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AN INVENTORY OF ZOOXANTHELLATE SCLERACTINIAN CORALS IN SINGAPORE, INCLUDING 33 NEW RECORDS

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***ABSTRACT.* –** Records of Scleractinia in Singapore have not been updated for 14 years. We present an inventory of zooxanthellate hard coral species by consolidating past work, coral collection records and recent publications, as well as conducting field surveys at eight coral reefs south of mainland Singapore. Species assessment surveys and recent literature revealed a total of 161 species. Using updated taxonomy, and including 33 new records, we report an increase in the number of species found in Singapore from 187 to 255. Raffles Lighthouse registered the largest number of species and represents the most undisturbed reefs of the sites studied. No clear relationship can be established between species richness and distance from the Mainland. The total number of species in Singapore is comparable to the reefs in neighboring countries if reef area is taken into account. Only 63.1% of total species recorded have been found in recent years, but this is not an exhaustive survey. As 12.9% of all species have been discovered in the last four years, and only 52.4% of species with distribution ranges encompassing Singapore have been found, more new records can be expected from further assessments.

KEY WORDS. – Coral reef, distribution, Scleractinia, Singapore, species list, zooxanthellae.

INTRODUCTION

Singapore is situated in the vicinity of the Indo-West Pacific center of marine biodiversity, which is home to the highest number of scleractinian coral species in the world (Ekman, 1953; Briggs, 1999, 2000; Veron, 2000; Spalding et al., 2001; Carpenter & Springer, 2005; Barber et al., 2006). The Philippines and Indonesia, for instance, host more than 400 species each, while 348 species have been recorded off the coasts of Malaysia (Spalding et al., 2001). Yet in Singapore, flanked by the reefs of Malaysia and Indonesia, only 197 hard coral species have been identified in the last assessments concluded 14 years ago (Chua & Chou, 1991; Chou et al., 1994b; Chou et al., 1994c; Loo & Chou, 1995). This count was based on line intercept transects at specific depths of the reef (Dartnall & Jones, 1986), but studies of this nature mainly address questions regarding coral abundance (English et al., 1994). As a result, rare species are likely to be omitted from such surveys, rendering this technique inappropriate for the appraisal of species richness. Since new scleractinian species have been described in recent years (e.g. Veron, 2002), the previous record of 197 species may be a considerable underestimation of the actual alpha diversity.

Coral reefs in Singapore have been impacted by the high rates of sedimentation resulting from land reclamation activities that commenced in 1963 (Chou, 1988a; Chou, 1996; Chou, 2006). Sediment deposition, suspended particles and associated light attenuation adversely affect the reproduction, recruitment, growth and survival of reef-building zooxanthellate (or hermatypic) corals (Roy & Smith, 1971; Endean, 1976; Rogers, 1990; Titlyanov & Latypov, 1991; Gilmour, 2002; Dikou & van Woesik, 2006; but see Lane, 1991). Singapore reefs tend not to thrive deeper than 3 m below the crest level, and reef accretion is thus limited to the shallows (Chou, 1988b; Goh & Chou, 1993). As coastal development continues unabated, there is a pressing need to assess and manage the hermatypic species that surround the offshore islands.

Records of Singapore's reef corals date back to the 1960s, when the first comprehensive list was published by Chuang (1961). It documented 63 zooxanthellate scleractinian species found along the Peninsula Malaysia coastline, of which Singapore's mainland and offshore islands accounted for the longest natural shore length prior to the systematic land reclamation (Chuang, 1961). Voucher specimens have also been collected during the intervening 48 years and deposited at the Zoological Reference Collection (ZRC), Raffles Museum of Biodiversity Research (RMBR), National University of Singapore (NUS). Taxonomic work by Koh & Chou (1989) and Leow (1992) revealed 13 species of Fungiidae and 18 species of *Acropora* respectively. Unfortunately, the inventory of 187 zooxanthellate species produced by Loo & Chou (1995) (ten less than the 197 hard coral records: three azooxanthellate, three non-scleractinian and four misnamed) did not account for the above. We therefore examined all relevant literature, revalidated museum records, and conducted surveys at selected reef sites using a more suitable method for species assessment. The primary objective of this study is to update the species inventory of zooxanthellate coral species in Singapore and present the new species records obtained since 2005.

MATERIAL AND METHODS

Field surveys. – Surveys were conducted between July 2006 and July 2007 at eight coral reefs fringing the southern offshore islands of Singapore: (1) Raffles Lighthouse (or Pulau [= Island] Satumu; two sites; 01°09'36.5''N 103°44'24.0''E; 01°09'37.0''N 103°44'29.0''E); (2) Pulau Semakau (01°12'11.5''N 103°45'15.0''E); (3) Pulau Jong (01°12'53.5''N 103°47'12.5''E); (4) Pulau Hantu (two sites: 01°13'36.5''N 103°44'47.0''E; 01°13'35.5''N 103°45'08.5''E); (5) Sisters Island (or Pulau Subar Laut; 01°12'49.0''N 103°49'59.0''E); (6) St John's Island (or Pulau Sakijang Bendera; two sites; 01°13'09.0''N 103°50'44.0''E; 01°13'25.5''N 103°50'42.5''E); (7) Lazarus Island (or Pulau Sakijang Pelepah; two sites; 01°13'12.5''N 103°51'15.0''E; 01°13'05.0''N 103°51'30.5''E) and (8) Kusu Island (or Pulau Tembakul; 01°13'33.0''N 103°51'34.0''E) (Fig. 1). Using SCUBA, meandering swim searches of approximately 60 minutes each were performed, starting from the deepest location where zooxanthellate corals could be found, usually at a depth of ~ 6 m (but ~ 9 m at Raffles Lighthouse), and ending at the shore (see DeVantier et al., 1998, 2000, 2004). Presence-absence data were collected to generate cumulative species lists of the zooxanthellate corals present at each site. Colonies that could not be identified in the field, along with new records were photographed and voucher specimens taken for identification in the laboratory. Each survey,

