the faunas from Antigua, Venezuela and Puerto Rico (Table 3).
- Intraprovincial generic similarity among the basins is expectedly very high (about 70–90%) (Table 3). Interestingly, interprovincial generic similarity is also quite high. The CNSAP and the WIP share about 69% and 82% of their genera with the MIP respectively. The WIP bears about 36% generic similarity with the CNSAP (Table 4).
- 3. The NAP shows descent similarity with the MIP (about 31%) and the CNSAP (about 26%). It has only one common genus with the WIP (Table 4). Generic similarities among the CNSAP, the MIP and the WIP are, however, much higher.
- 4. Out of 7 genera that were recorded from California, 6 are also known from the NAP. California also shares about 43% of its genera with the CNSAP and about 29% with the MIP. One genus is common between California and Kutch.

The strong generic similarity between the WIP and the MIP parallels the trend shown by contemporaneous gastropod molluscs (Harzhauser et al. 2009). This trend reflects Tethyan heritage and indicates that considerable connectivity still existed between these provinces during the Oligocene. These provinces were included in the Western Tethys Region of the Tethys Realm based on benthic mollusc fauna (Harzhauser et al. 2002 and references therein).

The strong Tethyan affinity of the Oligocene coral fauna from the CNSAP is worth noticing. The relationship between the CNSAP and the Tethyan provinces, especially the MIP lying on the other shore of Atlantic, has never been adequately explored (see Harzhauser et al. 2002). Harzhauser et al. (2002) showed significant commonness in the gastropod composition of the Caribbean and adjacent tropical areas with that of the MIP. Hence, the CNSAP should be considered as the western fringe of the Tethys Realm.

The Washington coral fauna appears to be unique in composition. It shares relatively less with any of the other provinces. The California fauna, which shares majority of its genera with the NAP, has little in common with the latter when specific composition is considered. The uniqueness of the NAP calls for its inclusion in a different region or even realm. The question of affinity of the California fauna remains unresolved because of the relatively poor nature of information. Unfortunately, we could not access information on the faunas from Indo-Pacific basins like Java and Borneo (Gerth 1921, 1923, 1925). This information can be crucial in delineating palaeobiogeographic relationship of the NAP and deciphering possible routes of dispersal of its constituent corals.

Remarks

The Oligocene coral species are seldom found beyond province boundaries. Most of them are also often endemic to a single basin. In contrast, majority of the genera appear to migrate great distances beyond province territories, often even crossing significant geographic barriers. This strong specific endemism and large generic pandemism indicate wide migration followed by rapid allopatric speciation.

The global distribution of the Oligocene corals clearly shows wide longitudinal vis-a-vis relatively restricted latitudinal occurrence mainly within palaeo-tropics and subtropics. Present day reef corals are known to be strongly sensitive to climatic factors and restricted to the tropical zone. Apparently, this attribute was already acquired by the Oligocene corals. The diverse coral fauna from Washington, USA, which flourished in higher latitudes, however is an exception. Presence of corals there perhaps indicates that the prevailing climate of the Oligocene was warmer and more equable than the present day. Palaeo-temperature data suggests the same (Hansen et al. 2013). However, the unique nature of the composition of the Washington fauna with large specific as well as generic endemism indicates the presence of a strong climatic barrier to the dispersal of the tropical corals to higher latitudes. Only more cold-tolerant genera could permeate into the higher latitudes and survive.

The presence of a seaway connection and regular migration between the WIP and the MIP during the Paleogene has been known for a long time in relation to the molluscs (Eames 1951, 1952; Iqbal 1969a, b, 1972; Halder 2012; Halder and Sinha 2014; Halder and Bano 2015; Harzhauser et al. 2002, 2009). The migration took place through the relict Tethys seaway. It may be pointed out that many early Paleogene molluscs of western India appear in younger strata of the Mediterranean Europe. However, Iqbal (1969a, b) declined to consider a westward migration of the fauna in the absence of more definitive evidences. Harzhauser et al. (2002) demonstrated the presence of an easterly surface current in the Tethys that bathed the western shores of the Indian Peninsula during the Paleogene (see also Popov 1993). The

information analysed in the present study is not adequate for the reconstruction of possible direction of migration of the coral fauna between the WIP and the MIP.

The presence of a coral fauna in the Western Atlantic CNSAP, similar to that of the MIP and the WIP, indicates an extension of the Tethyan faunal influence across the Atlantic Ocean and hence, the presence of a trans-Atlantic current system. The direction of migration, again, cannot be inferred from the present dataset. An analysis of the information on the contemporaneous gastropods also could not conclusively reveal the migration direction. However, a westward current from the MIP to the CNSAP appears to be the stronger possibility in terms of the gastropod distribution (Harzhauser et al. 2002). The relatively lower similarity between the WIP and the CNSAP may be attributed to the large geographic distance between these provinces and the relatively weak present state of the knowledge on the western Indian fauna.

It is more difficult to understand the relationship of the Pacific coastal basins of the USA with other provinces in the absence of data from other Pacific basins. California, however, having about 43% generic similarity with the CNSAP perhaps got its coral fauna from the latter. Presumably, this migration had taken place through the connection that existed at that time between the Caribbean Sea and the Pacific Ocean. The Isthmus of Panama severed this tie later. Washington, in spite of its unique faunal composition, might have got early settlers from California. Relatively cold-tolerant forms from the latter area perhaps migrated to Washington and flourished there in a relatively unusual setting as opportunist taxa. Data from the western Pacific archipelago is required to assess if and to what extent faunal similarity existed between the two shores of the Pacific. However, a migration route across the huge Pacific Ocean is difficult to perceive in the absence of hopping sites.

Conclusion

The global distribution of the Oligocene coral faunas indicates an almost circumtropical occurrence in nearly all coastal basins including the western Pacific. Significant absence of corals was from the tropical African countries. Whether it was real or reflects lack of study is not known. The distribution shows very strong Tethyan affinity of most of the provinces—including that on the western shore of the Atlantic and even the tropical eastern Pacific—elucidating a trans-Atlantic surface current and possible passage through the sea between the two American continents. However, strong endemism of the coral species to the provinces and even to the basins reflects rapid speciation was operative in allopatry.

It is interesting to note that several of the Oligocene coral genera are still extant. The Oligocene corals had a climate controlled distribution mainly in the tropical and the subtropical areas. They were generally associated with fairly shallow water shelf sediments (Bosellini 1998). They also had longitudinally wide geographic distribution. All these features correspond to the distribution of the present day reef corals (Veron 2016). Shallow water occurrence of the present day corals in the tropical zone is known to be controlled by the symbiotic association with photosynthetic

organisms. Protracted planktotrophic larval ontogeny of majority of the reef corals is responsible for their wide geographic distribution (Veron 2013). Apparently, these modern aspects of the coral biology had been attained by the reef corals already during the Oligocene.

Acknowledgements Tahthagata Roy Choudhury helped in drawing. KH got financial support from the Department of Science and Technology, India (Project No. SR/S4/ES-653/2012).

Appendix 1

			MIP			CNSAP		WIP		NAP
Sl. no.	Species name	Greece	Italy	Iran	Antigua	Venezuela	Puerto Rico	Kutch	California	Washington
1	Astrocoenia nana	V		V				√		
2	Astrocoenia cf. bistellata			V				V		
3	Astrocoenia cf. zitteli			\checkmark						
4	Astrocoenia portoricensis				V	~				
5	Astrocoenia guantanamensis				V	~				
6	Astrocoenia sp. B				V					
7	Agathiphyllia sp. 1			V						
8	Agathiphyllia sp.2			~						
9	Agathiphyllia gregaria	V	V				V			
	Agathiphyllia tenuis				V	V	V			
	Agathiphyllia hilli				V		V			
12	Agathiphyllia browni				V					
13	Agathiphyllia splendens				V					
	Agathiphyllia antiguensis					V	V			
	Agathiphyllia anguillensis						V			
	Agathiphyllia bosniaca						V			
	Agathiphyllia robusta						V			
	Agathiphyllia sp. 3				V					
	Antiguastrea cellulosa				V	V	V			
	Antiguastrea elegans						V			
21	Antiguastrea alveolaris						Ń			
22	Antiguastrea sp.			V						
23	Antiguastrea lucasiana	V	V							
24	Actinacis rollei		Ń	V						
	Actinacis sp. A				V					
	Astreopora stellaris			V						
27	Astreopora meneghiniana	V		V						
28	Astreopora tecta	· · ·	V							
29	Astreopora decaphyllia	V								
	Astreopora antiguensis				V					
31	Astreopora goethalsi				,	V				
	Alveopora sp.			1		,	V			
	Alveopora? sp.			V			,			
34	Alveopora tampae			· ·	V	V				
	Alveopora sp. A				V	,				
	Alveopora rudis		V							
	Astrangia persica			V						
38	Acanthastrea sp.			V						
39	Asterosmilia sp.			V						
	Acropora saludensis			, ,	7	V				

Global distribution of Coral species reported from different basins/provinces of the Oligocene Global distribution of Coral species reported from different basins/provinces of the Oligocene

