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Fishes of three North West Shelf atolls off Western Australia: Mermaid (Rowley Shoals), Scott and Seringapatam Reefs

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Abstract – The biodiversity of fishes on the Australian North West Shelf atolls is known to be the richest in the state. In recent years however, there has been minimal focus on comprehensive taxonomic fish surveys in this region. Since the atolls are subjected to an increasing frequency of pressures such as major cyclones, coral bleaching, tourism, fishing and natural resource exploitation, it is critical to monitor this region to have the information to safeguard the biodiversity for the future.

To obtain current data that would complement ongoing quantitative surveys in the region, the Western Australian Museum undertook a taxonomic and semi-quantitative survey of the shallow water reef fishes and other major phyla at Mermaid, Scott and Seringapatam Reefs in September 2006. Thirty nine underwater visual surveys were conducted, supplemented by limited intertidal collecting, angling and surface observations.

Analysis of the fish fauna across atolls demonstrated close similarities between North Scott, South Scott and Seringapatam Reefs, and, as a group, these reefs showed certain differences from the more southerly Mermaid Reef. Significant differences were found between lagoonal and outer reef slope habitats. At each atoll, the outer reef slope habitats were more homogeneous and had a greater diversity of fishes than the lagoon habitats, with South Scott lagoon housing a unique mix of both outer reef slope and lagoon species.

Fish diversity was found to increase towards the northern atolls, supporting previous research in the region. The fish fauna at all four atolls had more in common with fish assemblages at equivalent clear-water reefs in Indonesia than with those on the northwest coastal mainland and, as such, are unique within Western Australian waters.

INTRODUCTION

There is considerable concern about the declining biodiversity of coral reef species, including fishes, due to human activities and global warming (Roberts *et al*., 2002). Coral reefs are home to the most diverse shallow water marine ecosystems, with the Indo-Australian Archipelago being the centre of diversity worldwide (Allen, 1999; Bellwood and Wainwright, 2002). The atolls of Australia's North West Shelf are immediately adjacent to this fish diversity 'hotspot' and have some of the most diverse and abundant fish assemblages in the country (Hutchins, 2001; Russell *et al*., 2005). Additionally these atolls are regionally significant because they have many species that do not occur elsewhere in Western Australia (Allen and Russell, 1986; Berry and Marsh, 1986; Hutchins, 2001).

Few coral reefs remain in pristine condition, but some atolls on the North West Shelf are in relatively good condition (Kospartov *et al*., 2006; Gilmour *et al*., 2007). Current concern for the North West Shelf region focuses on increasing human impacts particularly from fishing, recreation and resource exploitation, and also on the increasing incidence and scale of storm events and coral bleaching, possibly exacerbated by global warming (Gilmour *et al*., 2007; Smith *et al*., 2008).

The protection of the biodiversity of the North West Shelf atolls must involve knowledge on how these complex ecosystems function. In order to do this it is important to employ a range of complementary taxonomic and quantitative techniques to examine the flora and fauna at regular intervals. In recent years, however, there has been an emphasis on quantitative surveys of selected families and ecological studies (e.g. Smith *et al.*, 2004; Meekan *et al.*, 2005) rather than comprehensive taxonomic fish surveys of the North West Shelf atolls.

The fishes of the North West Shelf atolls have been examined many times over the past 35 years (Table 1). The first comprehensive taxonomic survey (non-quantitative) of the shallow water fish fauna of the region was a Western Australian Museum survey in the early 1980's (Allen and Russell, 1986). During three ten-day surveys over three consecutive years the two authors used visual observations, rotenone, spearing, hand netting and angling methods to obtain specimens. Incorporating data from a brief survey made in the region by Hutchins of the Western Australian Museum in 1973, they recorded a total of 485 fish species from the three Rowley Shoals reefs and 483 fish species from the Scott and Seringapatam Reefs, providing a total of 688 species for the whole region.

A different approach, using semi-quantitative visual census methods for recording selected fish families, was employed by Williams, Hutchins and Newman on an Australian Institute of Marine Science (AIMS) expedition in late 1993 (Done *et al.*, 1994). In 19 days of visual surveys, they recorded an additional 161 species to those of Allen and Russell, bringing the total for Rowley Shoals, Scott and Seringapatam Reefs to 849 (Hutchins *et al.*, 1995).

Table 1 Summary of previous fish surveys on the Rowley Shoals, Scott and Seringapatam atolls. Institute codes as follows: WAM, Western Australian Museum; AMS, Australian Museum; NTM, Museum of Northern Territory; AIMS, Australian Institute of Marine Science; CSIRO, Commonwealth Scientific and Industrial Research Organisation.

Date	Organisation	Author/ Collector	Location	No. stations/ method	No. species
1973	WAM	Hutchins	Rowley Shoals	Taxonomic	33
1979	AMS	Talbot	Scott Reef	5 / Taxonomic	?
1982, 1983	WAM	Allen & Russell, 1986	Rowley Shoals	34 / Taxonomic	485
1984	WAM & NTM	Allen & Russell, 1986	Scott Reef Seringapatam Reef	54 / Taxonomic	483
				Total for region	688
1993	AIMS	Done *et al.*, 1994	Rowley Shoals Scott Reef Seringapatam Reef	91 / Taxonomic & quantitative	445
				Total for region	**849**
1995 to 2001	AIMS	Gilmour *et al.*, 2007	Rowley Shoals	Long term quantitative monitoring	N/A
1995 to 2008	AIMS	Heyward *et al.*, 1995; Smith *et al.*, 1994	Scott Reef Seringapatam Reef	Long term quantitative monitoring	N/A
1999	CSIRO	Skewes *et al.*, 1999	Scott Reef Seringapatam Reef	Quantitative	N/A
2003	AIMS	Meekan & Cappo, 2004	Rowley Shoals Scott Reef	Shark quantitative monitoring	N/A
2003, 2004	AIMS	Meekan *et al.*, 2005	Rowley Shoals Scott Reef	Shark & fin fish quantitative monitoring	N/A

Above: *Zanclus cornutus* (Linnaeus, 1758). A species widespread among all atolls and habitats. (Photo: Clay Bryce)

Since 1995 AIMS has been involved in regular semi-quantitative visual monitoring of fishes and corals at fixed transect sites on the outer reef slope and lagoon habitats at the Rowley Shoals, Scott and Seringapatam Reefs (Heyward *et al*., 1995; Gilmour *et al*., 2007). Additionally, they have employed baited remote underwater video stations (BRUVs) at greater depths to record deep-water fish assemblages (Meekan and Cappo, 2004; Meekan *et al*., 2005).

Non-quantitative taxonomic surveys of the more northerly atolls of Ashmore, Cartier and Hibernia reefs were conducted by the Western Australian Museum and Northern Territory Museum between 1984 and 1998. Over this period they recorded 924 species, giving a total of over 1,000 fish species for all the North West Shelf atolls (Allen, 1993; Hutchins, 1998; Russell *et al*., 2005).

These surveys found that the North West Shelf atolls had a distinctly different fish fauna from that of the adjacent Australian mainland coast (Allen and Russell 1986; Done *et al*., 1994; Hutchins, 1998; 2001). This was thought to be largely due to the continuous influx of clear oceanic water from the Indonesian throughflow in contrast to the relatively turbid north-west mainland coastal waters (Hutchins, 2001). Many fish species were common to both the Rowley Shoals and Scott Reefs, despite a distance of approximately 400 km between them. There were some clear differences however, with certain species confined to one atoll system and some species that were consistently more abundant at one atoll than the other. For example, the potato cod *Epinephelus tukula* was more abundant at the Rowley Shoals, but the vermicular coral trout *Plectropomus oligocanthus* was only found at Scott Reefs (Allen and Russell, 1986).

Additionally, the data from all surveys indicated a clear gradient of fish diversity increasing from the Rowley Shoals towards Ashmore Reef and Cartier Island, with the more northern fish fauna having stronger Indonesian affinities (Allen and Russell, 1986; Done *et al*., 1994; Heyward *et al*., 1995; Hutchins, 1998; 2001; Russell *et al*., 2005; Gilmour *et al*., 2007).

Some surveys found major differences between the lagoon habitats and the outer reef slope habitats at all Rowley Shoals, Scott and Seringapatam Reefs, with the lagoons having fewer abundant and/or widespread species than the outer reef slope (Done *et al*., 1994). Only a small number of species were abundant and/or widespread in both lagoon and outer reef slope habitats. Differences between the Rowley Shoals and Scott Reefs were largely due to the lagoonal fish assemblages that were generally more diverse and/or abundant at Scott Reefs. The outer reef slope fish communities were not so distinct between atolls. Clear differences were also demonstrated between the outer reef slopes of the North West atolls and outer reef slopes of the Western Coral Sea and outer Great Barrier Reef at similar latitudes (Done *et al*., 1994).

The aim of this survey was to determine current levels of species richness and semi-quantitative measures of abundance of diurnally active fishes in different habitats (lagoons and outer reef slopes) at the Rowley Shoals, Scott and Seringapatam Reefs. This data would enable the comparison of fish assemblages between different atolls and between different habitats within each atoll.

Additionally, the Western Australian Museum surveys are unique in being able to perform comprehensive and simultaneous assessment of major faunal and floral groups, giving a wider overview of the state of the reef ecosystems at any one time compared with previous surveys (see other contributions this volume).

METHODS

A semi-quantitative visual survey method was employed (Williams, 1982). Fish were counted over a 60-minute period, during which the divers swam from a deep location (maximum of 20 metres) to a shallower location at each station. These survey paths started at the station way point (Station and Transect Data section of this volume) and intersected one end of the fixed-depth invertebrate transect lines that were surveyed concurrently. All fish within a 10 metre wide belt were counted using a $\log_5$ scale of abundance – *1* (1 fish); *2* (2–5 fish); *3* (6–25 fish); *4* (26–125 fish); *5* (126–625 fish); *6* (626–3125 fish); *7* (3126 + fish). Effort was given to including some of the cryptic species in the counts. Counts were progressively recorded onto underwater slates. To ensure confidence in identification, waterproof field-guides were carried and where identification was uncertain, specimens were either collected or photographed for later confirmation. Since one of the main aims of this survey was to document maximum fish species richness, it was decided to balance the two tasks of estimating fish abundance and fish identification, resulting in a single long transect covering a wider range of depths (and therefore more fish species) than would be possible with replicate transects at fixed depths. The transect length varied depending on the physical configuration of each station. For the best estimates of species abundance it is recognised that replicates of a transect are required (Quinn and Keough, 2002), however, restrictions on bottom time for SCUBA divers and overall field time precluded such replication.