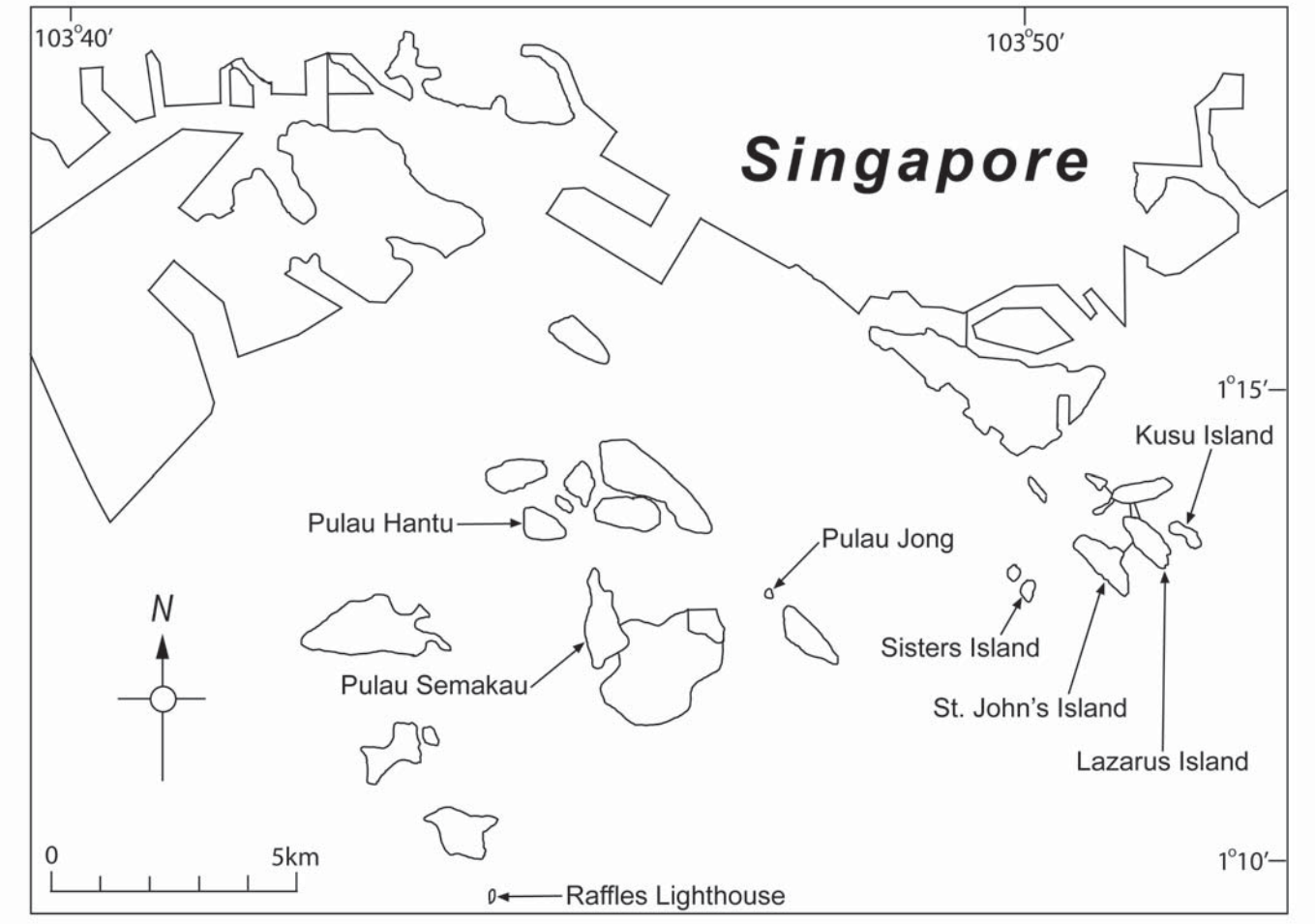

Fig. 1. Eight coral reefs located in the southern offshore islands of Singapore where scleractinian coral species assessments were conducted.

including the collection, generally covered an along-shore distance of 70 to 100 m. Species sightings outside of these samples but occurring in the same period were also included in the dataset.

Recent records. – Recent publications (since 2005) were analysed to extract presence-absence data for zooxanthellate coral species. Studies with relevant data were Guest et al. (2005a, 2005b), Ang (2007), Huang (2007), Huang et al. (2009) and Hoeksema (2009). With the exception of one species from Ang (2007) and Hoeksema's (2009) specimens, all records had locality information.

Museum collections and previous records. – We examined coral specimens of species deposited in the ZRC that were not found during the sampling surveys or in the work produced in the last four years. The species identities of skeletal specimens were verified and updated. For each of these species, we selected a representative specimen most identifiable based on current taxonomic descriptions as a reference for our inventory. Loo & Chou (1995) compiled a species list generated from surveys conducted during an eight-year period (1986 to 1993) and this was consulted for species not catalogued by the museum. Two species reported by Chou et al. (1994a) were also added to our list.