41 Acrogrom sp. A V V V 43 Colophylik expectation V V V 44 Colophylik expectation V V V 45 Colophylik expectation V V V 46 Colophylik expectation V V V 47 Calustrate spendplatellum V V V 48 Calustrate spendplatellum V V V 49 Calustrate spendplatellum V V V 50 Calustrate spendplatellum V V V 51 Calustrate portoricon's pectation V V V 52 Cardioxetis pectation V V V V 53 Cardioxetis pectation V V V V V 54 Cardioxetis annalus V V V V V V 55 Ceretoricolus (constructure) pp. V V V V V V V V V V V V							,			
43 Colognothia enzionica 4 4 45 Colognothia macandraoides 4 4 46 Colognothia macandraoides 4 4 47 Calutarrea grandofabellim 4 4 47 Calutarrea grandofabellim 4 4 48 Calutarrea grandofabellim 4 4 49 Calutarrea grandofabellim 4 4 40 Calutarrea grandofabellim 4 4 50 Calutarrea grandofabellim 4 4 51 Calutarrea promoteensis 4 4 52 Calutarrea promoteensis 4 4 52 Calutarrea promoteensis 4 4 54 Calutarrea promoteensis 4 4 55 Cericonalis Canotonchas yp. 4 4 56 Cericocatus canutalitas 4 4 57 Cericonalis ranica 4 4 58 Cerephyllia renuis 4 4 50 Diplocatrea costata 4 4 51 Diplocatrea	41	Acropora sp. A					V	-		8
44 Cologitalia magnificadis \vee \vee \vee 45 Cologitalia magnificadio \vee \vee \vee 46 Calubsree preside/lubellion \vee \vee \vee 47 Calubsree preside/lubellion \vee \vee \vee 48 Calubsree farsis \vee \vee \vee 50 Calubsree farsis \vee \vee \vee 51 Calubsree fashier \vee \vee \vee 52 Calubsree fashier \vee \vee \vee 53 Cyalhoserts of appointensis \vee \vee \vee 54 Cardioverts s. \vee \vee \vee 55 Ceratoinochus (Controchus) sp. \vee \vee \vee 57 Ceriosmilia tranica \vee \vee \vee 58 Cereforbilia tranica \vee \vee \vee 59 Diploastrae constat \vee \vee \vee 61 Diploastrae onsatifa \vee \vee \vee 62 Diploastrae sp. <t< td=""><td></td><td></td><td>√</td><td>V</td><td></td><td></td><td></td><td></td><td></td><td></td></t<>			√	V						
45 Colognative and models $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 47 Cadastree presiduatellam $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 48 Cadastree presiduatellam $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 49 Cadastree presiduatellam $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 49 Cadastree presiduatellaw $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 50 Cadastree presiduatellaw $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 51 Cadastree providentis $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 52 Cadastree cadastree formits $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 53 Carboneris Lagnemina $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 54 Cadastree acastree formits $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 55 Cercinstruits anniatus $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 56 Cercinstruits constat $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 57 Cercinstruits constat $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 58 Cerciphyllia renuits $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ $\sqrt{1}$ 50 <td>43</td> <td>Colpophyllia eocaenica</td> <td></td> <td></td> <td>\checkmark</td> <td></td> <td></td> <td></td> <td></td> <td></td>	43	Colpophyllia eocaenica			\checkmark					
46 Colognitic withoughlensis $\sqrt{4}$ $\sqrt{4}$ 47 Caulastrea preseludibalium $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 48 Caulastrea preseludibalium $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 50 Caulastrea printi $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 51 Caulastrea fusitieti $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 52 Caulastrea fusitieti $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 52 Caulastrea fusitieti $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 53 Caulastrea fusitieti $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 54 Caulastrea fusitieti $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 55 Certosoniku samulatus $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 56 Crécosoniku transica $\sqrt{4}$	- 44	Colpophyllia longicollis			\checkmark					
46 Cologophyllia willoughiensis \checkmark \checkmark \checkmark 47 Caulastrea spead/dubellum \checkmark \checkmark \checkmark 48 Caulastrea prevad/dubellum \checkmark \checkmark \checkmark 50 Caulastrea fusitiet \checkmark \checkmark \checkmark \checkmark 51 Caulastrea perotricensis \checkmark \checkmark \checkmark \checkmark 52 Caulastrea perotricensis \checkmark \checkmark \checkmark \checkmark 52 Caulastrea perotricensis \checkmark \checkmark \checkmark \checkmark 53 Catabastreis Appentituitu antica \checkmark \checkmark \checkmark \checkmark 54 Certicontilia transica \checkmark \checkmark \checkmark \checkmark 56 Cercicontilia transica \checkmark \checkmark \checkmark \checkmark 57 Cercicontilia transica \checkmark \checkmark \checkmark \checkmark \checkmark 57 Diploastrea constatu \checkmark \checkmark \checkmark \checkmark \checkmark 58 Diploastrea angenitia \checkmark \checkmark \checkmark \checkmark \checkmark 50 Diploastre	45	Colpophyllia maeandrinoides	V							
47 Caulastrae generalization N N N 48 Caulastrae generalization N N N 49 Caulastrae generalization N N N 51 Caulastrae generalization N N N N 52 Caulastrae generalization N N N N N 52 Caulastrae generalization N N N N N N 53 Caulastrae constant N <	46					V	V			
48 Caulastra q_{s} , q_{s} \sqrt{q} \sqrt{q} 49 Caulastrace positivities \sqrt{q} \sqrt{q} 51 Caulastrace positivities \sqrt{q} \sqrt{q} 52 Cythoseris q_{s} , q_{s} \sqrt{q} \sqrt{q} 53 Cythoseris q_{s} , q_{s} \sqrt{q} \sqrt{q} 55 Ceratotrochus Comorochus) q_{s} \sqrt{q} \sqrt{q} 55 Cericovitika camulatus \sqrt{q} \sqrt{q} 56 Cricovitika camulatus \sqrt{q} \sqrt{q} 57 Cerisonitika tranica \sqrt{q} \sqrt{q} 58 Cereiphylite truits \sqrt{q} \sqrt{q} 59 Diploastrea magnifica \sqrt{q} \sqrt{q} 61 Diploastrea magnifica \sqrt{q} \sqrt{q} 63 Diploastrea magnifica \sqrt{q} \sqrt{q} 64 Diploastrea magnifica \sqrt{q} \sqrt{q} 65 Diploastrea magnifica \sqrt{q} \sqrt{q} 66 Diploastrea magnifica \sqrt{q} \sqrt{q} 71 Favites positica sp. \sqrt{q} \sqrt{q} <			V							
49 Caulastrace funite: 4 4 50 Caulastrace portoricensis 4 4 51 Caulastrace portoricensis 4 4 52 Caulastrace portoricensis 4 4 51 Caulastrace portoricensis 4 4 52 Caulastrace portoricensis 4 4 53 Caulastrace classical states 4 4 54 Cytahoseris by portoricensis 4 4 55 Cericoxultus comutations 4 4 56 Cericoxultus consultas 4 4 57 Cericoxultus consultas 4 4 58 Cereiphyllia tenuits 4 4 50 Diploostrae consulta 4 4 60 Diploostrae magnifica 4 4 61 Diploostrae nucleani 4 4 62 Diploostrae magnifica 4 4 63 Eaphylitic cilculata 4 4 64 Diploostrae magnifica 4 4				<u> </u>				1	-	
50 Caulastrea portricensis V V V 51 Caulasteris poperateriformis V V V 52 Caulasteris spoperateriformis V V V 53 Caulasteris spoperateriformis V V V 54 Centorochus spoperateriformis V V V 55 Cerciostillia transica V V V 56 Cerciostillia transica V V V 57 Certostillia transica V V V 58 Cerciptivillia transica V V V 59 Diploastrea costata V V V 61 Diploastrea og. T V V V 62 Diploastrea og. T V V V 63 Diploastrea og. T V V V 64 Diploastrea og. T V V V 65 Diploastrea og. T V V V 71 Favites ophysmalts V V V 72			v	<u> </u>	1				-	
1 Caulastrace portrolensis \vee \vee 52 Caulasteris op. \vee \vee 53 Cyathoseris st. appennina \vee \vee 54 Cyathoseris stripocrateriformis \vee \vee 55 Certoinvalls Controlvens) sp. \vee \vee 56 Certoinvalls trainica \vee \vee 57 Cerisonilli rainica \vee \vee 58 Cereiphyllia tenuis \vee \vee 59 Diploastrea constata \vee \vee 60 Diploastrea constata \vee \vee 61 Diploastrea constata \vee \vee 62 Diploastrea magnifica \vee \vee 63 Diploastrea sp. \vee \vee 64 Diploastrea sp. \vee \vee 65 Diploastrea sp. \vee \vee 66 Diploastrea sp. \vee \vee 71 Favites insignis \vee \vee 72 Favites insignis \vee \vee 73 Fav					v					