Due to the vast diversity and abundance of the known fish fauna at Mermaid, Scott and Seringapatam atolls, species were divided between two observers. G. Moore was responsible for all Chondrichthyes, Caesionidae, Serranidae, Anthiinae, Ephippidae, Chaetodontidae, Pomacanthidae, Pomacentridae, Labridae and

Table 2 Summary of fish survey methodology and habitat types at each station. All stations were surveyed on SCUBA except where indicated for snorkel ^{sk} and rotenone collections ^{ro}.

Atoll	Habitat	Station
Mermaid Reef	Lagoon	*1, 6* ^{sk}*, 7, 8, 9, 11, 12, 14*
	Outer Reef Slope	2, 4, 5, 15, 16
	Intertidal	*3* ^{sk}
	Channel	10, 13
South Scott Reef	Lagoon	18, 23, 25, 26, 29
	Outer Reef Slope	17, 19, 20, 22, 28, 30
	Intertidal	*21* ^{ro}*, 27* ^{ro}
North Scott Reef	Lagoon	32, 38, 39
	Outer Reef Slope	31, 34, 36,
	Intertidal	*33* ^{ro}*, 35* ^{sk}
	Channel	40
Seringapatam Reef	Lagoon	42, 43
	Outer Reef Slope	41, 45
	Intertidal	*44* ^{ro}

several other small families. S. Morrison was responsible for Muraenidae, Synodontidae, Holocentridae, Scorpaenidae, Serranidae, Pseudochromidae, Apogonidae, Carangidae, Lutjanidae, Nemipteridae, Haemulidae, Lethrinidae, Pempheridae, Cirrhitidae, Pinguipedidae, Blenniidae, Gobiidae, Acanthuridae, Siganidae, Balistidae, Monacanthidae, Tetraodontidae, Diodontidae and several other small families. In addition, rare or unusual fishes were recorded by either observer, often following some underwater acknowledgement by both divers. Due to inconsistencies with identifications, scarids were omitted.

Thirty nine visual surveys were conducted on SCUBA or snorkel (Table 2). Station locations and descriptions are provided in the Station Transect Data section of this volume. Four intertidal stations were sampled by rotenone at low tide (Table 2), angling was utilised sporadically and a few species were recorded opportunistically from incidental sightings or via substrate sampling for other phyla. These other records were used to compile the species lists in Appendix 1, and were not included in any analyses. Intertidal Stations 24 and 37 were not sampled for fish because the water movement was too great for a rotenone station. Stations were selected to cover as many representative habitats as possible, within intertidal areas, channels, lagoon floors, bommies, inner reef slopes and outer reef slopes of each atoll, including different levels of exposure and habitat complexity. It was aimed to survey an equivalent number of stations in each of the various habitats, but unfavourable weather and time restrictions limited this plan. The outer reef slope on the west coast of each atoll was under-represented in the survey due to its exposed orientation/aspect and few stations at Seringapatam Reef were surveyed due to time restrictions.

Data were analysed using PRIMER (for Windows v.6.1.10). Data analysis was restricted to those species recorded during the visual surveys at lagoon, outer reef slope and channel sites. No transformation of the data was required since the original data was collected on a $\log_5$ scale. A Bray-Curtis similarity matrix of non-transformed $\log_5$ abundance data was subjected to cluster analysis using group averages to construct a dendrogram. The same similarity matrix was then used for non-metric multi-dimensional scaling analysis (nMDS) of the combined data, selecting the most parsimonious of 30 iterations. Two-way nested analysis of similarity (ANOSIM) was used for comparisons among atolls and among habitats. Two separate one-way ANOSIM analyses were

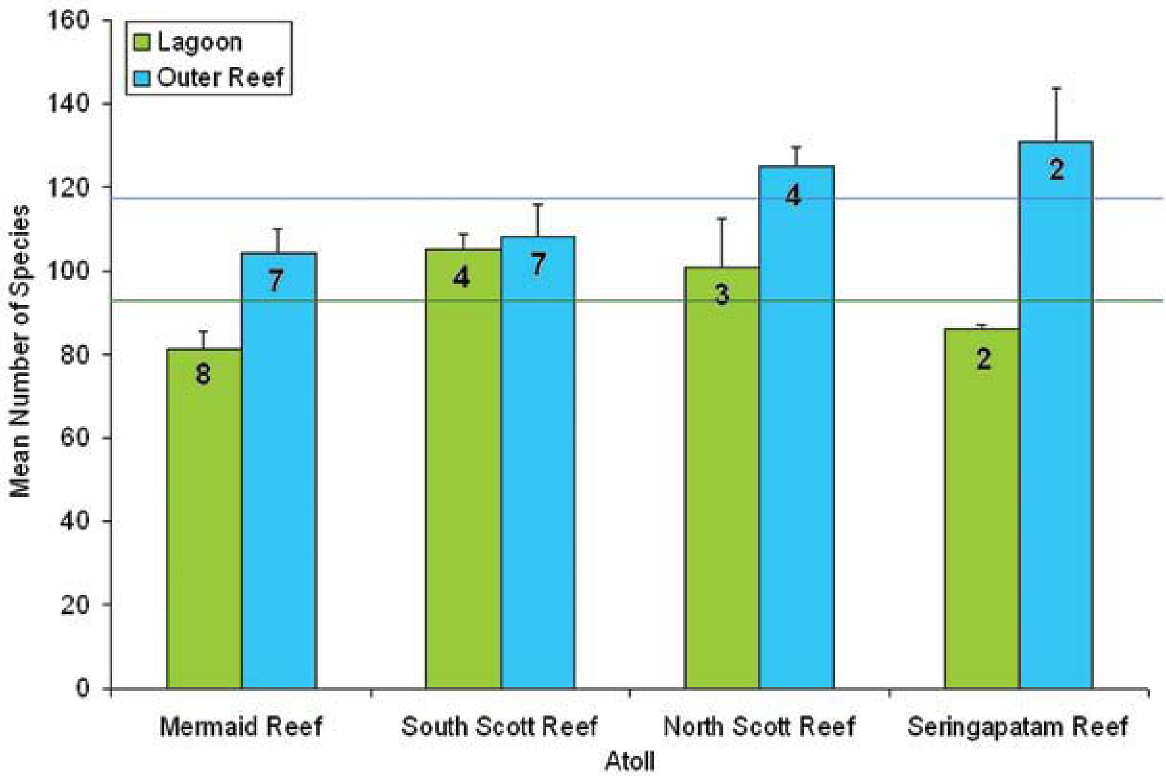


Figure 1 Mean number of species per station within each major habitat across the four atoll systems (visual survey data only). Number of stations is indicated by a numeral within the column and standard error is shown by a bar. Means for each habitat across all atolls are indicated by a green and blue line for lagoon and outer reef slopes, respectively.

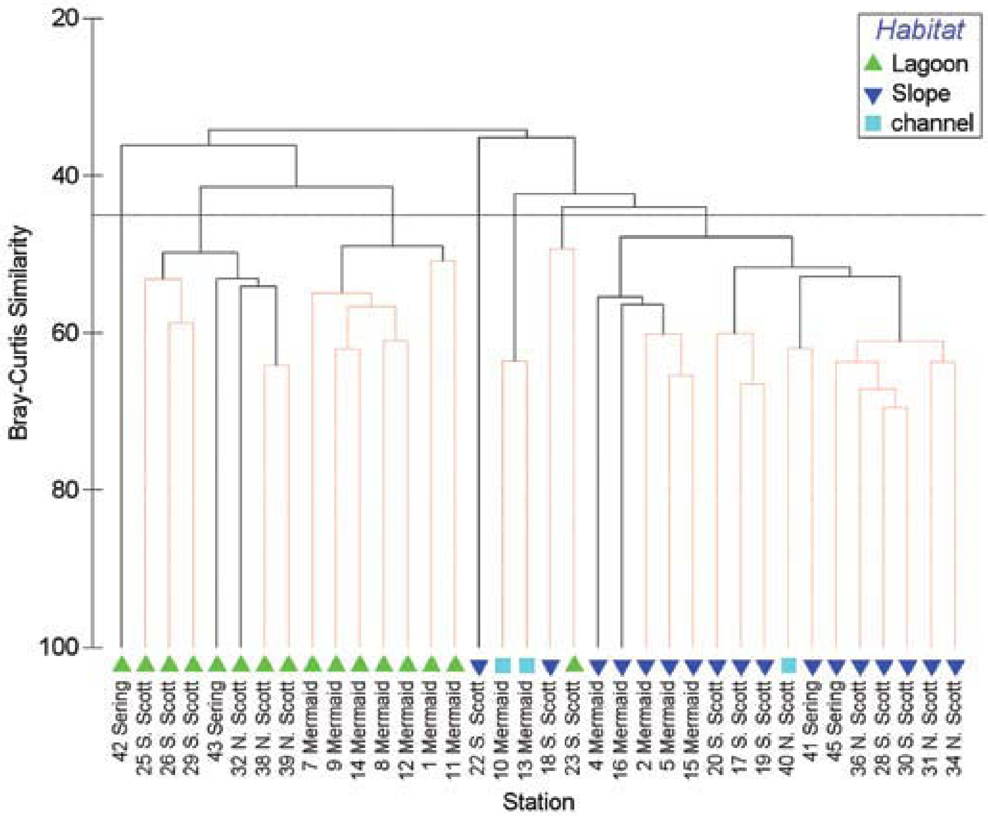


Figure 2 Cluster dendrogram (Bray-Curtis similarity) of $\log_5$ species abundance data from all stations at Mermaid, Scott and Seringapatam Reefs. Groups at 45% similarity are identified as significant by the black lines and non-significant by the red lines as determined by SIMPROF. Station numbers are indicated as a prefix to the atoll name and habitats are coded as in the key.