Species inventory. – All identifications follow Wallace (1999; see also Wallace et al., 2007) for *Acropora* spp., Hoeksema (1989) for Fungiidae, and Veron (2000) for all other zooxanthellate corals. For more detailed descriptions of corals apart from *Acropora* and Fungiidae, we referred to other taxonomic publications (Veron & Pichon, 1976, 1980, 1982; Veron et al., 1977; Veron, 1985, 1986, 1990, 2002). To obtain a comprehensive list of all species with ranges that include Singapore's reefs, we analysed the distribution maps in Wallace (1999), Hoeksema (1989) and Veron (2000). While the latter work had species ranges clearly demarcated, Wallace (1999) and Hoeksema (1989) stated the exact geographical locations where specimens were found. We set the criteria that, for reefs here to be within range of a particular *Acropora* or Fungiidae species, there must be at least two localities at approximately opposite directions of Singapore where specimens were described. Finally, we built an inventory of species in Singapore from results of the field surveys and recent records. This was supplemented by records from RMBR as well as from Chou et al. (1994a) and Loo & Chou (1995), several of which had undergone taxonomic revisions (Table 1).

RESULTS

We observed 141 species of zooxanthellate scleractinian corals during the field surveys. Including recent publications, 161 species have been encountered since 2005. Of these, 26 are newly recorded species, adding to two and five already registered in Veron (1986) and Wallace (1999), respectively. Most of the new records are from Acroporidae and Faviidae (both 33.3%). Poritidae accounts for 12.1%, Mussidae 9.1% and Fungiidae 6.1%, while Pectiniidae and Siderastreidae each contributeds 3.0% to our records. As a result, the count of coral records in Singapore reefs currently stands at 255 species from 56 genera and 15 families. This is a significant increase from the 187 zooxanthellate species listed in Loo & Chou (1995), although it still represents only 52.4% of the 487 species for which Singapore lies within the distribution ranges.

Species that were observed during the surveys and reported in recent literature since 2005 constitute 63.1% of the total number of corals ever recorded in Singapore. Of the eight reefs surveyed, Raffles Lighthouse (RL) had the highest species richness (141), followed by Pulau Jong (92), Kusu Island (91), St John's Island (74), Pulau Semakau and Pulau Hantu (both 73 species), Sisters Island (57) and Lazarus Island (55). Full data are presented in Table 2, in order of decreasing shortest straight-line distance to the mainland according to charts produced by the Hydrographic Department (2007).

DISCUSSION

The revised total number of zooxanthellate coral species recorded in Singapore is 255. This represents a 36.4% increase over the previous assessment (Loo & Chou, 1995). We also report 33 new records and present the distribution of all species encountered during our survey of eight coral reefs in Singapore (Table 2). Based on a consolidated analysis of museum records and past literature, aided by current taxonomy, we found that the inventory had 222 species prior to 2005. Thirty-five species that have been collected and deposited at the museum since the 1960s, but not recorded in the 1986–1993 transect surveys (Loo & Chou, 1995) or reported by Chou et al. (1994a), emphasize the importance of a coral reference collection. For Singapore's corals, RMBR has been an effective repository for 177 species found here. Unfortunately, newly described species such as *Goniastrea minuta* (Veron, 2000, 2002) and extremely rare species such as the endangered *Seriatopora hystrix* and *Stylophora pistillata* (see Chou et al., 1994a) may not be represented in the collection.

The distribution of new records among scleractinian families is heterogeneous. The majority of species identified for the first time in Singapore are Faviidae and Acropora corals (33.3% each). These are the result of studies by Wallace (1999), Guest et al. (2005a), Ang (2007), and Huang (2007) and Huang et al. (2009) that target specific taxonomic groups, allowing detailed evaluation of variations in coral morphology and habitat preferences. Species boundaries crucial to identification and delimitation of closely related corals can thus be clarified. Particularly in the phenotypically plastic Faviidae (e.g. Todd et al., 2001, 2002a,b, 2004), species-level assessments may omit species with overlapping morphological traits, leading to an underestimation of alpha diversity. In addition, species identification can be difficult in marginal habitats of Singapore. Corals from such areas tend to exhibit anatomical phenotypes distinct from less

impacted reefs (E. Turak & L. DeVantier, pers. comm.) where most specimen descriptions and photographs were derived (see Veron, 2000).

Changes in the recorded alpha diversity of zooxanthellate corals at three locations have occurred since the last published inventory. At Pulau Semakau, we encountered 73 zooxanthellate species in 45 genera, while 32 genera were reported in surveys from May 1986 to April 1987 (Chou & Koh, 1986; Leng et al., 1990a). At Pulau Hantu, we also observed 73 species from 45 genera, an increase over the 29 genera recorded between May 1986 and April 1987 (Chou & Koh, 1986; Leng & Lim, 1990). While 32 genera at Raffles Lighthouse were identified between September 1987 and December 1988 (Leng et al., 1990b; Goh & Chou, 1993), we found 141 species from 50 genera over the last four years. These increases are likely due to the change in survey methodology. Meandering swim searches employed in this study is a superior approach for species assessment compared to the line transect method used during the 1986–1993 surveys.

Raffles Lighthouse has the highest number of species recorded, but no clear trends exist for the other islands. Sedimentation rates increase with proximity to mainland Singapore (Lane, 1991; Low & Chou, 1994), while larval recruitment rates exhibit the opposite trend (Dikou & van Woesik, 2006), leading to the decrease in coral diversity (Chou, 1988a; Shoo, 2005; Dikou & van Woesik, 2006; Ang, 2007). Our results show that species richness is not lower for sites nearer to the mainland, although the furthest reef at Raffles Lighthouse has invariantly hosted higher diversity. A greater tidal range, as compared to sites closer to the mainland, and consequently stronger water circulation at Raffles Lighthouse could depress sedimentation rates (Purchon & Enoch, 1954; Goh & Chou, 1993). Access to the reef is also restricted, making it one of the most pristine reefs in Singapore (Goh & Chou, 1993). In fact, *Stylophora pistillata*, an endangered branching species not seen since the 1960s (Chuang, 1961; Chou et al., 1994a), has been rediscovered at Raffles Lighthouse in a single stand. No data are available for entry-prohibited islands under purview of Singapore's defense ministry, but the incidental conservation may allow their reefs to serve as refuge for many marine species, including corals.