15 Cynthoseris d. appendix $\sqrt{4}$ $\sqrt{4}$ $\sqrt{5}$ 15 Cynthoseris d. appendix $\sqrt{4}$ $\sqrt{5}$ 15 Certatorichus (Constructus) sp. $\sqrt{4}$ $\sqrt{4}$ 16 Circiowidus annulatus $\sqrt{4}$ $\sqrt{4}$ 17 Certosmilia traitica $\sqrt{4}$ $\sqrt{4}$ 18 Cerciptivilia traitis $\sqrt{4}$ $\sqrt{4}$ 19 Diplosstrea consulta $\sqrt{4}$ $\sqrt{4}$ 10 Diplosstrea consulta $\sqrt{4}$ $\sqrt{4}$ 11 Diplosstrea consulta $\sqrt{4}$ $\sqrt{4}$ 12 Diplosstrea magnifica $\sqrt{4}$ $\sqrt{4}$ 13 Diplostrea sg. $\sqrt{4}$ $\sqrt{4}$ 14 $\sqrt{4}$ $\sqrt{4}$ $\sqrt{4}$ 15 Diplostra sg. $\sqrt{4}$ $\sqrt{4}$ 16 Diplostra sg. $\sqrt{4}$ $\sqrt{4}$ 16 Diplostra sg. $\sqrt{4}$ $\sqrt{4}$ 16 Diplostra sg. $\sqrt{4}$ $\sqrt{4}$ 17 Favice splostra sg. $\sqrt{4}$ $\sqrt{4}$ 17 Favice splogen			-	N N	-	1				
53 Cvaluscris to Appendixation V V V 54 Cvaluscris to Spontonchus 3p. V V 55 Certacovalus aunualuus V V 56 Cercionita iranica V V 58 Cercionita iranica V V 58 Cercionita iranica V V 59 Diploastrea consulta V V 60 Diploastrea consulta V V 61 Diploastrea consulta V V 62 Diploastrea gp. T V V 63 Diploastrea gp. T V V 64 Diploastrea gp. T V V 65 Diploastrea gp. T V V 66 Diploria sp. V V 67 Diploastrea sp. T V V 68 Exp(N)Uicalucitata V V 71 Favites nisguits V V 72 Favites ninguits V V 73 Favites ninguits V V 74 </td <td></td> <td></td> <td></td> <td></td> <td>-</td> <td>Ŷ</td> <td></td> <td></td> <td></td> <td></td>					-	Ŷ				
54 Cyuhoseris hypocrateriformis \vee \vee 55 Ceratotrochus Genotrochus yp. \vee \vee 56 Cricocyuhis samulatus \vee \vee 57 Ceriosmilia iranica \vee \vee 58 Ceriofilia tranis \vee \vee 59 Diplostrea constat \vee \vee 60 Diplostrea constat \vee \vee 61 Diplostrea constat \vee \vee 62 Diplostrea magnifica \vee \vee 63 Diplostrea nugerni \vee \vee 64 Diplostrea nugerni \vee \vee 65 Diploria sp. \checkmark \vee 66 Diploria sp. \checkmark \vee 70 Favites of, inacquiseptata \vee \vee 71 Favites of, inacquiseptata \vee \vee 72 Favites of, inacquiseptata \vee \vee 73 Favites onigue \vee \vee 74 Favites onigue \vee \vee 75 Favi				N	-					
55 Creator Declars (Constructuus) sp. 4 4 56 Cricocculus smultuus 4 4 57 Cerioshilla irunica 4 4 58 Cereiphyllia tenuis 4 4 59 Diploastrea consulta 4 4 60 Diploastrea consulta 4 4 61 Diploastrea magnifica 4 4 62 Diploastrea magnifica 4 4 63 Diploastrea gp. 4 4 64 Diploastrea gp. 4 4 65 Diploastrea gp. 4 4 66 Eurlynic antiguespita 4 4 70 Favites chanequiceptata 4 4 71 Favites chanequiceptata 4 4 72 Favites constraint 4 4 73 Favites constraint 4 4 74 Favites constraint 4 4 75 Favites constraint 4 4 76										
56 Cricocyathus consultants $\sqrt{4}$ $\sqrt{4}$ 57 Ceriosmitia tranica $\sqrt{4}$ $\sqrt{4}$ 58 Cereiphvilla tenuits $\sqrt{4}$ $\sqrt{4}$ 59 Diplosstrea consulta $\sqrt{4}$ $\sqrt{4}$ 60 Diplosstrea consultantia $\sqrt{4}$ $\sqrt{4}$ 61 Diplosstrea magnifica $\sqrt{4}$ $\sqrt{4}$ 62 Diplosstrea sp. $\sqrt{4}$ $\sqrt{4}$ 64 Diplosstrea sp. $\sqrt{4}$ $\sqrt{4}$ 65 Diplostrea sp. $\sqrt{4}$ $\sqrt{4}$ 66 Diplostrea sp. $\sqrt{4}$ $\sqrt{4}$ 70 Faultes nigonis $\sqrt{4}$ $\sqrt{4}$ 71 Faultes miscocityx $\sqrt{4}$ $\sqrt{4}$ 72 Faultes oblycocita $\sqrt{4}$ $\sqrt{4}$ 73 Faultes oblycocita $\sqrt{4}$ $\sqrt{4}$ 74 Faultes oblycocita $\sqrt{4}$ $\sqrt{4}$ 75 Faultes oblycocita $\sqrt{4}$ $\sqrt{4}$ 76 Faultys oblycontalis $\sqrt{4}$ $\sqrt{4}$ 77 Faultes minerocityx			√							
57 Ceriasmilia iranica $\sqrt{1}$ $\sqrt{1}$ 58 Cereiphyllia tenuis $\sqrt{1}$ $\sqrt{1}$ 60 Diploastrea coronata $\sqrt{1}$ $\sqrt{1}$ 61 Diploastrea coronata $\sqrt{1}$ $\sqrt{1}$ 62 Diploastrea magenii $\sqrt{1}$ $\sqrt{1}$ 63 Diploastrea angenii $\sqrt{1}$ $\sqrt{1}$ 64 Diploastrea sp. T $\sqrt{1}$ $\sqrt{1}$ 65 Diploria anguensis $\sqrt{1}$ $\sqrt{1}$ 66 Diploria sp. $\sqrt{1}$ $\sqrt{1}$ 67 Diploria sp. $\sqrt{1}$ $\sqrt{1}$ 68 Euphyllia caliculata $\sqrt{1}$ $\sqrt{1}$ 70 Fovites of inacquisepitata $\sqrt{1}$ $\sqrt{1}$ 71 Favites anoreculyx $\sqrt{1}$ $\sqrt{1}$ 72 Favites soligocenia $\sqrt{1}$ $\sqrt{1}$ 73 Favites soligocenia $\sqrt{1}$ $\sqrt{1}$ 74 Favites andigua $\sqrt{1}$ $\sqrt{1}$ 75 Fovites soligocenia $\sqrt{1}$ $\sqrt{1}$ 76 Favites andigua $\sqrt{1}$	55	Ceratotrochus (Conotrochus) sp.								
S8 Coreighyllia tenuis \checkmark \checkmark 59 Diploastrea contata \checkmark \checkmark 60 Diploastrea costala \checkmark \checkmark 61 Diploastrea costala \checkmark \checkmark 62 Diploastrea sp. \checkmark \checkmark 63 Diploastrea sp. \checkmark \checkmark 64 Diploastrea sp. \checkmark \checkmark 65 Diploastrea sp. \checkmark \checkmark 66 Diploastrea sp. \checkmark \checkmark 67 Favites insignis \checkmark \checkmark 78 Favites of inacquiseptata \checkmark \checkmark 71 Favites insignis \checkmark \checkmark 72 Favites oilgocenia \checkmark \checkmark 73 Favites sploata \checkmark \checkmark 74 Favites sploata \checkmark \checkmark 75 Favites sp. \checkmark \checkmark 76 Favites sp. \checkmark \checkmark 77 Favites sp. \checkmark \checkmark 76 Favites sp. \checkmark \checkmark	56	Cricocyathus annulatus								
59 Diplositive constat \checkmark \checkmark 60 Diplositive constant \checkmark \checkmark 61 Diplositive constant \checkmark \checkmark 62 Diplositive angenifica \checkmark \checkmark \checkmark 63 Diplositive angenifica \checkmark \checkmark \checkmark 64 Diplositive angeni \checkmark \checkmark \checkmark 65 Diplori angiuensis \checkmark \checkmark \checkmark 66 Diplori angiuensis \checkmark \checkmark \checkmark 67 Diplori angiuensis \checkmark \checkmark \checkmark 68 Explicit caliculata \checkmark \checkmark \checkmark 70 Favites noisquista \checkmark \checkmark \checkmark 71 Favites noisquista \checkmark \checkmark \checkmark 72 Favites noisquista \checkmark \checkmark \checkmark 73 Favites soligoenia \checkmark \checkmark \checkmark 74 Favites soligoenia \checkmark \checkmark \checkmark 75 Favites soligoenia \checkmark \checkmark \checkmark 76	57	Ceriosmilia iranica			\checkmark				1	
99 Diploastrea contata \checkmark \checkmark 60 Diploastrea costata \checkmark \checkmark \checkmark 61 Diploastrea crassolamellata \checkmark \checkmark \checkmark 62 Diploastrea magenii \checkmark \checkmark \checkmark 63 Diploastrea sp. T \checkmark \checkmark \checkmark 64 Diploastrea sp. T \checkmark \checkmark \checkmark 65 Diploastrea sp. T \checkmark \checkmark \checkmark 66 Diploria antiguensis \checkmark \checkmark \checkmark 67 Diploria sp. \checkmark \checkmark \checkmark 68 Exp/Nilk caliculata \checkmark \checkmark \checkmark 69 Favites nisginis \checkmark \checkmark \checkmark 71 Favites nolgocenia \checkmark \checkmark \checkmark 72 Favites nolgocenia \checkmark \checkmark \checkmark 73 Favites nolgocenia \checkmark \checkmark \checkmark 74 Favites nolgocenia \checkmark \checkmark \checkmark 75 Favites sp. \checkmark \checkmark \checkmark \checkmark <td>58</td> <td>Cereiphyllia tenuis</td> <td></td> <td>1</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>	58	Cereiphyllia tenuis		1						
60 Diplostrea crostata \checkmark \checkmark \checkmark 61 Diplostrea magnifica \checkmark \checkmark \checkmark 62 Diplostrea magnifica \checkmark \checkmark \checkmark 63 Diplostrea sp. \checkmark \checkmark \checkmark 64 Diplostrea sp. \checkmark \checkmark \checkmark 65 Diplostrea sp. \checkmark \checkmark \checkmark 66 Diplostrea sp. \checkmark \checkmark \checkmark 70 Favites singuisi \checkmark \checkmark \checkmark 71 Favites oligocenia \checkmark \checkmark \checkmark 72 Favites spolygonalis \checkmark \checkmark \checkmark 73 Favites oligocenia \checkmark \checkmark \checkmark 74 Favites sp. \checkmark \checkmark \checkmark 75 Favites sp. \checkmark \checkmark \checkmark 76 Fungophylia sp. A \checkmark \checkmark \checkmark 77 Favia sp. 1 \checkmark \checkmark \checkmark 76 Ganigoner sp. 2 \checkmark \checkmark \checkmark \checkmark			-		V					
61 Diploastrea crassolamellata $\sqrt{1}$ $\sqrt{1}$ 62 Diploastrea nugenti $\sqrt{1}$ $\sqrt{1}$ 63 Diploastrea nugenti $\sqrt{1}$ $\sqrt{1}$ 64 Diploastrea nugenti $\sqrt{1}$ $\sqrt{1}$ 65 Diploria aniguensis $\sqrt{1}$ $\sqrt{1}$ 66 Diploria aniguensis $\sqrt{1}$ $\sqrt{1}$ 67 Diploria sp. $\sqrt{1}$ $\sqrt{1}$ 68 Euphyllik caliculata $\sqrt{1}$ $\sqrt{1}$ 69 Favites cinacquiseptata $\sqrt{1}$ $\sqrt{1}$ 70 Favites nacrocalyx $\sqrt{1}$ $\sqrt{1}$ 71 Favites soligocenia $\sqrt{1}$ $\sqrt{1}$ 72 Favites soligocenia $\sqrt{1}$ $\sqrt{1}$ 73 Favites soligocenia $\sqrt{1}$ $\sqrt{1}$ 74 Favites soligocenia $\sqrt{1}$ $\sqrt{1}$ 75 Favites soligocenia $\sqrt{1}$ $\sqrt{1}$ 76 Faragophylia sp. A $\sqrt{1}$ $\sqrt{1}$ 77 Favites soligocen sp. A $\sqrt{1}$ $\sqrt{1}$ 78 Favites soligoce										