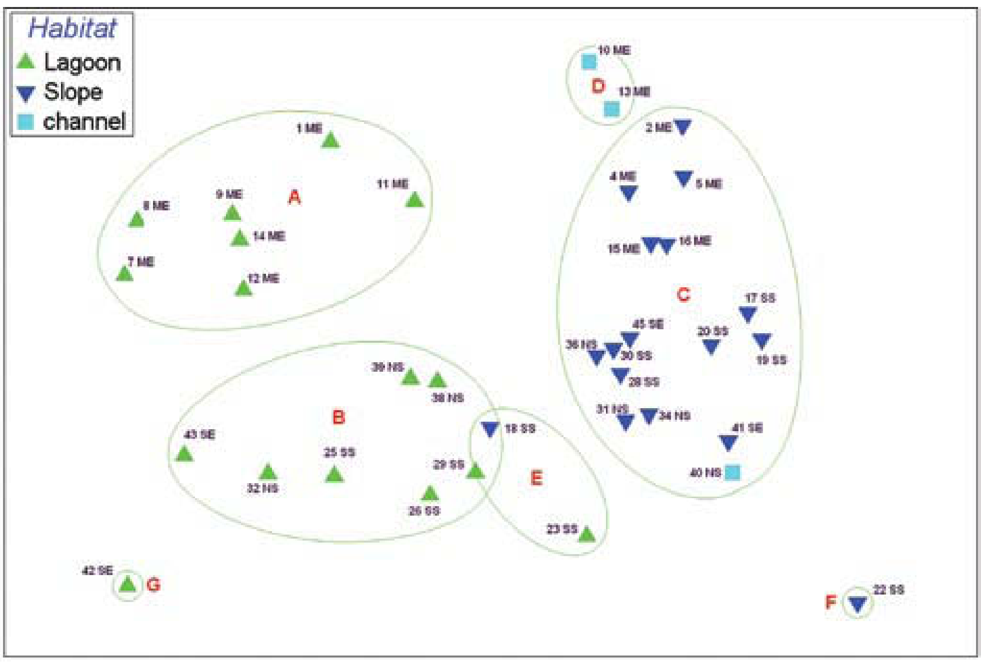


Figure 3 Non-metric multidimensional scaling (MDS) plot of $\log_5$ species abundance data from all habitats at Mermaid, Scott and Seringapatam Reefs (Stress coefficient = 0.14). Cluster pattern at 45% similarity. SIMPROF clusters indicated by letters A to F. Line added to indicate position of Mermaid Reef stations relative to others.

Above: *Caranx sexfasciatus* Quoy & Gaimard, 1825 (Photo: John Huisman)

run for each of the habitat factors (lagoon and outer reef slope) that were found to be significantly different in the nested ANOSIM test. Two separate one-way similarity percentage analyses (SIMPER) of non-transformed $\log_5$ abundance data were performed (excluding the lower 10% of contributing species), to determine the species characterising the assemblages within each habitat at each atoll. SIMPER analysis of the dendrogram cluster groups at the 45% similarity level was carried out to examine which families and species characterise each cluster.

RESULTS

Species richness across all atolls and habitats

A total of 461 species of fishes from 61 families was recorded over all three atoll systems, of which 417 species were recorded during the visual surveys. A further 37 species were added from rotenone and seven from opportunistic sightings and angling. The total fish fauna for each atoll was as follows; Mermaid, 293 species; South Scott Reef, 325 species; North Scott Reef, 271 species (combined Scott Reefs, 387 species) and Seringapatam, 267 species (Appendix 1).

Across all atolls, outer reef slopes ($\bar{x}$ =117 species) were on average more species rich than lagoon habitats ($\bar{x}$ =93 species). Mean species richness of outer reef slope stations increased with decreasing latitude of atoll system such that the outer reef slope stations at Mermaid Reef averaged 104 species and those at Seringapatam Reef averaged 131 species (Figure 1). Similarly, species richness within lagoons was lowest at Mermaid Reef (81 species) and peaked at South Scott Reef (105 species) (Figure 1).

Individual stations with the highest diversity of fishes were outer reef slope habitats at all atolls: Mermaid Reef station 16 (132 species); South Scott Reef station 28 (126 species); North Scott Reef station 34 (138 species) and Seringapatam Reef station 45 (140 species). Lowest diversity was recorded in lagoon habitats at Mermaid Reef stations 1 and 8 (74 species); North Scott Reef station 32 (80 species) and Seringapatam Reef station 42 (85 species), while outer reef slope station 22 on the north side of Sandy Islet held the lowest diversity at South Scott Reef (63 species).

Comparison of fish assemblages between atolls and habitats

Cluster analysis based on abundance data revealed strong clustering of stations by habitat, more so than for atoll (Figure 2). Lagoonal stations of Mermaid Reef were further separated from the Scott/Seringapatam Reef complex and, with a few

Table 3 Pairwise ANOSIM comparisons of lagoon and outer reef slope habitats at all atolls.

	Lagoon		Outer reef slope	
Comparison	**R**	**p**	**R**	**p**
Mermaid/South Scott	0.96	0.003	0.38	0.005
Mermaid/North Scott	0.83	0.008	0.96	0.018
Mermaid/Seringapatam	0.88	0.028	0.83	0.048
South Scott/North Scott	0.30	0.114	0.01	0.450
South Scott/Seringapatam	0.79	0.067	-0.05	0.500
North Scott/Seringapatam	0.42	0.100	0.17	0.400

exceptions, the same was true for outer reef slope stations. The communities at several stations (10, 13, 18, 22, 23, and 42) were 'atypical' in that they did not cluster with the above groups. Channel stations 10 and 13 at Mermaid Reef, and 40 at North Scott Reef had fish communities more similar to the outer reef slope fish assemblages than the lagoonal ones. Notable in this analysis was that lagoon stations 18 and 23 from South Scott Reef tended to cluster in an intermediate position between the outer reef slope and lagoon stations of the Scott/ Seringapatam Reef complex.

Unlike the cluster analysis, multidimensional scaling analysis (MDS) of abundance data indicated a possible difference between the fish communities at Mermaid Reef and those at the two northern atolls (Figure 3). Furthermore, stations at both of the atoll groups (Mermaid and Scott/Seringapatam reef complex) fell into two groupings loosely based on lagoon and outer reef slope habitats (Figure 3). As in the cluster analysis, stations 10, 13, 18, 22, 23 and 42 had various degrees of separation from the main groupings.

To determine whether any of the above differences were significant, two-way nested ANOSIM analysis was carried out. This showed no significant difference between atolls (Global R = 0.061, p=0.353). Pairwise tests between atolls were therefore not valid. Analysis of the habitats, however, resulted in a highly significant difference between habitats (Global R = 0.788, p=0.0001).

Separate one way ANOSIM analysis of the lagoon habitats and outer reef slope habitats showed a highly significant difference between lagoons at each atoll (Global R = 0.77, p=0.001), and between the outer reef slopes at each atoll (Global R = 0.30, p=0.012).

Pairwise tests between the habitats at each atoll showed significant differences between the lagoon at Mermaid and the lagoons at the Scott/ Seringapatam reef complex, but lagoon habitats at North Scott, South Scott and Seringapatam reefs showed no differences (Table 3). A similar pattern was evident for the outer reef slope habitats (Table 3).

Cluster analysis (Figure 4) and MDS analysis (Figure 5) of the lagoon stations across all atolls clearly supports the separation of Mermaid Reef lagoon assemblages from those at all other atolls. One South Scott Reef lagoon station (23) and one Seringapatam Reef lagoon station (42) were distinct from all other lagoon stations.