The growth form of a coral influences its response to stresses. Low light intensity in the turbid waters of Singapore may favour the foliose type of growth as the increased surface area enhances photosynthesis (Goh et al., 1994; Leng & Lim, 1990; Leng et al., 1990a; Leng et al., 1990b; Shoo, 2005). Wong (2001) found that foliose corals of the genus *Montipora* accumulate sediments faster than branching *Acropor*a, but are more efficient at silt removal. Growth rates and sediment tolerance of *Acropora* are also generally lower than the other taxa (Bak & Elgershuizen, 1976; Endean, 1976; Lane, 1991; but see Rogers, 1990). Hence, as expected, our results agree with previous surveys that *Acropora* does not occur in high abundance in Singapore, and is common only at Raffles Lighthouse (Chua & Chou, 1991; Goh & Chou, 1992).

Of the 487 zooxanthellate coral species that have ranges encompassing Singapore, 255 (52.4%) have been found to be present here, either historically or recently. Although this figure is lower than that recorded in neighbouring countries, Singapore's reef area (~ 10 km^2) is only approximately 0.25% of Malaysia's (4,006 km^2) and 0.02% of Indonesia's (50,875 km^2) reef expanses (Burke et al., 2002; Goh, 2007). Our study reveals that at least 161 species are present on the reefs here, but 94 have not been encountered recently. Land reclamation impact and associated stresses could have resulted in local extinction, but as this is not an exhaustive study—not all reefs have been surveyed—these species may still be present here. Given the large number of new species recorded in just four years, continuing survey efforts may provide further insights into the diversity and ecology of corals in Singapore.

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Table 1. Synonymised species recorded in Loo & Chou (1995) and the Zoological Reference Collection (ZRC) of the Raffles Museum of Biodiversity Research at the National University of Singapore.

Previous record	Synonymy/Change	Reference
Acroporidae		
Acropora brueggemanni	*Isopora brueggemanni* (Brook, 1893)	Wallace et al. (2007)
Acropora danai	*Acropora abrotanoides* (Lamarck, 1816)	Wallace (1999)
Acropora formosa	*Acropora muricata* (Linneaus, 1758)	Wallace (1999)
Acropora nobilis	*Acropora intermedia* (Brook, 1891)	Wallace (1999)
Acropora palifera	*Isopora palifera* (Lamarck, 1816)	Wallace et al. (2007)
Faviidae		
Favia amicorum	*Barabattoia amicorum* (Milne Edwards & Haime, 1850)	Veron (1986)
Hydnophora exesa	Family Merulinidae Verrill, 1866	Veron (1986)
Hydnophora rigida	Family Merulinidae Verrill, 1866	Veron (1986)
Fungiidae		
Cycloseris marginata	*Fungia (Cycloseris) costulata* Ortmann, 1889	Hoeksema (1989)
Fungia corona	*Fungia (Danafungia) scruposa* Klunzinger, 1879	Hoeksema (1989)
Fungia danai	*Fungia (Danafungia) scruposa* Klunzinger, 1879	Hoeksema (1989)
Fungia echinata	*Ctenactis echinata* (Pallas, 1776)	Hoeksema (1989)
Fungia klunzingeri	*Fungia (Danafungia) horrida* Dana, 1846	Hoeksema (1989)
Herpetoglossa simplex	*Ctenactis crassa* (Dana, 1846)	Hoeksema (1989)
Lithophyllon edwardsi	*Lithophyllon undulatum* Rehberg, 1892	Hoeksema (1989)

Table 2. Zooxanthellate scleractinian corals recorded in Singapore. The distribution among eight reefs of species observed during the 2006–2007 field surveys and those recorded in publications between 2005 and 2008 are shown. The source of each pre-2005 record is shown as the catalogue number and collection site, if available, for ZRC specimens, while those without specimens are referenced as Chou et al. (1994a) or Loo & Chou (1995). Localities are arranged according to decreasing shortest straight-line distance to the mainland. Abbreviations used: PR, previous record (pre-2005); NR, new record; RL, Raffles Lighthouse; SE, Pulau Semakau; JO, Pulau Jong; SI, Sisters Island; HA, Pulau Hantu; LA, Lazarus Island; SJ, St. John's Island; KU, Kusu Island; CY, Cyrene Reefs.

Species	PR	NR	Distribution (2005–2008)								Source
			RL	SE	JO	SI	HA	LA	SJ	KU	
Acroporidae											
Acropora abrotanoides (Lamarck, 1816)	X										Loo & Chou (1995)
Acropora aculeus (Dana, 1846)	X		X		X					X	
Acropora acuminata (Verrill, 1864)	X										ZRC.1991.600 (RL)
Acropora anthocercis (Brook, 1893)	X										Loo & Chou (1995)
Acropora aspera (Dana, 1846)		X									Wallace (1999)
Acropora austera (Dana, 1846)	X		X								Guest et al. (2005a)
Acropora cerealis (Dana, 1846)	X		X								Guest et al. (2005a)
Acropora cytherea (Dana, 1846)	X		X	X							
Acropora dendrum (Bassett-Smith, 1890)	X										ZRC.1991.597
Acropora digitifera (Dana, 1846)	X		X				X			X	
Acropora divaricata (Dana, 1846)	X										ZRC.1987.1507 (JO)
Acropora donei Veron & Wallace, 1984	X		X								Guest et al. (2005a)
Acropora elseyi (Brook, 1892)	X										ZRC.1991.611 (RL)
Acropora florida (Dana, 1846)		X	X								Guest et al. (2005a)
Acropora glauca (Brook, 1893)		X									Wallace (1999)
Acropora grandis (Brook, 1892)	X		X								Guest et al. (2005a)
Acropora granulosa (Milne Edwards & Haime, 1860)		X	X								Guest et al. (2005a)
Acropora horrida (Dana, 1846)	X										ZRC.1991.614 (LA)
Acropora humilis (Dana, 1846)	X		X								

Table 2. (Continued).