62 Diploastrea magnifica $\sqrt{1}$ $\sqrt{1}$ 63 Diploastrea sp. T $\sqrt{1}$ $\sqrt{1}$ 64 Diploastrea sp. T $\sqrt{1}$ $\sqrt{1}$ 65 Diplorita antiguensis $\sqrt{1}$ $\sqrt{1}$ 66 Diplorita antiguensis $\sqrt{1}$ $\sqrt{1}$ 67 Diplorita antiguensis $\sqrt{1}$ $\sqrt{1}$ 68 Euphyllita caliculata $\sqrt{1}$ $\sqrt{1}$ 70 Favites f.imaequiseptata $\sqrt{1}$ $\sqrt{1}$ 71 Favites collogoenia $\sqrt{1}$ $\sqrt{1}$ 72 Favites collogoenia $\sqrt{1}$ $\sqrt{1}$ 73 Favites spolyzonalis $\sqrt{1}$ $\sqrt{1}$ 74 Favites spolyzonalis $\sqrt{1}$ $\sqrt{1}$ 75 Favites sp $\sqrt{1}$ $\sqrt{1}$ 76 Favites sp $\sqrt{1}$ $\sqrt{1}$ 77 Favites sp $\sqrt{1}$ $\sqrt{1}$ 78 Favites sp $\sqrt{1}$ $\sqrt{1}$ 79 Gardinseries? sp $\sqrt{1}$ $\sqrt{1}$ 79 Gardinseries? sp					,	V	7			
63 Diploastrea angenti $\sqrt{1}$ $\sqrt{1}$ 64 Diploastrea sp. T $\sqrt{1}$ $\sqrt{1}$ 65 Diploastrea sp. $\sqrt{1}$ $\sqrt{1}$ 66 Diploria antiguensis $\sqrt{1}$ $\sqrt{1}$ 67 Diploria sp. $\sqrt{1}$ $\sqrt{1}$ 68 Euplyfila caliculata $\sqrt{1}$ $\sqrt{1}$ 69 Favites clinequisptata $\sqrt{1}$ $\sqrt{1}$ 70 Favites clinequisptata $\sqrt{1}$ $\sqrt{1}$ 71 Favites clinequisptata $\sqrt{1}$ $\sqrt{1}$ 72 Favites plogeonalis $\sqrt{1}$ $\sqrt{1}$ 73 Favites plogeonalis $\sqrt{1}$ $\sqrt{1}$ 74 Favites sp. $\sqrt{1}$ $\sqrt{1}$ 75 Favites sp. $\sqrt{1}$ $\sqrt{1}$ 76 Fungophyllia sp. A $\sqrt{1}$ $\sqrt{1}$ 77 Favites sp. $\sqrt{1}$ $\sqrt{1}$ 78 Favite sp. $\sqrt{1}$ $\sqrt{1}$ 79 Gardinoseries? gp. $\sqrt{1}$ $\sqrt{1}$ 80 Goniopora sp. 3 $\sqrt{1}$ $\sqrt{1}$ </td <td></td>										
64 Diploastrea sp. T \checkmark \checkmark 65 Diploria antiguensis \checkmark \checkmark 67 Diploria antiguensis \checkmark \checkmark 68 Euphyllia caliculata \checkmark \checkmark 68 Euphyllia caliculata \checkmark \checkmark 68 Favites insignis \checkmark \checkmark 70 Favites clinequiseptata \checkmark \checkmark 71 Favites oligocenia \checkmark \checkmark 72 Favites onigonalis \checkmark \checkmark 73 Favites sombigua \checkmark \checkmark 74 Favites sombigua \checkmark \checkmark 75 Favites sp. \checkmark \checkmark 76 Fangophyllia sp. A \checkmark \checkmark 77 Favia sp. 2 \checkmark \checkmark 78 favia sp. 4 \checkmark \checkmark 80 Goniopora cf. nodulosa \checkmark \checkmark 81 Goniopora sp. 3 \checkmark \checkmark 82 Goniopora sp. 4 \checkmark \checkmark 83 Goniopora sp. 4 \checkmark				-			v			0
65 Diplorita antiguensis $\sqrt{1}$ 66 Diploria antiguensis $\sqrt{1}$ 67 Diploria sp. $\sqrt{1}$ 68 Euphyllia caliculata $\sqrt{1}$ 69 Favites insignis $\sqrt{1}$ 70 Favites clinacquiseptata $\sqrt{1}$ 71 Favites coligocenia $\sqrt{1}$ 72 Favites coligocenia $\sqrt{1}$ 73 Favites polygonalis $\sqrt{1}$ 74 Favites songigua $\sqrt{1}$ 75 Favites sp. $\sqrt{1}$ 76 Fungophyllia sp. A $\sqrt{1}$ 77 Favites sp. $\sqrt{1}$ 78 Favita sp. 1 $\sqrt{1}$ 78 Favita sp. 1 $\sqrt{1}$ 79 Gardinoseries? sp. $\sqrt{1}$ 80 Goniopora sp. 2 $\sqrt{1}$ 81 Goniopora sp. 2 $\sqrt{1}$ 82 Goniopora sp. 4 $\sqrt{1}$ 83 Goniopora sp. 4 $\sqrt{1}$ 84 Goniopora sp. 4 $\sqrt{1}$ 85 Goniopora sp. 4 $\sqrt{1}$ 86 <td>_</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>-</td> <td></td>	_								-	
66 Diploria antiguensis \checkmark 67 Diploria sp. \checkmark 68 Euphyllia caliculata \checkmark 69 Favites insignis \checkmark 70 Favites insignis \checkmark 71 Favites macrocalyx \checkmark 72 Favites macrocalyx \checkmark 73 Favites molecocalyx \checkmark 74 Favites annigua \checkmark 75 Favites sp. \checkmark 76 Fungophyllia sp. A \checkmark 77 Favitas sp. \checkmark 78 Favitas sp. \checkmark 79 Gardinoscries? sp. \checkmark 80 Goniopora sp. \checkmark 81 Goniopora sp. \checkmark 82 Goniopora sp. \checkmark 83 Goniopora sp. \checkmark 84 Goniopora sp. \checkmark 85 Goniopora rulis \checkmark 86 Goniopora rulis \checkmark 87 Galacas ap. \checkmark 88 Goniopora rulis \checkmark 89			-			N			-	
67 Diploria sp. \checkmark 68 Euphyllia caliculata \checkmark 69 Favites insignis \checkmark 70 Favites cf.inaequiseptata \checkmark 71 Favites oligocenia \checkmark 72 Favites oligocenia \checkmark 73 Favites polygonalis \checkmark 74 Favites sp. \checkmark 75 Favites sp. \checkmark 76 Fungophyllia sp. A \checkmark 77 Favites sp. \checkmark 78 favits sp. \checkmark 79 Gardinoseries? sp. \checkmark 80 Goniopora sp. \checkmark 81 Goniopora sp. \checkmark 82 Goniopora sp. 2 \checkmark 83 Goniopora sp. 4 \checkmark 84 Goniopora sp. 4 \checkmark 85 Goniopora sp. 4 \checkmark 86 Goniopora sp. 4 \checkmark 91 Hydnophora cl. nuclis \checkmark 92 Hydnophora sp. \checkmark 93 Hydnophora sp. \checkmark 9	65	Diploastrea sp.		-	· · · ·		N	-		
68 Exphyllic caliculata \checkmark \checkmark 69 Favites insignis \checkmark \checkmark 71 Favites insignis \checkmark \checkmark 72 Favites oligocenia \checkmark \checkmark 73 Favites oligocenia \checkmark \checkmark 73 Favites obligocenia \checkmark \checkmark 73 Favites obligocenia \checkmark \checkmark 74 Favites spolygonalis \checkmark \checkmark 75 Favites spolygonalis \checkmark \checkmark 76 Fungophyllic sp. A \checkmark \checkmark 77 Favita sp. 1 \checkmark \checkmark \checkmark 79 Gardinoscries? sp. \checkmark \checkmark \checkmark 80 Goniopora sp. 2 \checkmark \checkmark \checkmark 81 Goniopora sp. 3 \checkmark \checkmark \checkmark 82 Goniopora sp. 4 \checkmark \checkmark \checkmark 83 Goniopora sp. 4 \checkmark \checkmark \checkmark 84 Goniopora sp. 4 \checkmark \checkmark \checkmark \checkmark 85 Goniopor	66	Diploria antiguensis								
60 Favites cf.inaequiseptata $$ 70 Favites cf.inaequiseptata $$ 71 Favites macrocolyx $$ 72 Favites oligocenia $$ 73 Favites polygonalis $$ 74 Favites polygonalis $$ 75 Favites polygonalis $$ 76 Favites sp. $$ 77 Favites sp. $$ 78 Favites sp. $$ 79 Gardinoseries? sp. $$ 80 Goniopora cf. nodulosa $$ 81 Goniopora sp. $$ 82 Goniopora sp. $$ 83 Goniopora sp. $$ 84 Goniopora sp. $$ 85 Goniopora sp. $$ 86 Goniopora inperatoris $$ 87 Galaxea sp. $$ 88 Goniopora inperatoris $$ 89 Hydnophora scl. inaequalis $$ 90 Hydnophora sp. $$ 91	67	Diploria sp.	V							
69 Favites cf.inaequiseptata $\sqrt{1}$ 70 Favites cf.inaequiseptata $\sqrt{1}$ 71 Favites macrocalyx $\sqrt{1}$ 72 Favites noispocalis $\sqrt{1}$ 73 Favites polygonalis $\sqrt{1}$ 74 Favites polygonalis $\sqrt{1}$ 75 Favites polygonalis $\sqrt{1}$ 76 Favites sombigua $\sqrt{1}$ 77 Favia sombigua $\sqrt{1}$ 78 Favia sp. 2 $\sqrt{1}$ 79 Gardinoseries? sp. $\sqrt{1}$ 80 Goniopora sf. nodulosa $\sqrt{1}$ 81 Goniopora sp. 2 $\sqrt{1}$ 82 Goniopora sp. 4 $\sqrt{1}$ 83 Goniopora sp. 4 $\sqrt{1}$ 84 Goniopora sp. 4 $\sqrt{1}$ 85 Goniopora inperatoris $\sqrt{1}$ 86 Goniopora inperatoris $\sqrt{1}$ 87 Galaxea sp. $\sqrt{1}$ 90 Hydnophora solidor $\sqrt{1}$ 91 Hydnophora solidor $\sqrt{1}$ 92 Hydnophora sp. A $\sqrt{1}$	68	Euphyllia caliculata	V							
70 Favites of, inaequise ptata \checkmark \checkmark 71 Favites macrocalyx \checkmark \checkmark 72 Favites oligocenia \checkmark \checkmark 73 Favites oligocenia \checkmark \checkmark 74 Favites oligocenia \checkmark \checkmark 75 Favites onbigua \checkmark \checkmark 76 Fungophyllia sp. A \checkmark \checkmark 77 Favia sp. 2 \checkmark \checkmark 78 Favia sp. 2 \checkmark \checkmark 79 Gardinoseries? sp. \checkmark \checkmark 80 Goniopora sp. \checkmark \checkmark 81 Goniopora sp. 4 \checkmark \checkmark 82 Goniopora sp. 4 \checkmark \checkmark 83 Goniopora sp. 4 \checkmark \checkmark 84 Goniopora imperatoris \checkmark \checkmark 85 Goniopora imperatoris \checkmark \checkmark 86 Galaxea sp. \checkmark \checkmark 87 Galaxea sp. \checkmark \checkmark 98 Hydnophora solidior \checkmark \checkmark					V					
71 Favites macrocalyx V V 72 Favites oligocenia V V 73 Favites oligocenia V V 74 Favites oligocenia V V 74 Favites oligocenia V V 74 Favites oligocenia V V 75 Favites ambigua V V 76 Favites p.p. V V 77 Favia sp. 1 V V 78 Favia sp. 1 V V 79 Gardinoseries? sp. V V 80 Goniopora sp. V V 81 Goniopora sp. V V 82 Goniopora sp. 4 V V 83 Goniopora sp. 4 V V 84 Goniopora sp. 4 V V 86 Goniopora sp. 4 V V 87 Galacea sp. V V 88 Goniopora solidior V V 91 Hydnophora cf. rudis V				<u> </u>						