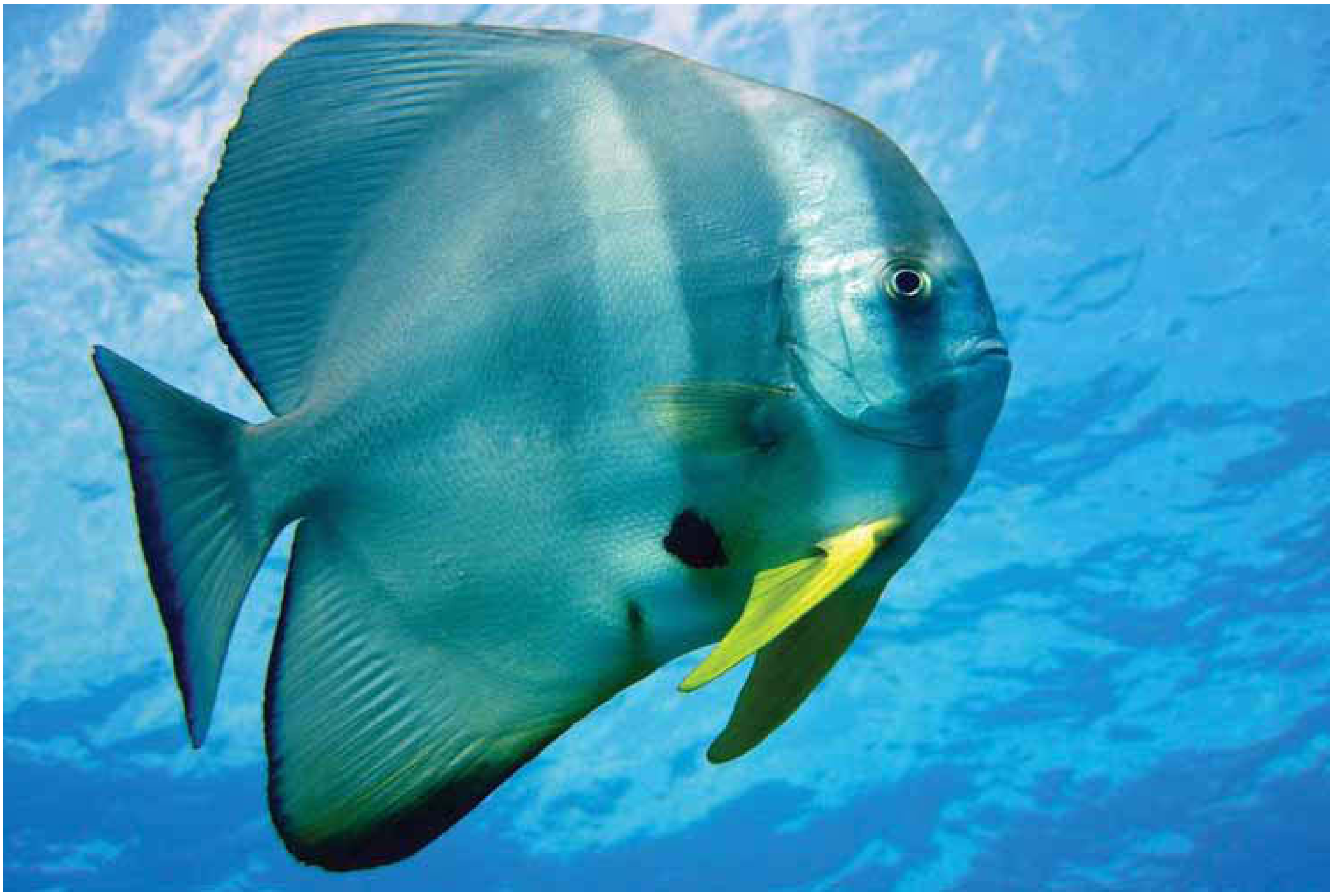
Cluster analysis (Figure 6) and MDS analysis (Figure 7) of the outer reef slope stations across all atolls also supports the separation of Mermaid Reef outer reef slope assemblages from those at all other atolls, although the distinction is not so clear as in the lagoon stations. South Scott outer reef slope stations 18 and 22 and Seringapatam Reef outer reef slope station 42 are distinct from all other outer reef slope stations.

Taxonomic characteristics of SIMPROF groupings

The main differences between the SIMPROF groups were driven by a small number of families. The twenty most abundant fish species were dominated by Pomacentridae, Labridae and Acanthuridae in all groups, except for group G where Acanthuridae were not recorded (Figure 8). Chaetodontidae, Lethrinidae and Lutjanidae were the next most abundant families in the majority of SIMPROF groups. Fifteen other families (Holocentridae, Zanclidae, Apogonidae, Pomacanthidae, Gobiidae, Balistidae, Serranidae, Mullidae, Haemulidae, Carangidae, Nemipteridae, Clupeidae, Cirrhitidae, Synodontidae and Caesionidae) represented the remaining top twenty species to a lesser degree and only occurred in one or two of the SIMPROF groups.

The top twenty species accounted for between 44% and 51% of the abundance at lagoon stations, approximately 37% of the abundance at outer slope stations, and around 52% of the abundance in the channels. Only one species occurred among

Above: *Epinephelus tukula Morgans*, 1959. A species regularly found at the Rowley Shoals. (Photo: John Huisman)



Above: *Platax teira* (Forsskål, 1775) (Photo: John Huisman)

Left: *Pomacentrus vaiuli* Jordan & Seale, 1906 (Photo: Glenn Moore); **Right:** *Amphiprion clarkii* (Bennett, 1830) (Photo: Clay Bryce)

the top twenty in all SIMPROF groups, namely; *Pomacentrus philippinus*. Two species (*Pomacentrus vaiuli* and *Monotaxis grandoculis*) were present in four of the five SIMPROF groups, and six species (*Chromis margaritifer, Dascyllus aruanus, Pomacentrus coelestis, P. moluccensis, Thalassoma amblycephalum and Ctenochaetus striatus*) were present in three of the five SIMPROF groups.

The distribution of species at each atoll indicates that a greater percentage of species were confined to the outer reef slope habitats, compared with the lagoon habitats.(Table 4). Species found in both habitats comprised the greatest proportion at all atolls except Seringapatam Reef where the proportion was intermediate between the lagoon and the outer reef slope habitats.

Fish assemblages at each atoll

All atolls and habitats had slightly different fish assemblages based on the ten most abundant species (Figure 9; Tables 5 to 8). North and South Scott Reefs had six of the ten most abundant species in common, combined Scott Reefs and Seringapatam Reef had five species in common, and Mermaid Reef had four in common with both combined Scott Reefs and Seringapatam Reefs. A great diversity of less-abundant species from these families were recorded, many wide-ranging between atolls and habitats, and others confined to a certain atoll or habitat. Some of the widespread, but not necessarily abundant species among all atolls and habitats were *Chaetodon auriga*, *C. trifasciatus*, *C. ulietensis*, *Chromis margaritifer*, *Pomacentrus vaiuli*, *Halichoeres hortulanus*, *Labroides dimidiatus*, *Thalassoma amblycephalum*, *T. hardwickei*, *Cephalopholis argus*, *Lutjanus bohar*, *L. decussatus*, *L. gibbus*, *Ctenochaetus striatus*, *Naso lituratus*, *Zebrasoma scopas* and *Zanclus cornutus*.

Mermaid Reef

Mermaid Reef lagoon and outer reef slope habitats had distinctly different fish faunas (Table 5). Of a total of 290 fish species recorded visually from Mermaid Reef, approximately 13% were confined to the lagoon, 23% were confined to the outer reef slope and 64% were found in both habitats (Table 4). Of the ten most abundant species only two (*Pomacentrus philippinus* and *P. vaiuli*) were common to both habitats. The most abundant species in both habitats were pomacentrids, however, outer reef slope assemblages were strongly influenced by labrids, acanthurids and

Table 4. Percentage distribution of species at each atoll, using SIMPER dissimilarity analysis (cut off at 90% of species).

Atoll	Lagoon only	Outer Reef only	Both habitats
Mermaid	13%	23%	64%
South Scott	11%	18%	71%
North Scott	12%	31%	57%
Seringapatam	23%	45%	32%

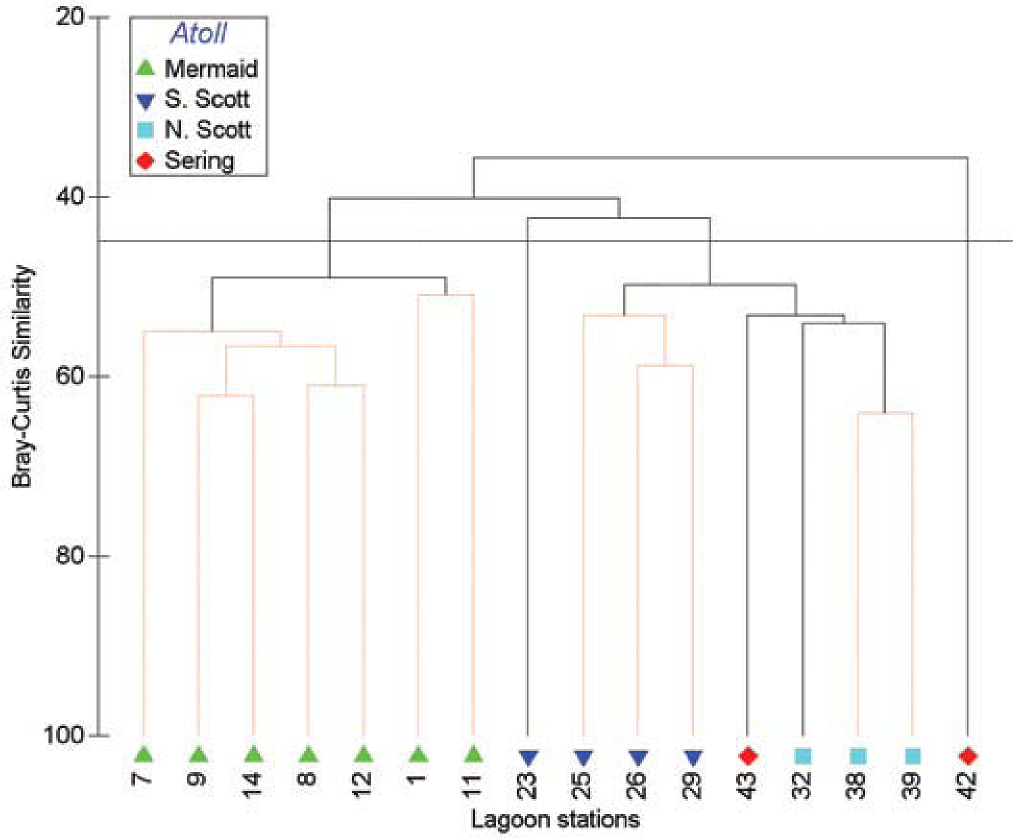


Figure 4 Cluster dendrogram (Bray-Curtis similarity) of $\log_5$ species abundance data from lagoon stations at Mermaid, Scott and Seringapatam Reefs. Groups at 45% similarity are identified as significant by the black lines and non-significant by the red lines as determined by SIMPROF. Station numbers are indicated and atolls are coded as in the key.