Species	PR	NR	Distribution (2005–2008)								Source
			RL	SE	JO	SI	HA	LA	SJ	KU	
Acropora hyacinthus (Dana, 1846)	X		X				X				
Acropora intermedia (Brook, 1891)	X		X								Guest et al. (2005a)
Acropora latistella (Brook, 1892)	X				X						
Acropora longicyathus (Milne Edwards & Haime, 1860)	X										ZRC.1991.624
Acropora loripes (Brook, 1892)		X	X								Guest et al. (2005a)
Acropora lutkeni Crossland, 1952	X										ZRC.1987.1510
Acropora microclados (Ehrenberg, 1834)		X	X								Guest et al. (2005a)
Acropora microphthalma (Verrill, 1869)	X										ZRC.1991.619 (RL)
Acropora millepora (Ehrenberg, 1834)	X		X								
Acropora muricata (Linneaus, 1758)	X		X								
Acropora nana (Studer, 1878)	X										Loo & Chou (1995)
Acropora nasuta (Dana, 1846)	X		X								
Acropora palmerae Wells, 1954	X										ZRC.1987.1511
Acropora polystoma (Brook, 1891)	X										ZRC.1987.1512
Acropora pulchra (Brook, 1891)	X										ZRC.1987.1514
Acropora robusta (Dana, 1846)	X										ZRC.1992.3387 (SI)
Acropora samoensis (Brook, 1892)		X	X	X	X					X	Wallace (1999)
Acropora secale (Studer, 1878)	X		X		X						
Acropora selago (Studer, 1878)	X		X								Guest et al. (2005a)
Acropora solitaryensis Veron & Wallace, 1984		X									Wallace (1999)
Acropora spicifera (Dana, 1846)		X									Wallace (1999)
Acropora subglabra (Brook, 1891)		X									Veron (1986)
Acropora subulata (Dana, 1846)	X										ZRC.1987.2030 (HA)
Acropora tenuis (Dana, 1846)	X										ZRC.1991.588
Acropora valenciennesi (Milne Edwards & Haime, 1860)		X									Wallace (1999)
Acropora valida (Dana, 1846)	X		X		X	X				X	
Acropora verweyi Veron & Wallace, 1984	X		X								Guest et al. (2005a)
Acropora willisae Veron & Wallace, 1984	X										ZRC.1987.2033 (JO)
Astreopora cucullata Lamberts, 1980	X										Loo & Chou (1995)
Astreopora expansa Brüggemann, 1877	X										ZRC.1991.692 (HA)
Astreopora gracilis Bernard, 1896	X		X	X	X	X	X	X	X	X	
Astreopora incrustans Bernard, 1896	X										ZRC.1991.691 (CY)
Astreopora listeri Bernard, 1896	X										ZRC.1991.695 (RL)
Astreopora myriophthalma (Lamarck, 1816)	X		X	X	X				X	X	
Isopora brueggemanni (Brook, 1893)	X										ZRC.1991.609 (RL)
Isopora palifera (Lamarck, 1816)	X										ZRC.1991.596
Montipora aequituberculata Bernard, 1897	X		X		X			X	X		
Montipora angulata (Lamarck, 1816)	X										ZRC.1987.1521 (HA)
Montipora capricornis Veron, 1985	X										Loo & Chou (1995)
Montipora corbettensis Veron & Wallace, 1984	X		X							X	
Montipora crassituberculata Bernard, 1897	X										ZRC.1987.1596 (HA)
Montipora danae (Milne Edwards & Haime, 1851)	X		X		X	X				X	
Montipora digitata (Dana, 1846)	X									X	
Montipora efflorescens Bernard, 1897	X										Loo & Chou (1995)
Montipora foliosa (Pallas, 1766)	X										Loo & Chou (1995)
Montipora grisea Bernard, 1897	X		X	X	X	X		X		X	
Montipora hispida (Dana, 1846)	X										ZRC.1987.1600 (HA)
Montipora hoffmeisteri Wells, 1954	X										ZRC.1987.1533 (HA)
Montipora informis Bernard, 1897	X		X	X	X	X	X	X	X	X	
Montipora mollis Bernard, 1897	X		X								
Montipora monasteriata (Forskål, 1775)	X		X	X	X	X	X			X	
Montipora peltiformis Bernard, 1897	X										ZRC.1987.1554 (HA)
Montipora spongodes Bernard, 1897	X		X		X					X	