72 Favites polygonalis \checkmark \checkmark 73 Favites polygonalis \checkmark \checkmark 74 Favites ambigua \checkmark \checkmark 75 Favites ambigua \checkmark \checkmark 76 Favites sp. \checkmark \checkmark 77 Favite sp. 2 \checkmark \checkmark 78 Favia sp. 2 \checkmark \checkmark 79 Gardinoseries? sp. \checkmark \checkmark 80 Goniopora sp. \checkmark \checkmark 81 Goniopora sp. 2 \checkmark \checkmark 82 Goniopora sp. 3 \checkmark \checkmark 83 Goniopora sp. 4 \checkmark \checkmark 84 Goniopora rudis \checkmark \checkmark 85 Goniopora rudis \checkmark \checkmark 86 Goniopora solidior \checkmark \checkmark 87 Galaxea sp. \checkmark \checkmark 88 Goniostrea canalis \checkmark \checkmark 91 Hydnophora sp. A \checkmark \checkmark 92 Hydnophora sp. A \checkmark \checkmark <t< td=""><td></td><td></td><td>al</td><td>-</td><td>•</td><td></td><td></td><td></td><td></td><td></td></t<>			al	-	•					
73 Favites polygonalis \checkmark \checkmark 74 Favites ambigua \checkmark \checkmark 75 Favites sp. \checkmark \checkmark 76 Fungophyllia sp. A \checkmark \checkmark 77 Favites sp. \checkmark \checkmark 76 Fungophyllia sp. A \checkmark \checkmark 77 Favia sp. 2 \checkmark \checkmark 78 Favia sp. 2 \checkmark \checkmark 79 Gardinoscrices? sp. \checkmark \checkmark 80 Goniopora sp. \checkmark \checkmark 81 Goniopora sp. 2 \checkmark \checkmark 82 Goniopora sp. 4 \checkmark \checkmark 83 Goniopora sp. 4 \checkmark \checkmark 84 Goniopora sp. 4 \checkmark \checkmark 85 Goniopora sp. \checkmark \checkmark 86 Goniopora solidior \checkmark \checkmark 87 Galaxea sp. \checkmark \checkmark 98 Hydnophora solidior \checkmark \checkmark 91 Hydnophora sp. A \checkmark \checkmark 92				-	-					
74 Favites ambigua $$ $\sqrt{$ $\sqrt{$ 75 Favites sp. $\sqrt{$ $\sqrt{$ $\sqrt{$ 76 Fungophyllia sp. A $\sqrt{$ $\sqrt{$ $\sqrt{$ 77 Favia sp. 2 $\sqrt{$ $\sqrt{$ $\sqrt{$ 78 Favia sp. 1 $\sqrt{$ $\sqrt{$ $\sqrt{$ 79 Gardinoseries? sp. $\sqrt{$ $\sqrt{$ $$ 80 Goniopora cf. nodulosa $$ $$ $$ 81 Goniopora sp. $$ $$ $$ 82 Goniopora sp. 3 $$ $$ $$ 83 Goniopora sp. 4 $$ $$ $$ 84 Goniopora andis $$ $$ $$ 85 Goniopora imperatoris $$ $$ $$ 86 Ganizera canalis $$ $$ $$ 90 Hydnophora cf. inaegualis $$ $$ $$ 91 Hydnophora sp. $$ $$ $$ $$ 93 Hydnophora s			V	<u> </u>	-				-	
75 Favites sp. \vee \vee \vee 76 Fungophyllia sp. A \vee \vee \vee 77 Favita sp. 2 \vee \vee \vee 78 Favita sp. 1 \vee \vee \vee 79 Gardinoseries? sp. \vee \vee \vee 80 Goniopora sp. \vee \vee \vee 81 Goniopora sp. \vee \vee \vee 82 Goniopora sp. 3 \vee \vee \vee 84 Goniopora sp. 4 \vee \vee \vee 85 Goniopora rulis \vee \vee \vee 86 Goniopora inperatoris \vee \vee \vee 86 Goniopora cf. inaequalis \vee \vee \vee 90 Hydnophora cf. inaequalis \vee \vee \vee 91 Hydnophora sp. \vee \vee \vee 92 Hydnophora sp. \vee \vee \vee 93 Hydnophora sp. A \vee \vee \vee <t< td=""><td></td><td></td><td></td><td><u> </u></td><td>-</td><td>N</td><td></td><td></td><td></td><td> </td></t<>				<u> </u>	-	N				
76 Fungophyllia sp. A \checkmark \checkmark \checkmark 77 Favia sp. 2 \checkmark \checkmark \checkmark \checkmark 78 Favia sp. 1 \checkmark \checkmark \checkmark \checkmark 90 Gardinoscries? sp. \checkmark \checkmark \checkmark \checkmark 80 Goniopora sp. \checkmark \checkmark \checkmark \checkmark 81 Goniopora sp. \checkmark \checkmark \checkmark \checkmark 82 Goniopora sp. 2 \checkmark \checkmark \checkmark \checkmark 83 Goniopora sp. 4 \checkmark \checkmark \checkmark \checkmark 84 Goniopora sp. 4 \checkmark \checkmark \checkmark \checkmark 85 Goniopora inperatoris \checkmark \checkmark \checkmark \checkmark 86 Goniopora inperatoris \checkmark \checkmark \checkmark \checkmark 87 Galaxea sp. \checkmark \checkmark \checkmark \checkmark 88 Goniastrea canalis \checkmark <			V							
1 Image product V V 77 Favia sp. 1 V V 78 Favia sp. 1 V V 79 Gardinoseries? sp. V V 80 Goniopora t. nodulosa V V 81 Goniopora sp. V V 82 Goniopora sp. V V 83 Goniopora sp. V V 84 Goniopora sp. V V 85 Goniopora sp. V V 86 Goniopora sp. V V 87 Galaxea sp. V V 88 Goniastrea candis V V 89 Hydnophora cf. inaequalis V V 90 Hydnophora sp. V V 91 Hydnophora sp. V V 92 Hydnophora sp. V V 93 Hydnophora sp. V V 94 Hydnophora sp. V V 95 Heliopora sp. V V <t< td=""><td></td><td></td><td></td><td></td><td>1</td><td></td><td></td><td>√</td><td></td><td></td></t<>					1			√		
78 Favia sp. 1 \checkmark \checkmark \checkmark 79 Gardinoseries? sp. \checkmark \checkmark \checkmark 80 Goniopora sp. notation \checkmark \checkmark \checkmark 81 Goniopora sp. 2 \checkmark \checkmark \checkmark 82 Goniopora sp. 2 \checkmark \checkmark \checkmark 83 Goniopora sp. 4 \checkmark \checkmark \checkmark 84 Goniopora andis \checkmark \checkmark \checkmark 85 Goniopora imperatoris \checkmark \checkmark \checkmark 86 Goniopora solidior \checkmark \checkmark \checkmark 87 Galaxea sp. \checkmark \checkmark \checkmark 88 Goniopora solidior \checkmark \checkmark \checkmark 89 Hydnophora cf. inaequalis \checkmark \checkmark \checkmark 90 Hydnophora sp. \checkmark \checkmark \checkmark \checkmark 91 Hydnophora sp. \checkmark \checkmark \checkmark \checkmark 93 Hydnophora sp. \checkmark \checkmark \checkmark \checkmark 94 Hydnophora sp. \checkmark	76					V				
10 Image: Section of the sectin of the section of the section of the section of the section of	77	Favia sp. 2	V							
Nome Nome Nome Nome 80 Goniopora sp. Nome Nome Nome 81 Goniopora sp. Nome Nome Nome 82 Goniopora sp. Nome Nome Nome 83 Goniopora sp. Nome Nome Nome 84 Goniopora sp. Nome Nome Nome 85 Goniopora rudis Nome Nome Nome 86 Goniopora imperatoris Nome Nome Nome 87 Galaxea sp. Nome Nome Nome Nome 88 Goniastrea canalis Nome Nome Nome Nome Nome 90 Hydnophora cf. rudis Nome	78	Favia sp. 1	V							
80 Goniopora cf. nodulosa \checkmark \checkmark \checkmark \checkmark 81 Goniopora sp. \checkmark \checkmark \checkmark \checkmark 82 Goniopora sp. 2 \checkmark \checkmark \checkmark \checkmark 83 Goniopora sp. 3 \checkmark \checkmark \checkmark \checkmark 84 Goniopora sp. 4 \checkmark \checkmark \checkmark \checkmark 85 Goniopora nulis \checkmark \checkmark \checkmark \checkmark 86 Goniopora inperatoris \checkmark \checkmark \checkmark \checkmark 87 Galaxea sp. \checkmark \checkmark \checkmark \checkmark \checkmark 88 Goniastrea canalis \checkmark \checkmark \checkmark \checkmark \checkmark 99 Hydrophora cf. inaequalis \checkmark \checkmark \checkmark \checkmark \checkmark 91 Hydrophora cf. rudis \checkmark \checkmark \checkmark \checkmark \checkmark 91 Hydrophora cf. rudis \checkmark \checkmark \checkmark \checkmark \checkmark 92 Hydrophora sp. A \checkmark \checkmark \checkmark \checkmark \checkmark \checkmark <	79				\checkmark					
81 Goniopora sp. $$ $$ $$ 82 Goniopora sp. 2 $$ $$ $$ 83 Goniopora sp. 3 $$ $$ $$ 84 Goniopora sp. 4 $$ $$ $$ 85 Goniopora sp. 4 $$ $$ $$ 86 Goniopora imperatoris $$ $$ $$ 87 Galaxea sp. $$ $$ $$ $$ 88 Goniastrea candis $$ $$ $$ $$ 89 Hydnophora solidior $$ $$ $$ $$ 90 Hydnophora cf. inaequalis $$ $$ $$ $$ 91 Hydnophora sp. $$ $$ $$ $$ $$ 93 Hydnophora sp. $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ <	80		V	-	V					
0 bit Work of P V V 82 Goniopora sp. 2 V V V 83 Goniopora sp. 3 V V V 84 Goniopora sp. 4 V V V 85 Goniopora imperatoris V V V 86 Goniopora imperatoris V V V 87 Galaxea sp. V V V 88 Goniopora cl. inaequalis V V V 90 Hydnophora cl. rudis V V V 91 Hydnophora sp. V V V 92 Hydnophora sp. V V V 93 Hydnophora sp. V V V 94 Hydnophora sp. V V V 95 Heliopora sp. A V V V 94 Hydnophora sp. A V V V 97 Leptoseries irregularis V V V 98 Leptoseries sp. C V V V				-				1		
83 Goniopora sp. 4 $$ 84 Goniopora sp. 4 $$ 85 Goniopora rulis $$ 86 Goniopora imperatoris $$ 87 Galaxea sp. $$ 88 Goniopora imperatoris $$ 89 Hydrophora solidior $$ 90 Hydrophora cf. inaequalis $$ 91 Hydrophora cf. rulis $$ 92 Hydrophora cf. rulis $$ 93 Hydrophora sp. A $$ 94 Hydrophora sp. A $$ 95 Heliopora sp. A $$ 96 Hariosmilia subcurvata $$ 97 Leptoseries irregularis $$ 98 Leptoseries cf. dinarica $$ 99 Leptoseries sp. C $$ 91 Leptoseries sp. C $$ 92 Hydrophora sp. A $$ 93 Hydrophora sp. A $$ 94 Hydrophora sp. A $$ 95 Heliopora sp. A $$				-	al			v		0