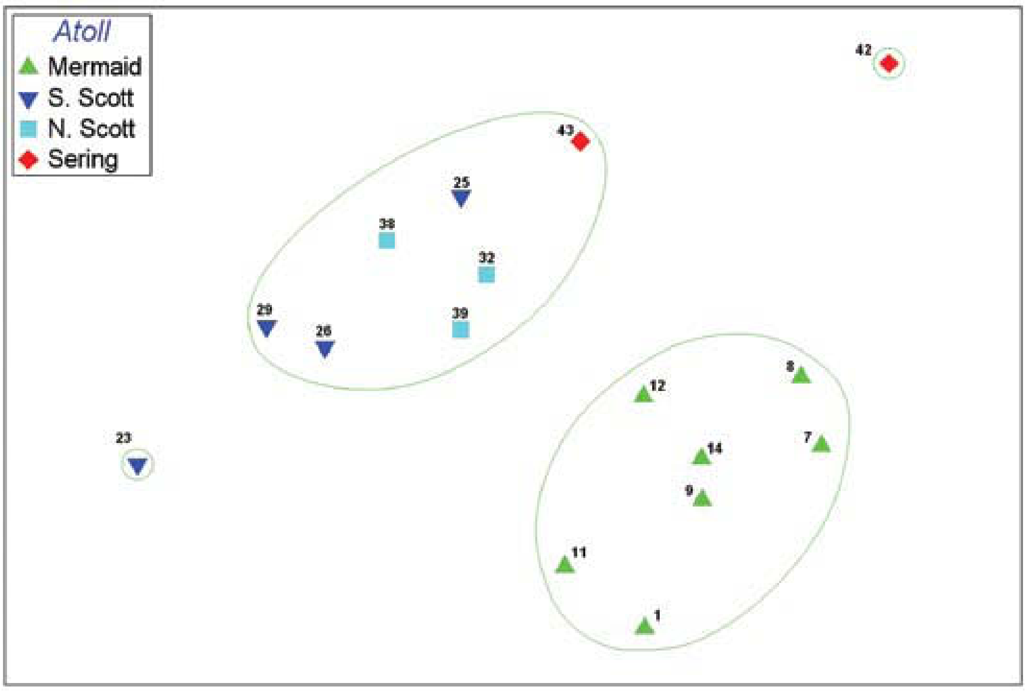


Figure 5. Non-metric multidimensional scaling (MDS) plot of $\log_5$ species abundance data from lagoon stations at Mermaid, Scott and Seringapatam Reefs (Stress coefficient = 0.12). Cluster pattern at 45% similarity.

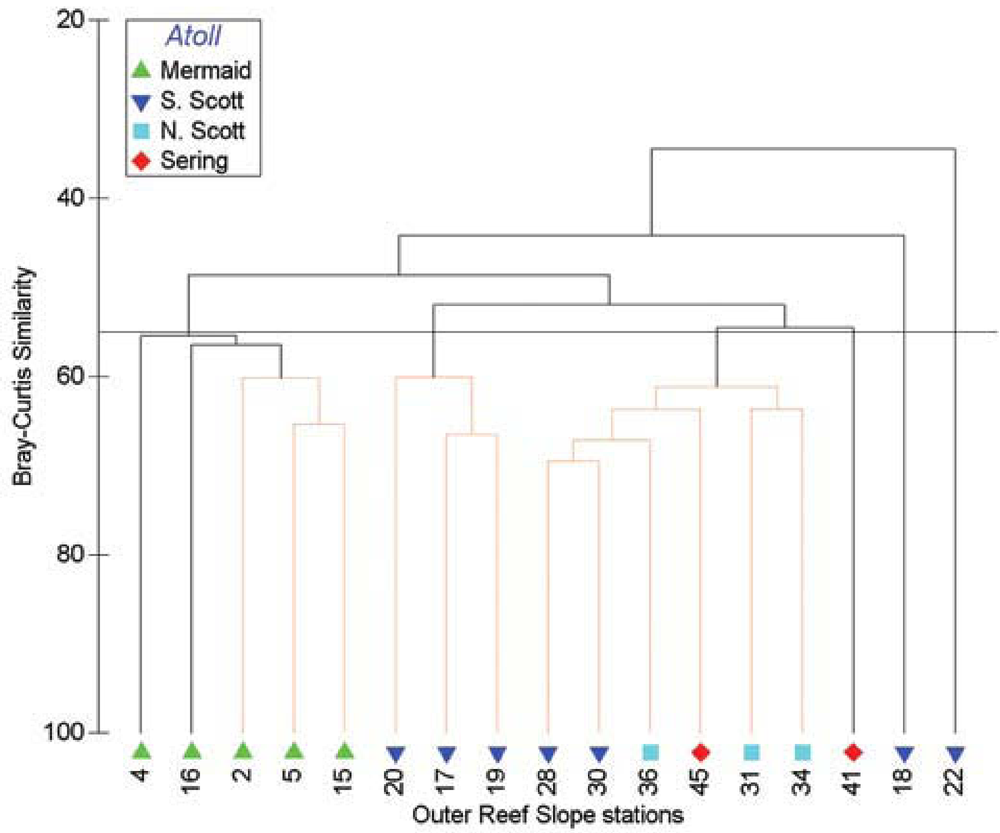


Figure 6 Cluster dendrogram (Bray-Curtis similarity) of $\log_5$ species abundance data from outer reef slope stations at Mermaid, Scott and Seringapatam Reefs. Groups at 55% similarity are identified as significant by the black lines and non-significant by the red lines as determined by SIMPROF. Station numbers are indicated and atolls are coded as in the key.

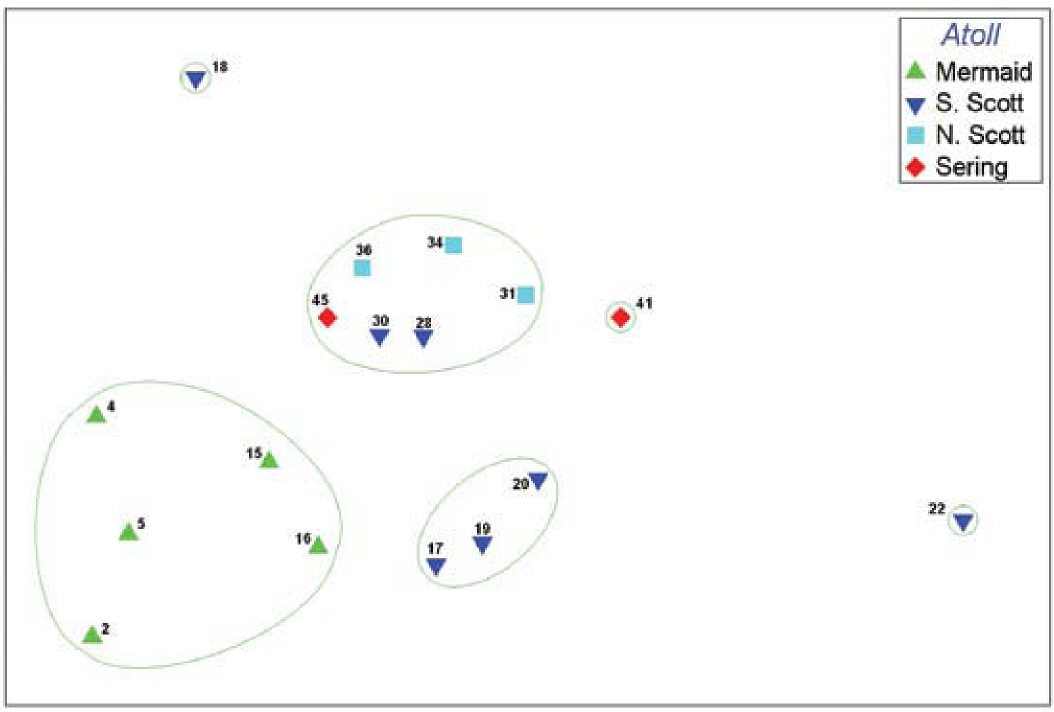


Figure 7 Non-metric multidimensional scaling (MDS) plot of $\log_5$ species abundance data from outer reef slope stations at Mermaid, Scott and Seringapatam Reefs (Stress coefficient = 0.1). Cluster pattern at 55% similarity.

serranids (Table 5). *Pomacentrus moluccensis* was very abundant in the lagoon but occurred in small numbers on the outer reef slope. *Acanthurus nigricans* occurred only on the outer reef slope, wheareas *Zebrasoma scopas*, *Ctenochaetus striatus* and *Naso lituratus* were in greater abundance on the outer reef slope than in the lagoon. Further distinctions were due to *Halichoeres melanurus* being more abundant in the lagoon regions, and *Thalassoma quinquevittatum* and *Pseudanthias tuka* only occurring on the outer reef slope.

The lagoon at Mermaid Reef was characterised by the following abundant and/or widespread species that were only recorded from this habitat; *Epinephelus merra*, *Pseudochromis fuscus*, *Symphorichthys spilurus*, *Dascyllus aruanus*, *Pomacentrus adelus*, *P. grammatorhynchus*, *Hemiglyphidodon plagiometapon*, *Chaetodon punctatofasciatus*, *C. lineolatus* and *Meiacanthus atrodorsalis*. The outer reef slope of Mermaid Reef had a greater number of abundant and/or widespread species confined to this habitat as follows; *Pictichromis paccagnellae, Cheilodipterus quinquelineatus, Lutjanus rivulatus, Parupeneus bifasciatus, Chaetodon unimaculatus, C. meyeri, Abudefduf vaigiensis, Chromis xanthura, Dischistodus perspicillatus, Thalassoma quinquevittatum, Halichoeres melanurus, Siganus doliatus, Acanthurus nigricans, Naso caesius, Melichthys niger* and *M. vidua* (Appendix 1).

South Scott Reef

Of a total of 297 species recorded from South Scott Reef, around 11% were confined to the lagoon, 18% confined to the outer reef slope and 71% were found in both habitats (Table 4). Of the ten most abundant species (Table 6) there were three common to both habitats: *Pomacentrus lepidogenys*, *P. philippinus* and *Ctenochaetus striatus*. Pomacentrids dominated the most abundant species in the lagoon habitats with *Chrysiptera rex*, *Dascyllus aruanus* and *Pomacentrus moluccensis* much more abundant in the lagoon than the outer reef slope region. The labrids *Cirrhilabrus randalli* and *Thalassoma lunare* were also more abundant within the lagoon compared with the outer reef slope. The outer reef slope had the reverse pattern for the pomacentrids *Pomacentrus vaiuli*, *Chromis margaritifer* and the serranid *Pseudanthias tuka*. Of the ten most abundant species, only *Naso caesius* was confined to the outer reef slope.