Species	PR	NR	Distribution (2005–2008)								Source
			RL	SE	JO	SI	HA	LA	SJ	KU	
Montipora spumosa (Lamarck, 1816)	X								X	X	
Montipora stellata Bernard, 1897	X		X	X	X	X	X	X	X	X	
Montipora tuberculosa (Lamarck, 1816)	X		X				X				
Montipora turgescens Bernard, 1897	X		X	X							
Montipora undata Bernard, 1897	X										ZRC.1987.1533 (HA)
Montipora venosa (Ehrenberg, 1834)	X										Loo & Chou (1995)
Montipora verrucosa (Lamarck, 1816)	X										Loo & Chou (1995)
Agariciidae											
Gardineroseris planulata (Dana, 1846)	X										Loo & Chou (1995)
Leptoseris explanata Yabe & Sugiyama, 1941	X		X		X						
Leptoseris hawaiiensis Vaughan, 1907	X										ZRC.1987.1732 (HA)
Leptoseris scabra Vaughan, 1907	X		X				X		X	X	
Pachyseris rugosa (Lamarck, 1801)	X		X		X						
Pachyseris speciosa (Dana, 1846)	X		X	X	X	X	X		X	X	
Pavona cactus (Forskål, 1775)	X		X								
Pavona clavus (Dana, 1846)	X										ZRC.1987.2094 (HA)
Pavona decussata (Dana, 1846)	X		X		X	X			X	X	
Pavona explanulata (Lamarck, 1816)	X				X		X			X	
Pavona frondifera (Lamarck, 1816)	X		X	X	X		X				
Pavona varians Verrill, 1864	X		X								
Astrocoeniidae											
Madracis kirbyi Veron & Pichon, 1976	X										ZRC.1991.799 (RL)
Stylocoeniella armata (Ehrenberg, 1834)	X		X	X	X		X	X	X	X	
Dendrophylliidae											
Turbinaria frondens (Dana, 1846)	X										Loo & Chou (1995)
Turbinaria irregularis Bernard, 1896	X										Loo & Chou (1995)
Turbinaria mesenterina (Lamarck, 1816)	X		X	X	X			X		X	
Turbinaria peltata (Esper, 1794)	X		X	X	X	X	X	X	X	X	
Turbinaria radicalis Bernard, 1896	X										Loo & Chou (1995)
Turbinaria reniformis Bernard, 1896	X										ZRC.1991.704 (RL)
Turbinaria stellulata (Lamarck, 1816)	X										ZRC.1987.2174 (HA)
Euphyllidae											
Euphyllia ancora Veron & Pichon, 1980	X		X		X		X			X	
Euphyllia divisa Veron & Pichon, 1980	X		X								
Euphyllia glabrescens (Chamisso & Eysenhardt, 1821)	X										ZRC.1987.2164 (HA)
Physogyra lichtensteini (Milne Edwards & Haime, 1851)	X										ZRC.1987.1889 (CY)
Plerogyra sinuosa (Dana, 1846)	X		X	X	X	X	X		X	X	
Faviidae											
Barabattoia amicorum (Milne Edwards & Haime, 1850)	X		X		X				X		
Caulastrea echinulata (Milne Edwards & Haime, 1849)	X		X	X					X	X	
Caulastrea furcata Dana, 1846		X		X	X		X			X	Ang (2007)
Cyphastrea chalcidicum (Forskål, 1775)	X		X				X	X	X		
Cyphastrea microphthalma (Lamarck, 1816)	X				X	X	X	X	X		
Cyphastrea serailia (Forskål, 1775)	X		X	X	X	X	X	X	X	X	
Diploastrea heliopora (Lamarck, 1816)	X		X	X	X	X	X		X	X	
Echinopora gemmacea Lamarck, 1816	X		X		X				X		
Echinopora hirsutissima Milne Edwards & Haime, 1849	X		X								
Echinopora horrida Dana, 1846	X										ZRC.1980.3.20.42

Table 2 (continued).