84 Goniopora sp. 4 \vee \vee 85 Goniopora rudis \vee \vee 86 Goniopora imperatoris \vee \vee 87 Galaxea sp. \vee \vee 88 Goniastrea canalis \vee \vee 89 Hydnophora solidior \vee \vee 90 Hydnophora cf. inaequalis \vee \vee 91 Hydnophora cf. rudis \vee \vee 92 Hydnophora sp. \vee \vee 93 Hydnophora sp. \vee \vee 94 Hydnophora sp. A \vee \vee 95 Heliopora sp. A \vee \vee 96 Iariosmilia subcurvata \vee \vee 97 Leptoseries irregularis \vee \vee 98 Leptoseries portoricensis \vee \vee 99 Leptoseries portoricensis \vee \vee 100 Leptoseris alternas \vee \vee \vee 101 Leptoria bithecata \vee \vee \vee 1			v	<u> </u>						
Schribber Schribber N N N 85 Goniopora iniperatoris N N N N 86 Goniopora iniperatoris N N N N 87 Galaxea sp. N N N N N 88 Goniastrea candis N N N N N N 88 Goniastrea candis N				-					-	
86 Goniopora imperatoris $$ $$ $$ 87 Galaxea sp. $$ $$ $$ 88 Goniastrea canalis $$ $$ $$ 89 Hydnophora solidior $$ $$ $$ 90 Hydnophora cf. inaequalis $$ $$ $$ 91 Hydnophora cf. inaequalis $$ $$ $$ 92 Hydnophora cf. rudis $$ $$ $$ 93 Hydnophora sp. $$ $$ $$ 94 Hydnophora sp. $$ $$ $$ 95 Heliopora sp. A $$ $$ $$ 96 Hariosmilia subcurvata $$ $$ $$ 97 Leptoseries irregularis $$ $$ $$ $$ 98 Leptoseries p.C $$ $$ $$ $$ $$ 99 Leptoseries alternas $$ $$ $$ $$ $$ $$ $$,	N				-	
87 Galaxea sp. $$ $\sqrt{$ 88 Goniastrea conalis $\sqrt{$ $\sqrt{$ 89 Hydnophora solidior $\sqrt{$ $\sqrt{$ 90 Hydnophora cl. inaequalis $\sqrt{$ $\sqrt{$ 91 Hydnophora cl. inaequalis $\sqrt{$ $\sqrt{$ 92 Hydnophora sp. $\sqrt{$ $\sqrt{$ 93 Hydnophora sp. $\sqrt{$ $\sqrt{$ 94 Hydnophora sp. $\sqrt{$ $\sqrt{$ 95 Heliopora sp. A $\sqrt{$ $\sqrt{$ 96 Ilariosmilia subcurvata $\sqrt{$ $\sqrt{$ 97 Leptoseries irregularis $\sqrt{$ $\sqrt{$ 98 Leptoseries cf. dinarica $\sqrt{$ $\sqrt{$ 99 Leptoseries f. dinarica $\sqrt{$ $\sqrt{$ 100 Leptoseris portoricensis $\sqrt{$ $\sqrt{$ 101 Leptoseris alternas $\sqrt{$ $\sqrt{$ 103 Leptoria pi. $\sqrt{$ $\sqrt{$				V						
88 Goniastrea canalis $$ $\sqrt{$ $\sqrt{$ 89 Hydnophora solidior $\sqrt{$ $\sqrt{$ $\sqrt{$ 90 Hydnophora solidior $\sqrt{$ $\sqrt{$ $\sqrt{$ 91 Hydnophora cf. inadis $\sqrt{$ $\sqrt{$ $\sqrt{$ 92 Hydnophora pulchara $\sqrt{$ $\sqrt{$ $\sqrt{$ 93 Hydnophora sp. $\sqrt{$ $$ $$ 94 Hydnophora sp. A $$ $$ $$ 95 Heliopora sp. A $$ $$ $$ 96 Itariosmilia subcurvata $$ $$ $$ 97 Leptoseries irregularis $$ $$ $$ 98 Leptoseries cf. dinarica $$ $$ $$ 100 Leptoseris sp. C $$ $$ $$ $$ 101 Leptoseris alternas $$ $$ $$ $$ 103 Leptoria bithecata $$ $$ $$ $$			-			V	√ ·	-		
89 Hydnophora solidior $$ $$ 90 Hydnophora cf. inaequalis $$ $$ 91 Hydnophora cf. inaequalis $$ $$ 92 Hydnophora gpi. Chara $$ $$ 93 Hydnophora sp. $$ $$ 94 Hydnophora sp. $$ $$ 95 Heliopra sp. A $$ $$ 96 Iariosmilia subcurvata $$ $$ 97 Leptoseries irregularis $$ $$ 98 Leptoseries cf. dinarica $$ $$ 99 Leptoseries sp. C $$ $$ 100 Leptoseries alternas $$ $$ 101 Leptoseritic alternas $$ $$ 103 Leptoria sp. $$ $$	87	Galaxea sp.			\checkmark					
89 Hydnophora solidior $$ $$ 90 Hydnophora cf. inaequalis $$ $$ 91 Hydnophora cf. inaequalis $$ $$ 92 Hydnophora pulchara $$ $$ 93 Hydnophora sp. $$ $$ 94 Hydnophora sp. $$ $$ 95 Heliopra sp. A $$ $$ 96 Iariosmilia subcurvata $$ $$ 97 Leptoseries irregularis $$ $$ 98 Leptoseries cf. dinarica $$ $$ 99 Leptoseries sp. C $$ $$ 100 Leptoseris sp. C $$ $$ 101 Leptoseris alternas $$ $$ 102 Leptoria cl. concentrica $$ $$ 103 Leptoria sp. $$ $$	88	Goniastrea canalis				V	V			
90 Hydnophora cf. inaequalis \checkmark \checkmark 91 Hydnophora cf. rudis \checkmark \checkmark 92 Hydnophora cf. rudis \checkmark \checkmark 93 Hydnophora sp. \checkmark \checkmark 94 Hydnophora sp. \checkmark \checkmark 95 Heliopora sp. A \checkmark \checkmark 96 Iariosmilia subcurvata \checkmark \checkmark 97 Leptoseries irregularis \checkmark \checkmark 98 Leptoseries cf. dinarica \checkmark \checkmark 99 Leptoseries s.C \checkmark \checkmark 100 Leptoseris sp. C \checkmark \checkmark 101 Leptoseris alternas \checkmark \checkmark 102 Leptoria cf. concentrica \checkmark \checkmark 103 Leptoria asp. \checkmark \checkmark	89				V					
91 Hydnophora cf. rudis $$ $$ 92 Hydnophora pulchara $$ $$ 93 Hydnophora sp. $$ $$ 94 Hydnophora sp. A $$ $$ 95 Heliopora sp. A $$ $$ 96 Itariosmilia subcurvata $$ $$ 97 Leptoseries irregularis $$ $$ 98 Leptoseries cf. dinarica $$ $$ 99 Leptoseries dilemas $$ $$ 100 Leptoseris alternas $$ $$ 101 Leptoseria alternas $$ $$ 103 Leptoria sp. $$ $$										
92 Hydnophora pulchara $$ $$ 93 Hydnophora sp. $$ $$ 94 Hydnophora sp. A $$ $$ 95 Heliopora sp. A $$ $$ 96 Ilariosmilia subcurvata $$ $$ 97 Leptoseries irregularis $$ $$ 98 Leptoseries cf. dinarica $$ $$ 99 Leptoseris sp. C $$ $$ 100 Leptoseris sp. cf. concentrica $$ $$ 101 Leptoseris cf. concentrica $$ $$ 103 Leptoria sp. $$ $$										
93 Hydnophora sp. \vee \vee 94 Hydnophora sp. \vee \vee 95 Heliopora sp. A \vee \vee 96 Hariosmilia subcurvata \vee \vee 97 Leptoseries irregularis \vee \vee 98 Leptoseries cf. dinarica \vee \vee 99 Leptoseries sp. C \vee \vee 100 Leptoseris sp. C \vee \vee 101 Leptoseris alternas \vee \vee 102 Leptoria cf. concentrica \vee \vee 103 Leptoria sp. \vee \vee 104 Leptoria sp. \vee \vee			1		· ·					
94 Hydrophora sp. A \checkmark \checkmark 95 Heliopora sp. A \checkmark \checkmark 96 Ilariosmilia subcurvata \checkmark \checkmark 97 Leptoseries irregularis \checkmark \checkmark 98 Leptoseries cf. dinarica \checkmark \checkmark 99 Leptoseris sp. C \checkmark \checkmark 100 Leptoseris alternas \checkmark \checkmark 101 Leptoria cf. concentrica \checkmark \checkmark 103 Leptoria sp. \checkmark \checkmark			v	-						 -
95 Heliopora sp. A $$ $$ 96 Ilariosmilia subcurvata $$ $$ 97 Leptoseries irregularis $$ $$ 98 Leptoseries cf. dinarica $$ $$ 99 Leptoseries cf. dinarica $$ $$ 100 Leptoseris portoricensis $$ $$ 101 Leptoseria cliternas $$ $$ 102 Leptoria cf. concentrica $$ $$ 103 Leptoria sp. $$ $$					V	./				
96 Ilariosmilia subcurvata $$ \sim 97 Leptoseries irregularis $$ \sim 98 Leptoseries cf. dinarica $$ \sim 99 Leptoseries sp. C $$ \sim 100 Leptoseris sp. Croinciensis $$ \sim 101 Leptoseris alternas $$ \sim 102 Leptoria cf. concentrica $$ \sim 103 Leptoria sp. $$ \sim				-	-					
97 Leptoseries irregularis $$ $$ 98 Leptoseries cf. dinarica $$ $$ 99 Leptoseris sp. C $$ $$ 100 Leptoseris sp. Criticensis $$ $$ 101 Leptoseris alternas $$ $$ 102 Leptoria cf. concentrica $$ $$ 103 Leptoria bithecata $$ $$ 104 Leptoria sp. $$ $$						N				
98 Leptoseries cf. dinarica Image: Constraint of the second										
98Leptoseries cf. dinarica \checkmark \checkmark 99Leptoseris sp. C \checkmark \checkmark 100Leptoseris portoricensis \checkmark \checkmark 101Leptoseris alternas \checkmark \checkmark 102Leptoria cf. concentrica \checkmark \checkmark 103Leptoria bithecata \checkmark \checkmark 104Leptoria sp. \checkmark \checkmark	97	Leptoseries irregularis			\checkmark					
99 Leptoseris sp. C \checkmark \checkmark 100 Leptoseris portoricensis \checkmark \checkmark 101 Leptoseris alternas \checkmark \checkmark 102 Leptoria cf. concentrica \checkmark \checkmark 103 Leptoria bithecata \checkmark \checkmark 104 Leptoria sp. \checkmark \checkmark										
100 Leptoseris portoricensis \checkmark 101 Leptoseris alternas \checkmark 102 Leptoria cf. concentrica \checkmark 103 Leptoria bithecata \checkmark 104 Leptoria sp. \checkmark						V				
101 Leptoseris alternas $$ \sim \sim 102 Leptoria cf. concentrica $$ \sim \sim 103 Leptoria bithecata $$ \sim \sim 104 Leptoria sp. $$ $$ \sim										
102 Leptoria cf. concentrica $$ \sim 103 Leptoria bithecata $$ \sim 104 Leptoria sp. $$ $$				<u> </u>	V	· ·				-
103 Leptoria bithecata $$				-						
104 Leptoria sp. $\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{\sqrt{$./	-	V				-	
				-						
105 Leptomussa variabilis N N			N						-	
	105	Leptomussa variabilis	V		V					