Pomacentrids and labrids dominated the fish assemblages in the lagoon areas. Some of the more widespread and/or abundant species only recorded from the 'lagoon' stations at South Scott Reef included *Pseudochromis fuscus, Caesio caerulaurea, Forcipiger flavissimus, Dischistodus prosoptaenia, Coris schroederi* and *Ecsenius bicolor*. A greater diversity of species were found confined to the outer reef slope assemblage including the more abundant and/or widespread species; *Plectropomus oligocanthus, Parupeneus bifasciatus, Chaetodon citrinellus, Gomphosus varius, Halichoeres prosopeion, Thalassoma quinquevittatum, Nemateleotris magnifica, Ptereleotris evides, Naso brachycentron, N. caesius, Melichthys niger, M. vidua* and *Sufflamen bursa*. The most speciose families were the chaetodontids, pomacentrids, labrids, acanthurids and balistids.

North Scott Reef

Of the 260 fish species recorded from North Scott Reef, 12% were confined to the lagoon, 31% confined to the outer reef slope and 57% were found in both habitats (Table 4). The lagoon and outer reef slope at North Scott Reef had equivalent numbers of pomacentrids, labrids, acanthurids and

Table 5. The ten most abundant fish species in lagoon and outer reef slope habitats at Mermaid Reef.

Order of abundance	Mermaid lagoon	Mermaid outer reef
1	Pomacentrus moluccensis	Thalassoma amblycephalum
2	Dascyllus aruanus	Zebrasoma scopas
3	Chromis viridis	Acanthurus nigricans
4	Pomacentrus coelestis	Pseudanthias tuka
5	Thalassoma hardwickei	Pomacentrus philippinus
6	Pomacentrus adelus	Ctenochaetus striatus
7	Pomacentrus philippinus	Thalassoma quinquevittatum
8	Pomacentrus vaiuli	Pomacentrus vaiuli
9	Acanthurus blochi	Naso lituratus
10	Halichoeres trimaculatus	Chromis ternatensis
Percentage of total abundance	**31%**	**23%**

Above: *Chaetodon ephippum* Cuvier, 1831 (Photo: Clay Bryce)

lutjanids among the ten most abundant species (Table 7). Of these, three species, *Pomacentrus lepidogenys*, *P. philippinus* and *Lutjanus gibbus*, were common to both regions. Three species of pomacentrids that were restricted to the lagoon were *Chromis viridis*, *Chrysiptera hemicyanea* and *Pomacentrus moluccensis*. Two additional species (*Dascyllus aruanus* and *Thalassoma hardwickei*) were more abundant in the lagoon than the outer reef slope. Of the ten most abundant outer reef slope species, two (*Chromis weberi* and *Naso caesius*) were restricted to this habitat. Of the remaining species, *Thalassoma amblycephalum*, *Cirrhilabrus randalli* and *Pomacentrus nigromarginatus*, were markedly more abundant on the outer reef slope than in the lagoon. There appeared to be less interchange of species between the lagoon and outer reef slope than at South Scott Reef.

Species confined to the lagoon that were abundant and/or widespread included *Epinephelus merra, Amblyglyphidodon curacao, Chromis viridis, Chrysiptera hemicyanea, Plectroglyphidodon lacrymatus, Pomacentrus chrysurus, P. moluccensis, Stegastes nigricans* and *Hemigymnus melapterus*. The assemblages were dominated by pomacentrids and labrids, which differs from the more even spread of families in South Scott Reef lagoon. Species confined to the outer reef slope of North Scott Reef were more diverse and numerous. Among the more abundant and/or widespread were; *Cephalopholis urodeta, Plectropomus laevis, Gymnocranius aurolineatus, Chaetodon ornatissimus, Forcipiger flavissimus, Abudefduf vaigiensis, Amphiprion clarkii, Chromis weberi, C. xanthura, Dascyllus trimaculatus, Bodianus axillaris, Coris gaimardi, Halichoeres marginatus, H. prosopeion, Macropharyngodon meleagris, Pseudodax moluccanus, Nemateleotris magnifica, Acanthurus nigricans, A. olivaceus, Naso brevirostris, N. caesius, Balistoides conspicillum, B. viridescens, Odonus niger, Sufflamen chrysopterus* and *S. bursa*. The most speciose of these families were pomacentrids, labrids, gobiids, acanthurids and balistids.

Seringapatam Reef

Of the 256 fish species recorded from Seringapatam Reef, approximately 23% were confined to the lagoon, 45% were confined to the outer reef slope, and 32% were found in both habitats (Table 4). Among the ten most abundant lagoon and outer reef slope species at Seringapatam, half were restricted to one habitat or the other (Table 8). Only one species, *Labroides dimidiatus*, was common to both habitats. Six species were restricted to the lagoon; apogonids *Cheilodipterus quinquelineata* and *C. macrodon*, pomacentrids *Pomacentrus coelestis*, *Chromis viridis*, *Dascyllus aruanus* and *Amblyglyphidodon curacao*. The labrids *Thalassoma lunare* and *T. hardwickei* were more abundant in the lagoon than the outer reef slope. Four species were restricted to the outer reef slope habitat; *Pseudanthias tuka*, *Cirrhilabrus randalli, Chromis xanthura* and *Naso caesius*. The remaining five species, *Chromis margaritifer, C. weberi, C. lepidolepis*, *Ctenochaetus striatus* and *Thalassoma amblycephalum* were clearly more abundant on the outer reef slope than the lagoon.

Some of the abundant and/or widespread

Table 6 The ten most abundant fish species at South Scott Reef habitats

Order of abundance	South Scott lagoon	South Scott outer reef slope
1	*Pomacentrus lepidogenys*	*Pomacentrus vaiuli*
2	*Chrysiptera rex*	*Pomacentrus philippinus*
3	*Pomacentrus philippinus*	*Pomacentrus lepidogenys*
4	*Dascyllus aruanus*	*Chromis margaritifer*
5	*Pomacentrus moluccensis*	*Pseudanthias tuka*
6	*Ctenochaetus striatus*	*Halichoeres hortulanus*
7	*Cirrhilabrus randalli*	*Chromis amboinensis*
8	*Thalassoma lunare*	*Ctenochaetus striatus*
9	*Monotaxis grandoculis*	*Naso caesius*
10	*Lutjanus decussatus*	*Thalassoma amblycephalum*
Percentage of total abundance	**27%**	**27%**

Table 7 The ten most abundant fish species at North Scott Reef habitats

Order of abundance	North Scott lagoon	North Scott outer reef slope
1	*Chromis viridis*	*Thalassoma amblycephalum*
2	*Ctenochaetus striatus*	*Chromis weberi*
3	*Pomacentrus lepidogenys*	*Pomacentrus lepidogenys*
4	*Dascyllus aruanus*	*Pomacentrus philippinus*
5	*Chrysiptera hemicyanea*	*Lutjanus gibbus*
6	*Pomacentrus philippinus*	*Cirrhilabrus randalli*
7	*Pomacentrus moluccensis*	*Pomacentrus nigromarginatus*
8	*Thalassoma lunare*	*Pomacentrus amboinenesis*
9	*Lutjanus gibbus*	*Naso caesius*
10	Thalassoma hardwickei	Pomacentrus vaiuli
Percentage of total abundance	**27%**	**23%**

Table 8 The ten most abundant fish species at Seringapatam Reef habitats.

Order of abundance	Seringapatam lagoon	Seringapatam outer reef slope
1	*Cheilodipterus quinquelineatus*	*Pseudanthias tuka*
2	*Thalassoma lunare*	*Chromis margaritifer*
3	*Pomacentrus coelestis*	*Chromis weberi*
4	*Chromis viridis*	*Ctenochaetus striatus*
5	*Dascyllus aruanus*	*Cirrhilabrus randalli*
6	*Thalassoma hardwickei*	*Pomacentrus lepidogenys*
7	*Amblyglyphidodon curacao*	*Chromis xanthura*
8	*Labroides dimidiatus*	*Naso caesius*
9	*Cheilodipterus macrodon*	*Thalassoma amblycephalum*
10	*Naso lituratus*	*Labroides dimidiatus*
Percentage of total abundance	**47%**	**27%**

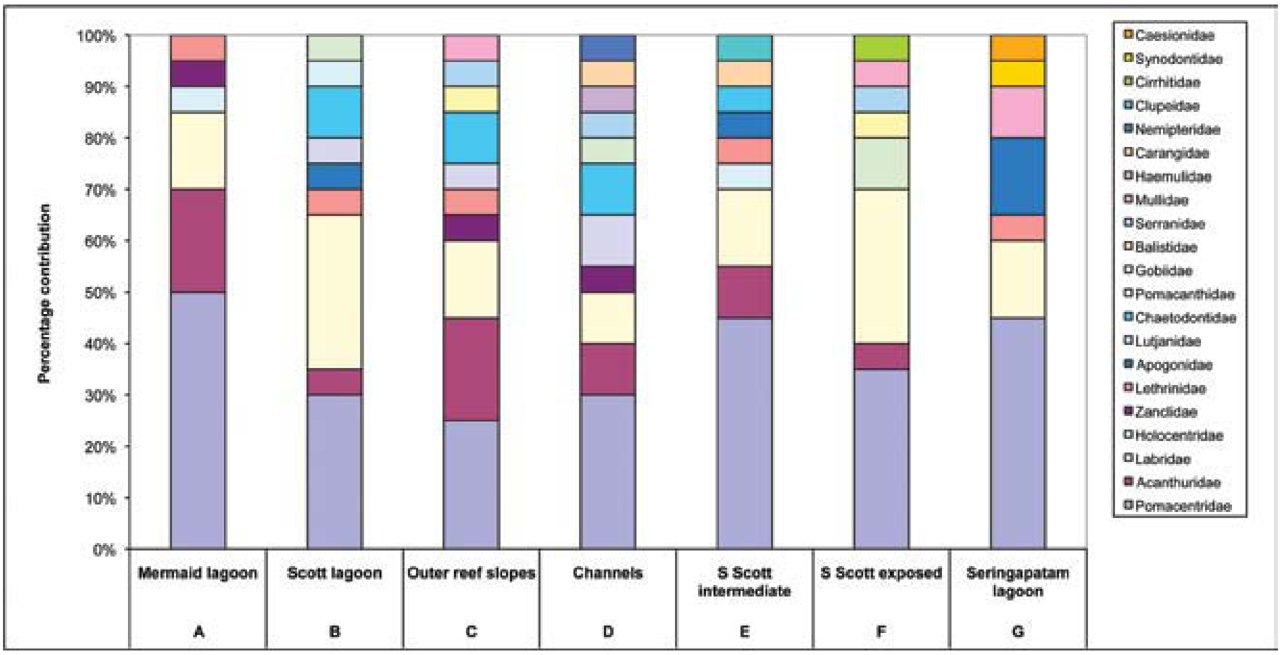


Figure 8 Families of the twenty most abundant fish species in the 45% SIMPROF groupings determined by cluster analysis (Figure 2) and nMDS (Figure 3) derived from $\log_5$ species abundance data from Mermaid, Scott and Seringapatam Reefs. SIMPROF groupings (Figure 3) are labelled A to G.