Species	PR	NR	Distribution (2005–2008)								Source
			RL	SE	JO	SI	HA	LA	SJ	KU	
Echinopora lamellosa (Esper, 1795)	X		X	X	X	X	X	X	X	X	
Echinopora pacificus Veron, 1990		X	X		X			X		X	ZRC.CNI.0194 (RL)
Favia danae Verrill, 1872		X	X	X				X			ZRC.CNI.0190 (LA)
Favia favus (Forskål, 1775)	X		X	X	X	X	X	X	X	X	
Favia laxa (Klunzinger, 1879)	X		X		X		X		X	X	
Favia lizardensis Veron & Pichon, 1977	X		X		X			X	X	X	
Favia maritima (Nemenzo, 1971)	X										Loo & Chou (1995)
Favia matthaii Vaughan, 1918	X		X		X	X	X	X	X	X	
Favia maxima Veron & Pichon, 1977		X	X			X	X	X		X	ZRC.CNI.0142 (RL)
Favia pallida (Dana, 1846)	X		X	X	X	X			X	X	
Favia rotumana (Gardiner, 1899)		X	X				X		X		ZRC.CNI.0197 (RL)
Favia rotundata (Veron & Pichon, 1977)	X		X								Ang (2007)
Favia speciosa Dana, 1846	X		X	X	X	X	X	X	X	X	
Favia stelligera (Dana, 1846)	X				X		X				Ang (2007)
Favia veroni Moll & Borel-Best, 1984	X		X								Ang (2007)
Favites abdita (Ellis & Solander, 1786)	X		X	X	X	X	X	X	X	X	
Favites chinensis (Verrill, 1866)	X		X				X	X	X	X	
Favites complanata (Ehrenberg, 1834)	X		X		X	X		X	X	X	
Favites flexuosa (Dana, 1846)	X		X		X			X	X		
Favites halicora (Ehrenberg, 1834)	X		X		X	X	X	X	X	X	
Favites paraflexuosa Veron, 2000		X				X		X	X		ZRC.CNI.0165 (SI)
Favites pentagona (Esper, 1794)	X		X				X	X	X	X	
Favites russelli (Wells, 1954)	X										Loo & Chou (1995)
Goniastrea aspera Verrill, 1905	X		X	X	X	X	X			X	
Goniastrea australensis (Milne Edwards & Haime, 1857)	X		X		X	X				X	
Goniastrea edwardsi Chevalier, 1971	X		X	X	X	X		X		X	
Goniastrea favulus (Dana, 1846)	X		X					X	X		
Goniastrea minuta Veron, 2000		X	X				X				Guest et al. (2005b)
Goniastrea palauensis (Yabe & Sugiyama, 1936)	X		X						X		
Goniastrea pectinata (Ehrenberg, 1834)	X		X	X	X	X	X	X	X	X	
Goniastrea retiformis (Lamarck, 1816)	X		X	X	X	X		X	X	X	
Leptastrea pruinosa Crossland, 1952	X		X	X				X		X	
Leptastrea purpurea (Dana, 1846)	X		X	X	X	X	X	X	X		
Leptastrea transversa Klunzinger, 1879	X		X	X	X	X	X		X	X	
Leptoria phrygia (Ellis & Solander, 1786)	X		X		X					X	
Montastrea annuligera (Milne Edwards & Haime, 1849)	X										Loo & Chou (1995)
Montastrea colemani Veron, 2000		X	X								ZRC.CNI.0237 (RL)
Montastrea curta (Dana, 1846)	X		X			X	X		X	X	
Montastrea magnistellata Chevalier, 1971	X		X		X	X	X	X	X	X	
Montastrea valenciennesi (Milne Edwards & Haime, 1848)	X		X	X	X	X	X	X	X	X	
Oulastrea crispata (Lamarck, 1816)	X		X	X	X		X	X		X	
Oulophyllia bennettae (Veron & Pichon, 1977)		X	X	X		X			X	X	ZRC.CNI.0169 (SJ)
Oulophyllia crispa (Lamarck, 1816)		X	X			X				X	ZRC.CNI.0145 (RL)
Platygyra daedalea (Ellis & Solander, 1786)	X		X	X	X	X		X	X	X	
Platygyra lamellina (Ehrenberg, 1834)	X		X						X		
Platygyra pini Chevalier, 1975	X		X	X	X	X	X		X	X	
Platygyra ryukyuensis Yabe & Sugiyama, 1936		X	X				X				Guest et al. (2005b)
Platygyra sinensis (Edwards & Haime, 1849)	X		X	X	X	X	X	X	X	X	
Platygyra verweyi Wijsman-Best, 1976	X		X		X	X			X	X	
Fungiidae											
Ctenactis albitentaculata Hoeksema, 1989	X										ZRC.1987.1749
Ctenactis crassa (Dana, 1846)	X										ZRC.1987.3578 (HA)

Table 2 (continued).

Species	PR	NR	Distribution (2005–2008)								Source
			RL	SE	JO	SI	HA	LA	SJ	KU	
Ctenactis echinata (Pallas, 1766)	X		X	X	X		X			X	
Fungia (Cycloseris) vaughani Boschma, 1923	X										Loo & Chou (1995)
Fungia (Danafungia) horrida Dana, 1846	X										ZRC.1987.3493 (HA)
Fungia (Danafungia) scruposa Klunzinger, 1879	X		X	X	X	X					
Fungia (Fungia) fungites (Linneaus, 1758)	X		X		X	X	X		X	X	
Fungia (Lobactis) scutaria Lamarck, 1801	X										Loo & Chou (1995)
Fungia (Pleuractis) moluccensis van der Horst, 1919	X										Hoeksema (2009)
Fungia (Pleuractis) paumotensis Stutchbury, 1833	X		X	X	X	X		X	X	X	
Fungia (Verrillofungia) concinna Verrill, 1864	X			X		X		X	X	X	
Fungia (Verrillofungia) repanda Dana, 1846	X		X	X	X		X	X	X	X	
Fungia (Verrillofungia) scabra Döderlein, 1901	X				X		X		X	X	
Fungia (Wellsofungia) granulosa Klunzinger, 1879	X										ZRC.1987.2206 (CY)
Heliofungia actiniformis (Quoy & Gaimard, 1833)	X		X	X	X		X				
Herpolitha limax (Esper, 1797)	X		X	X	X		X		X		
Lithophyllon undulatum Rehberg, 1892	X		X	X	X		X	X	X	X	
Podabacia crustacea (Pallas, 1766)	X		X	X	X	X	X		X	X	
Podabacia kunzmanni Hoeksema, 2009		X									Hoeksema (2009)
Podabacia motuporensis Veron, 1990		X									
Polyphyllia talpina (Lamarck, 1801)	X			X			X				
Merulinidae											
Hydnophora exesa (Pallas, 1766)	X		X	X	X		X	X		X	
Hydnophora rigida (Dana, 1846)	X		X							X	
Merulina ampliata (Ellis & Solander, 1786)	X		X	X	X	X	X	X	X	X	
Merulina scabricula Dana, 1846	X		X						X	X	
Scapophyllia cylindrica Milne Edwards & Haime, 1848	X		X							X	
Mussidae											
Acanthastrea echinata (Dana, 1846)	X			X	X		X		X	X	
Acanthastrea hillae Wells, 1955	X		X				X	X		X	
Acanthastrea rotundoflora Chevalier, 1975		X		X	X						ZRC.CNI.0238 (SE)
Lobophyllia corymbosa (Forskål, 1775)	X										ZRC.1987.1829 (JO)
Lobophyllia hataii Yabe & Sugiyama, 1936	X										Loo & Chou (1995)
Lobophyllia hemprichii (Ehrenberg, 1834)	X		X	X	X		X		X	X	
Symphyllia agaricia Milne Edwards & Haime, 1849		X	X						X		ZRC.CNI.0239 (SJ)
Symphyllia radians Milne Edwards & Haime, 1849	X		X	X	X	X	X	X	X	X	
Symphyllia recta (Dana, 1846)	X		X	X	X		X		X	X	
Symphyllia valenciennesii Milne Edwards & Haime, 1849		X									Veron (1986)
Oculinidae											
Galaxea astreata (Lamarck, 1816)	X		X								Guest et al. (2005b)
Galaxea fascicularis (Linneaus, 1767)	X		X		X	X	X	X	X	X	
Pectiniidae											
Echinophyllia aspera (Eillis & Solander, 1788)	X		X	X		X	X	X	X	X	
Echinophyllia echinata (Saville-Kent, 1871)	X										ZRC.1987.2146
Echinophyllia echinoporoides Veron & Pichon, 1980	X										Loo & Chou (1995)
Mycedium elephantotus (Pallas, 1766)	X		X	X	X	X	X			X	
Oxypora crassispinosa Nemenzo, 1979	X										Loo & Chou (1995)
Oxypora glabra Nemenzo, 1959	X										ZRC.1987.1845 (SE)
Oxypora lacera (Verrill, 1864)	X		X	X	X		X				
Pectinia alcicornis (Saville-Kent, 1871)	X		X	X	X	X	X		X	X	
Pectinia ayleni (Wells, 1935)		X		X							ZRC.CNI.0240 (SE)