The Oligocene Corals Had Circumtropical Distribution

106	Leptomussa sp.		V	V			1			
107	Montipora sp. A		,	Ż	V					
107	Montastrea sp.	V		Ĵ						
100	Montastraea canalis	v			V	V	V			
	Montastraea endothecata				V	N.	Ň			
111					Y	V	V			
	Montastraea imperatoris					V V	V		-	
						N	V			
						/	N			
114	Montastraea sp.		1			V				
			V		,					
	V				Ń					
		V			,					
118					V					
	Porites macdonaldi				V	,				
	Porites portoricensis				V	√				
					V					
122	Porites reguiaris			<u> </u>	N					
123		1		L	V	V		L	L	
124	Porites trinitatis					V			L	
125	Porites waylandi					V				
	1					\checkmark				
127		\checkmark	V	\checkmark			1			√
128	Plocophyllia bartai		\checkmark							
129	Pavona bronni	V	\checkmark							
130	Platycoenia iranica	\checkmark		\checkmark						
	Plesiastrea sp.	V		V						
132	Placosmiliopsis fimbriatus			V						
	Placosmiliopsis multisinuous			\checkmark						
134	Rhizangia sp.	V								
135					V	V				
	Siderastrea (Siderofungia) sp.	1		V			l	1		
137	Solenastrea sp. B		1			V	l			
	Stephanocyathus									
138	(Odontocyathus) sp.			\checkmark						
	Stephanocoenia duncani				V	√				
140	Stylophora affinis					V				
141	Stylophora granulate		1			V	l			
142			1			V	l			
					V					
144	Stylophora minor				Ń					
145	Stylophora sp. C				Ń					
	Stylophora sp.	V	√				V			
140	Stylophora thirsiformis	· ·	<u> </u>	1			· ·	<u> </u>		
	Stylofora conferta	V		<u> </u>					1	
	Stylophora cf. sokkohensis	v		V						
149	Acanthastrea n. sp.1			N N				V		
150	Acanthastrea n. sp. 2	+						V V		
		+	V					v		
		V	N N							
153	Tethocyathus persicus	V				V				
154		.1				N			+	
155		√								
156	Turbinaria cf. sitaensis			V						
157	Tarbellastrea carryensis			V						
158	Pavona n. sp. 1							V,		
159	Pavona n. sp. 2							√ √		
160	Pavona n. sp. 3									

References

Biswas SK (1992) Tertiary stratigraphy of Kutch. J Palaeont Soc India 37:1–29

Bosellini FR (1998) Diversity, composition and structure of Late Eocene shelf-edge coral associations (Nago Limestone, Northern Italy). Facies 39:203–226

Budd AF (2000) Diversity and extinction in the Cenozoic history of Caribbean reefs. Coral Reefs 19:23–35