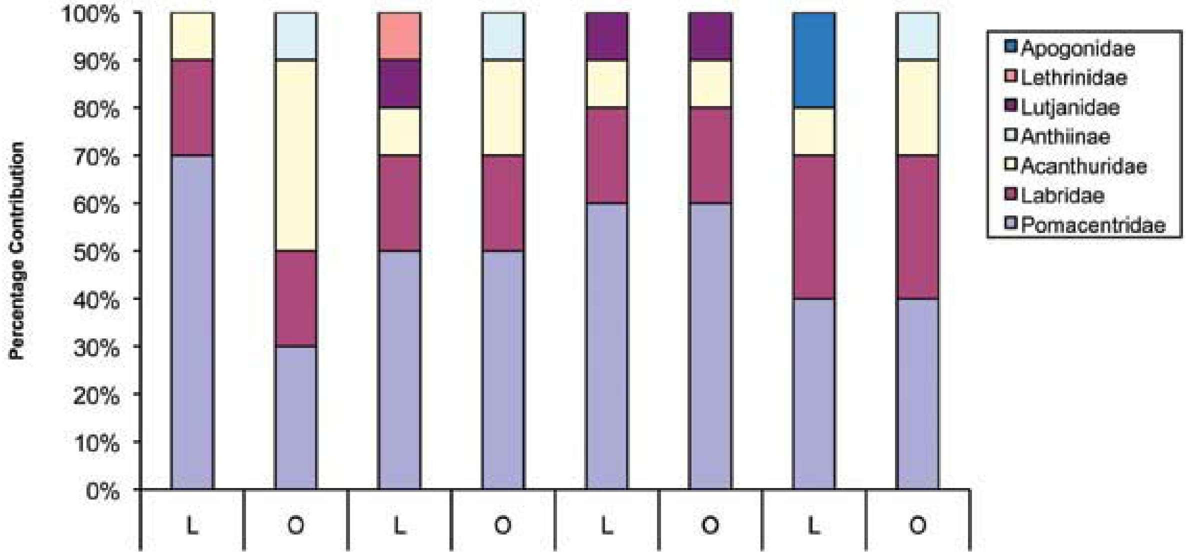


Figure 9 Contribution of families to the ten most abundant species in both habitats at each atoll. L = lagoon, O = outer reef slope.

Above: *Corythoichthys schultzi* Herald, 1953 on the sea star, Müller and Troschel. 1842. (Photo: Sue Morrison)

species confined to the lagoon were; *Epinephelus merra, Cheilodipterus quinquelineatus, Symphorichthys spilurus, Chromis viridis, Dascyllus aruanus, Dischistodus prosopotaenia, Plectroglyphidodon lacrymatus, Pomacentrus moluccensis, Halichoeres melanurus* and *H. trimaculatus.* Species confined to the outer reef slope had the greatest diversity when compared with all other reefs. A selection of the most abundant and/or widespread species are as follows; *Sargocentron caudimaculatum, Cephalopholis urodeta, Lutjanus bohar, Macolor macularis, Parupeneus bifasciatus, Chaetodon vagabundus, C. semeion, Amblyglyphidodon curacao, Chromis atripes, Bodianus axillaris, Cirrhilabrus exquisitus, Epibulus insidiator, Nemateleotris magnifica, Naso brevirostris* and *N. caesius*. This habitat had many speciose families including serranids, chaetodontids, pomacentrids, labrids, acanthurids and balistids.

DISCUSSION

Some 530 fish species have now been reported from the Rowley Shoals and some 600 fish species from Scott/Seringapatam Reefs (Allen and Russell, 1986, Done *et al*., 1994; Hutchins, 1998). This includes collections from all three Rowley Shoals reefs (Mermaid, Clerke and Imperieuse), and derived using a variety of methods including visual surveys, spear, rotenone and angling. The records from the present study include species from 61 families with a range of pelagic, demersal and benthic life histories. Considering the brevity of the present survey, the inclusion of only Mermaid Reef at the Rowley Shoals, limited rotenone sampling and the exclusion of scarids, the results of 293 species at the Rowley Shoals, 387 species at Scott Reefs and 267 species at Seringapatam Reef represent a substantial component of the known fauna. Only one new record was added to the known fauna of the region - *Helcogramma chica* Rosenblatt, 1960. This new record for Australia was found at Seringapatam Reef during the present survey, and was only previously known from the Indonesian region, Christmas Island, Cocos Keeling Islands and north west Pacific region.

Gradient of species richness and recruitment

Reefs closer to Indonesia, which is the centre of reef fish diversity, have a more diverse fish fauna (Allen, 1999). The present results indicate that fish species richness increased in a northerly direction from Mermaid Reef in the Rowley Shoals to the Scott/Seringapatam Reef complex, which supports the findings of Allen (1993), Allen and Russell (1986), Done *et al.*, (1994) and Hutchins (1998). It is thought that the Indonesian throughflow has the potential to transport fish eggs and larvae from Indonesia to the North West Shelf atolls (Hutchins, 2001). It is most likely therefore that the proximity to the rich fish fauna of Indonesia, rather than latitude is the main reason for this species gradient.

The level of self-recruitment at each atoll as opposed to recruitment from further afield however, is not fully known. AIMS have considered weather patterns and oceanic currents to assess the degree of connectivity between the offshore reef systems (Gilmour *et al*., 2007). Results from sub-surface drifters have indicated that dispersal times for fish eggs or larvae between Ashmore and Scott Reefs can be between three to four weeks, and between Scott Reefs and Rowley Shoals around one to two months

Left: *Pseudobalistes flavimarginatus* (Rüppell, 1829); **Right:** *Amblyeleotris steinitzi* (Klausewitz, 1974) (Photo: Clay Bryce)

Left: *Gymnothorax javanicus* (Bleeker, 1859) (Photo: John Huisman); **Right:** *Istigobius rigilius* (Herre, 1953) (Photo: Sue Morrison)

(Gilmour *et al*., 2007). These times would limit fish dispersal between the atolls for most species, and consequently the North West Shelf atolls are likely to depend heavily on self-recruitment (Gilmour *et al*., 2007). The present survey indicates a decreasing species richness of fish assemblages between atolls with increasing distance from Indonesia, which supports slow rates of fish recruitment at the North West Shelf atolls from Indonesia. An example of a species that is potentially a relatively new arrival from Indonesia, is the newly recorded trypterygiid *Helcogramma chica.* The fish fauna of the North West Shelf atolls have more in common with Indonesian reefs than with coastal Australian reefs (Hutchins, 1994; 2001). It has been suggested that the differences in fish assemblages between the Australian mainland and the offshore atolls is largely due to gradients in the physical and biological environments acting as barriers to dispersal (Hutchins, 2001), although most of these are yet to be examined.

Reef Comparisons

Fifteen families dominated the fish assemblages (pomacentrids, acanthurids, labrids and apogonids, with smaller contributions from serranids, lutjanids, chaetodontids, lethrinids, mullids, zanclids, haemulids, clupeids, carangids, synodontids and caesionids) and these accounted for approximately one quarter of the abundance at all atolls. The first seven families are among the most diverse and abundant of the Indo-West Pacific reef fish families (Allen, 1993; Russell *et al*., 2005). Only a very small percentage of fish species were restricted to a single atoll and just under half of all species were common to all atolls. There is a trend for Mermaid Reef fish assemblages to be different from those at the Scott/Seringapatam Reef complex. This is likely to be a consequence of Mermaid Reef being more than 400 km south west of the other atolls. North Scott, South Scott and Seringapatam Reef fish assemblages had more in common with each other, which is to be expected because of their close proximity (there is a maximum of 55 km between them). Exchange of species between these three reefs might be further facilitated by the open formation of South Scott Reef.

The differences in fish assemblages between the North West Shelf atoll systems is thought to be greatly influenced by differences in reef habitat structure (Allen, 1994; Done *et al*., 1994; Hutchins, 2001; Gilmour *et al*., 2007). North and South Scott Reefs, which were more varied in coral species richness, depth and exposure than Mermaid or

Seringapatam Reefs (Done *et al*., 1994) had the greatest fish species richness. After extensive damage by cyclone Jacob at the Rowley Shoals in 1996, the most stable fish population occurred at Mermaid Reef which had the least physical damage and therefore retained the greatest habitat diversity of the Rowley Shoals reefs (Gilmour *et al*., 2007). Furthermore, the present study shows that outer reef slope habitats at Mermaid, Scott and Seringapatam Reefs, which had well developed and steep drop-offs, supported richer fish assemblages than lagoonal habitats at all atolls.

Habitat Comparisons

Fish assemblages in lagoonal and outer reef slope habitats differed from each other. The differences in fish assemblages between the two habitat types are likely to be influenced by physical and oceanographic factors such as shape, orientation, depth, exposure, temperature and salinity, resulting in different benthic biota and ultimately, distinct fish assemblages.