Table 2 (continued).

Species	PR	NR	Distribution (2005–2008)								Source
			RL	SE	JO	SI	HA	LA	SJ	KU	
Pectinia lactuca (Pallas, 1766)	X		X		X						
Pectinia paeonia (Dana, 1846)	X		X	X	X		X				
Pocilloporidae											
Pocillopora damicornis (Linneaus, 1758)	X		X	X	X	X	X	X	X	X	
Pocillopora verrucosa (Ellis & Solander, 1786)	X										ZRC.1991.625
Seriatopora hystrix Dana, 1846	X										Chou et al. (1994a)
Stylophora pistillata Esper, 1797	X		X								
Poritidae											
Alveopora allingi Hoffmeister, 1925	X										Loo & Chou (1995)
Alveopora catalai Wells, 1968	X										ZRC.1987.1890 (HA)
Alveopora excelsa Verrill, 1863	X										ZRC.1980.3.20.120
Alveopora fenestrata (Lamarck, 1816)	X										ZRC.1987.1892 (HA)
Alveopora marionensis Veron & Pichon, 1982	X										Loo & Chou (1995)
Alveopora spongiosa Dana, 1846		X	X	X							ZRC.CNI.0241 (RL)
Alveopora tizardi Bassett-Smith, 1890		X	X	X			X			X	ZRC.CNI.0245 (SE)
Goniopora columna Dana, 1846	X		X	X	X	X		X		X	
Goniopora djiboutiensis Vaughan, 1907	X										ZRC.1987.2184 (CY)
Goniopora eclipsensis Veron & Pichon, 1982	X										ZRC.1987.1905 (HA)
Goniopora fruticosa Saville-Kent, 1893	X										ZRC.1987.1903 (CY)
Goniopora lobata Milne Edwards & Haime, 1860	X		X		X				X		
Goniopora pandoraensis Veron & Pichon, 1982	X										ZRC.1987.1909
Goniopora pendulus Veron, 1985	X										ZRC.1987.1916 (HA)
Goniopora somaliensis Vaughan, 1907	X										ZRC.1987.1914 (HA)
Goniopora stokesi Milne Edwards & Haime, 1851	X										Loo & Chou (1995)
Goniopora stutchburyi Wells, 1955	X										ZRC.1980.3.20.130
Porites australiensis Vaughan, 1918	X			X	X			X	X		
Porites cylindrica Dana, 1846	X										ZRC.1987.1925 (SE)
Porites deformis Nemenzo, 1955		X	X	X							ZRC.CNI.0242 (RL)
Porites lichen Dana ,1846	X				X						
Porites lobata Dana, 1846	X		X	X	X	X	X	X	X	X	
Porites lutea Milne Edwards & Haime, 1851	X		X	X	X	X	X		X	X	
Porites monticulosa Dana, 1846		X	X			X		X	X	X	ZRC.CNI.0243 (RL)
Porites murrayensis Vaughan, 1918	X										Loo & Chou (1995)
Porites nigrescens Dana, 1846	X										ZRC.1987.1951 (HA)
Porites rus (Forskål, 1775)	X										ZRC.1987.1961 (SE)
Porites solida (Forskål, 1775)	X										ZRC.1980.3.20.132
Porites stephensoni Crossland, 1952	X										ZRC.1987.1936 (HA)
Porites vaughani Crossland, 1952	X										Loo & Chou (1995)
Siderastreidae											
Coscinaraea columna (Dana, 1846)	X		X	X	X	X		X		X	
Coscinaraea exesa (Dana, 1846)	X										Loo & Chou (1995)
Psammocora contigua (Esper, 1797)	X										ZRC.1989.41 (HA)
Psammocora digitata Milne Edwards & Haime, 1851	X		X	X	X		X			X	
Psammocora explanulata van der Horst, 1922	X										Loo & Chou (1995)
Psammocora superficialis Gardiner, 1898	X							X		X	
Pseudosiderastrea tayami Yabe & Sugiyama, 1935		X	X	X	X		X	X	X		ZRC.CNI.0244 (RL)
Trachyphylliidae											
Trachyphyllia geoffroyi (Audouin, 1826)	X		X	X			X				