		1	1			1		1	1	1
161	Tarbellastrea hamedanii	V		Ń						
162	Tarbellastrea cf. distans			\checkmark						
163	Balanophyllia elongate								√	
164	Stylophora ponderosa									
165	Stephanocyathus holcombensis									
166	Flabellum hertleini									
167	Archohelia weaveri									V
168	Astrangia clarki									V
169	Balanophyllia fulleri									Ń
170										V
171	Favia n. sp. 1							V		
172	Favia n. sp. 2							Ń		
172	Favia n. sp. 3							V		
174	Favia n. sp. 4							V		
174	Favia n. sp. 5							V		
175	Favia n. sp. 6			-				Ĵ		
170	Favia n. sp. 7							V		
								V		
178	Favia n. sp. 8	-						V		
179	Favia n. sp.9	-						V		+/
180	Paracyathus sp.	+								N
181	Stylaster milleri	+								√
182	Trochocyathus townsendensis		I							N
183	Tubastrea nomlandi									N
184	Dendrophyllia hannibali									N
185										N
186	Balanophyllia teglandae									V
187	Montastrea n. sp. 1							V		
188	Eusmilia bainbridgensis									N
189	Paracyathus sp.									N
190	Platycyathus? sp.									N
191	Siderastrea washingtonensis									N
192	Flabellum rhomboideuui									
193	Plesiastrea n. sp. 1							\checkmark		
194	Turbinolia insiguitica									
195	Steriphonotrochus pulcher									
196	Oculiua aldrichi									\checkmark
197	Oculiua harrisi									
	Balanophyllia caulifera var.									
198	nuiltigrauosa									Ń
199	Trochocyathus californianus								√	
200	Stylophora minutissima									Ń
201	Astrocoenia pumpellyi									Ń
202	Flabellum remoudianum								\checkmark	
203	Flabellum califonicum			1					V	
204	Trochocyathus striatus									
205	Trochocyathus zitteli								V	
206	Trococyatbus stantoni								V	
207	Pocillopora damicornis	1							V	
208	Pocillopora meandrina		1	1	1		1		v	
209			1	1					Ń	
210										V
211		1	1							V.
212								V		· ·
212			1					,	V	
	Siderastrea clarki	+	1						V	
214		+							v	V
215			-					V		N N
210	Hydnophora n. sp. 2		-					,		
217		-					1	V		V
218	Colpophyllia sp. Montipora schencki	1					V			N V
219		+	V						1	V
220	Pavona sp.	1	Y	1	1		1		V	

Champagne TAN (2010) Oligocene coral evolution in Puerto Rico and Antigua: morphometric analysis of Agathiphyllia, Antiguastrea, and Montastraea. Master of Science thesis, University of Iowa. http://ir.uiowa.edu/etd/1128

The Oligocene Corals Had Circumtropical Distribution

221	Turbinolia sp.							1	V	V
222	Platycoenia sp.									V
223	Astrangia sp.									V
224	Platytrochus sp.									
225	Discotrochus sp.									V
226	Madracis sp.									V
227	Dichocoenia sp.									V
228	Stephanocoenia sp.									V
229	Spenotrochus sp.									V
230	Leptoria n. sp. 1							1		
231	Endopachys sp.									V
232	Eupsammia sp.									N
233	Euphyllia sp.		V							
234	Galaxea sp.		V							
235	Montipora sp.			\checkmark						
236	Rhabdophyllia sp.			1						
237	Stylocoenia sp.			1						
238	Pocillopora sp.				1	√				
239	Siderastrea sp.						1			
240	Astreopora sp.						1			
241	Flabellum sp.						1	1		V
242	Astrohelia sp.							1		V
243	Eupsammid sp.									V
244	n. gen. 1 n. sp. 1							1		
245	n. gen. 2 n. sp. 1							1		
	Total	38	20	61	45	32	25	24	14	46

D' Archiac V, Haime J (1854) Description des animaux fossiles du Groupe Nummulitique de l'Inde, Seconde Livraison: Mollusques, Gide et J. Baudry, Paris, France

Durham JW (1942) Eocene and Oligocene coral faunas of Washington. J Paleont 16:84-104

- Eames FE (1951) A contribution to the study of the Eocene in western Pakistan and western India. B. The description of the Lamellibranchia from standard sections in the Rakhi Nala and Zinda Pir areas of the western Punjab and in the Kohat District. Phil. Trans Royal Soc London B Bio Sci 235:311–482
- Eames FE (1952) A contribution to the study of the Eocene in western Pakistan and western India, C. The description of the Scaphopoda and Gastropoda from standard sections in the Rakhi Nala and Zinda Pir areas of the western Punjab and in the Kohat district. Phil. Trans Royal Soc London B Bio Sci 236:1–168
- Geister J, Ungaro S (1977) The Oligocene coral formations of the ColliBerici (Vicenza, Northern Italy). Eclogae Geol Helv 70:811–823
- Gerth H (1921) Die Fossilien von Java auf Grund einer Sammlung von Dr. R.D.M. Verbeek und von anderen bearbeitet durch Dr. K.Martin,Professor der Geologie an der Universitat zu Leiden. Anthozoen von Java und die Mollusken der Njalindungschichten, erster Teil. Samml. Geol. Reichs-Mus. Leiden, N.F.1, 2. Abt Heft 3:387–445
- Gerth H (1923) Die Anthozoen des Jungtertiars von Borneo. Samml Geol Reichs-Mus Leiden. 10 (Ser. 1):37–136
- Gerth H (1925) Jungtertiare Korallen von Nias, Java und Borneo, nebst einer Uebersicht uber die aus dem Kanozoikum des indischen Archipels bekannten Arten. Leidsche Geol Meded 1:22–81
- Halder K (2012) Cenozoic fossil nautiloids (Cephalopoda) from Kutch, Western India. Palaeoworld 21:116–130
- Halder K, Bano S (2015) Cenozoic Corbulidae (Bivalvia, Mollusca) from the Indian subcontinent palaeobiogeography and revision of three species from Kutch. India Arab J Geosci 8:2019–2034
- Halder K, Sinha P (2014) Some Eocene cerithioids (Gastropoda, Mollusca) from Kutch, Western India, and their bearing on palaeobiogeography of the Indian subcontinent. Hindawi Publishing Corporation. Paleont J 2014:11 pages (Article ID 673469). http://dx.doi.org/10.1155/2014/ 673469
- Hansen J, Sato M, Russell G, Kharecha P (2013) Climate sensitivity, sea level, and atmospheric carbon dioxide. Phil Trans R Soc A 371:20120294. https://doi.org/10.1098/rsta.2012.0294

- Harzhauser M (2007) Oligocene and Aquitanian gastropod faunas from the Sultanate of Oman and their biogeographic implication for the early western Indo-Pacific. Palaeontographica 280:75–121
- Harzhauser M, Piller WE, Steininger FF (2002) Circum-Mediterranean Oligo-Miocene biogeographic evolution—the gastropods' point of view. Palaeogeogr Palaeoclim Palaeoeco 183:103–133
- Harzhauser M, Reuter M, Piller WE, Berning B, Kroh A, Mandic O (2009) Oligocene and Early Miocene gastropods from Kutch (NW India) document an early biogeographic switch from Western Tethys to Indo-Pacific. Paläont Z 83:333–372
- Iqbal MWA (1969a) Bibliography of tertiary pelecypod and gastropod species of West Pakistan. Rec Geol Surv Pakistan 18:1–63
- Iqbal MWA (1969b) The Tertiary pelycopod and gastropod fauna from Drug, Zindapir, Vidor (district D.G. Khan), Jhalar and Chharat (district Campbellpore), West Pakistan. Mem Geol Surv Pak Palaeontol Pak 6:1–77
- Iqbal MWA (1972) Palaeocene bivalve and gastropod fauna from Jherruk-Lakhra-Bara Nai (Sind), Salt Range (Punjab) and Samana Range (N. W. F. P.). Pak Palaeontol Pak 9:1–105
- Johnson KG (2007) Reef-coral diversity in the Late Oligocene Antigua Formation and temporal variation of local diversity on Caribbean Cenozoic Reefs. In: Hubmann B, Piller WE (eds) Fossil Corals and Sponges. Proceedings of the 9th international symposium on Fossil Cnidaria and Porifera. Osterr. Akad. Wiss., Schriftenr. Erdwiss. Komm., vol 17, pp 471–491
- Johnson KG, Sanchez-Villagra MR, Aguilera OA (2009) The Oligocene-Miocene Transition on coral reefs in the Falcó N Basin (NW Venezuela). Palaios 24:59–69
- Kolodziej B, Marcopoulou-Diacantoni A (2003) Late Eocene-Oligocene corals from Evros (Thrace Basin, NE Greece). Ber Inst Geol Paläont K.-F.-Univ Graz 7:45
- López-Pérez RA (2012) Late Miocene to Pleistocene reef corals in the Gulf of California. Bull Am Paleont 383:1–78
- Popov SV (1993) Zoogeography of the Late Eocene basins of Western Eurasia based on bivalve molluscs. Strat Geol Correl 2:103–118
- Schuster F (2002) Taxonomy of Oligocene to Early Miocene scleractinian corals from Iran, Egypt, Turkey, and Greece, vol 239. Courier Forschungsinstitut Senckenberg, pp 1–161
- Schuster F, Wielandt U (1999) Oligocene and Early Miocene coral faunas from Iran: palaeoecology and palaeobiogeography. Int J Earth Sci 88:571–581
- Smith AG, Smith DG, Funnel DM (1994) Atlas of Mesozoic and Cenozoic Coastlines. Cambridge University Press, Cambridge
- Sowerby JC (1840) Explanations of the plates and wood-cuts. Plates XX to XXVI, to illustrate Capt. Grant's Memoir on Cutch. Trans Geol Soc London 5:1–289
- Vaughan TW (1900) The Eocene and lower Oligocene coral faunas of the united states with descriptions of a few doubtfully Cretaceous species. Monographs of the USGS 39:1–263
- Veron J (2013) Overview of the taxonomy of zooxanthellate Scleractinia. Zool J Linnean Soc 169:485–508
- Veron J (2016) Patterns of diversity. Corals of the World—about corals and reefs. Australian Institute of Marine Sciences. Viewed online March 2016. http://www.coral.aims.gov.au/aboutcorals
- Vredenburg E (1925) Description of Mollusca from the Post-Eocene Tertiary formations of North-Western India. 1. Mem Geol Surv India 50:1–350
- Vredenburg E (1928) Description of Mollusca from the Post-Eocene Tertiary formations of North-Western India. 2. Mem Geol Surv India 50:351–463