Generally the outer reef slopes assemblages were more homogeneous between reefs than the lagoonal fish assemblages. This is possibly because it is physically easier for fish (both adults and larvae) to move between outer reef slope habitats than traverse the barriers of the reef flats and channels in and out of lagoons at different atolls. Additionally, Mermaid Reef lagoonal fish assemblages were significantly different from all other lagoonal assemblages, which is most likely a function of distance from the other reefs.

South Scott Reef lagoon fish assemblages were distinct from those at other reefs. South Scott Reef is physically different from the other atolls in that it is incomplete along the northern side. Additionally, there are some very deep regions 35 to 55 m depth within the lagoon (Berry and Marsh, 1986), which provide similar habitat to that on the outer reef slope. As such it could almost be considered a third habitat type that is restricted to South Scott Reef. Done *et al.*, (1994) also noted this important distinction. This physical structure is likely to allow easy movement of fish between inner and outer reef slope locations, resulting in more uniformity in the distribution of fish species than in the other three atolls. The mixture of lagoonal and outer reef slope species at stations 18 and 23 reflect this idea. Another factor that contributed to the separation of South Scott Reef was outer reef slope station 22 on the outside of Sandy Islet. It had extremely low fish species richness and low abundance that was likely to be a result of it being a very exposed, low relief, well-scoured habitat, and the current at the time of the survey would probably have forced many fish into refuges and out of view.

There were indications that Seringapatam Reef was distinct from other atolls, particularly in the lagoonal fish assemblages, but no strong conclusions can be drawn from this because the reef was under-sampled. For example, station 42 at Seringapatam Reef was shallow and sandy with sparse reef structure, unlike any others sampled in the present study and consequently contained several species largely confined to sandy habitats such as the trichonotids, certain labrids and gobiids. Further surveys at this reef would clarify the fish distribution patterns and abundances.

Impacts on fish assemblages

These offshore atolls are regularly subjected to severe 'natural' damage. For example the Rowley Shoals were hit by cyclone Jacob in 1996, and Scott and Seringapatam Reefs, were subject to a mass coral bleaching event in 1998 (Smith *et al*., 2008) and in 2004 tropical cyclone Fay hit the region (Smith, 2004). Investigations by AIMS after these events indicated major impacts on the hard coral, soft coral and fish communities. These and other natural forces, together with escalating human impacts such as fishing pressures, tourism and global climate change affect the ecology of the region and consequently the fish assemblages. Fish assemblages are constantly changing in response to such factors and are therefore complex. Surveys such as this can only provide data on fish assemblages at a single time, season and at limited locations. No single method will give sufficient data to understand the full biodiversity, ecology and dynamics of fish assemblages. For example, a tool such as rotenone is vital to assess biodiversity since it has been shown that only around 36% of fish species sampled with rotenone may be recorded by underwater visual surveys (Smith-Vaniz *et al*., 2006). Population and community changes need to be assessed by quantitative methods carried out regularly at fixed locations. Temporal changes in fish larval assemblages are known to occur in other areas of the North West Shelf and are likely to influence recruitment and community structure at a local level (Sampey, *et al*., 2004). Deeper water surveys below diving depths are a further challenge, and are currently partially addressed with the use of BRUVs (Meekan, *et al*., 2005). These issues illustrate the need to employ a variety of survey techniques, to cover spatial and temporal variables of natural and human impacts in order to manage and maintain the biodiversity of fish assemblages, along with the physical and biological dynamics, of these unique Australian North West Shelf atolls.

CONCLUSIONS

The present survey recorded an Indo-West Pacific fish fauna with close affinities to fish assemblages

Above: *Naso hexacanthus* (Bleeker, 1855) (Photo: John Huisman)

Above: *Triaenodon obesus* Rüppell, 1837. WhiteTip Reef Shark. (Photo: Glenn Moore) of Indonesia. The range of species and families recorded were similar to those observed in previous taxonomic surveys, and the previously observed gradient of increasing fish species richness with closer proximity to Indonesia, was confirmed. The differences observed between habitats at the different atolls were likely to be a function of physical characteristics and distances between the atolls.

These survey methods would be improved by increasing the number of stations in each of the atolls and within each habitat, and also including replicate surveys at each station. In order to continually assess changes in biodiversity of these unique, yet increasingly utilised atolls, it is important to include a combination of taxonomic, semi-quantitative and quantitative methods.

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Appendix 1.

Fish species recorded from Mermaid, North Scott, South Scott and Seringapatam Reefs, September 2006.
Key: + = present, +* = reef flat, +^ = angling, +o = open water

Scientific name	Common name	Mermaid	Scott	Seringapatam
Ginglymostomatidae	**Nurse Sharks**			
Nebrius ferrugineus (Lesson, 1830)	Tawny Nurse Shark	+		
Carcharhinidae	**Whaler Sharks**			
Carcharhinus amblyrhynchos (Bleeker, 1856)	Grey Reef Shark	+	+	
Carcharhinus melanopterus (Quoy and Gaimard, 1824)	Blacktip Reef Shark	+		
Triaenodon obesus (Rüppell, 1837)	Whitetip Reef Shark	+	+	
Dasyatididae	**Stingrays**			
Dasyatis kuhlii (Müller and Henle, 1841)	Bluespotted Maskray		+	
Taeniura lymma (Forsskål, 1775)	Bluespotted Fantail Ray	+	+	+
Taeniura meyeni Müller and Henle, 1841	Blotched Fantail Ray	+		
Mobulidae	**Devilrays**			
Manta birostris (Donndorff, 1798)	Manta Ray			+
Moringuidae	**Spaghetti Eels**			
Moringua sp.	Spaghetti Eel		+*	
Muraenidae	**Moray Eels**			
Gymnomuraena zebra (Shaw and Nodder, 1797)	Zebra Moray		+*	
Gymnothorax buroensis (Bleeker, 1857)	Latticetail Moray		+*	
Gymnothorax fimbriatus (Bennett, 1832)	Fimbriate Moray		+*	
Gymnothorax javanicus (Bleeker, 1859)	Giant Moray	+	+, +*	+
Gymnothorax pictus (Ahl, 1789)	Painted Moray	+	+*	+*
Rhinomuraena quaesita Garman, 1888	Ribbon Eel		+	
Ophichthidae	**Snake Eels**			
Brachysomophis crocodilinus (Bennett, 1833)	Crocodile Snake Eel		+*	
Leiuranus semicinctus (Lay & Bennett, 1839)	Saddled Snake Eel		+*	
Clupeidae	**Herrings**			
Spratelloides gracilis (Temminck and Schlegel, 1846)	Slender Sprat		+	
Synodontidae	**Lizardfishes**			
Saurida gracilis (Quoy and Gaimard, 1824)	Gracile Saury	+		+
Synodus sp.	Lizardfish		+*	
Synodus binotatus Schultz, 1953	Twospot Lizardfish		+	+
Synodus dermatogenys Fowler, 1912	Banded Lizardfish	+	+	+
Synodus jaculum Russell and Cressey, 1979	Tailspot Lizardfish		+	

Chanidae	**Milkfishes**			
Chanos chanos (Forsskål, 1775)	Milkfish	+		
Gobiesocidae	**Clingfishes**			
Diademichthys lineatus (Sauvage, 1883)	Striped Clingfish	+	+	+
Antennariidae	**Frogfishes**			
Antennarius maculatus (Desjardins, 1840)	Warty Anglerfish		+*	
Exocoetidae	**Flyingfishes**			
Cheilopogon intermedius Parin, 1961	Intermediate Flyingfish	+o	+o	
Cheilopogon spilopterus (Valenciennes, 1847)	Manyspot Flyingfish	+o	+o	
Parexocoetus mento Valenciennes, 1847	African Flyingfish	+o	+o	
Belonidae	**Longtoms**			
Tylosurus sp.	Longtom	+		
Holocentridae	**Squirrelfishes**			
Myripristis adusta Bleeker, 1853	Shadowfin Soldierfish	+	+	+
Myripristis murdjan (Forsskål, 1775)	Crimson Soldierfish	+	+	+
Myripristis pralinia Cuvier, 1829	Bigeye Soldierfish	+		
Neoniphon sammara (Forsskål, 1775)	Slender Squirrelfish	+	+	
Sargocentron caudimaculatum (Rüppell, 1838)	Whitetail Squirrelfish	+	+	+
Sargocentron diadema (Lacépède, 1802)	Crown Squirrelfish	+	+	
Sargocentron spiniferum (Forsskål, 1775)	Sabre Squirrelfish	+	+	+
Aulostomidae	**Trumpetfishes**			
Aulostomus chinensis (Linnaeus, 1766)	Trumpetfish	+	+	
Fistulariidae	**Flutemouths**			
Fistularia commersonii Rüppell, 1838	Smooth Flutemouth	+	+	
Syngnathidae	**Pipefishes**			
Corythoichthys haematopterus (Bleeker, 1851)	Reeftop Pipefish	+	+	
Coryithoichthys schultzi Herald, 1953	Schultz's Pipefish	+		
Pteroidae	**Lionfishes**			
Dendrochirus zebra (Cuvier, 1829)	Zebra Lionfish		+	
Pterois antennata (Bloch, 1787)	Spotfin Lionfish		+	
Pterois volitans (Linnaeus, 1758)	Common Lionfish		+	
Scorpaenidae	**Scorpionfishes**			
Parascorpaena mossambica (Peters, 1855)	Mozambique Scorpionfish		+*	+*
Scorpaenodes guamensis Quoy & Gaimard, 1824	Guam Scorpionfish		+*	
Scorpaenopsis venosa (Cuvier, 1829)	Raggy Scorpionfish	+		
Serranidae	**Rockcods**			
Aethaloperca rogaa (Forsskål, 1775)	Redmouth Rockcod	+	+	+
Anyperodon leucogrammicus (Valenciennes, 1828)	Whitelined Rockcod	+	+	+
Cephalopholis argus Bloch and Schneider, 1801	Peacock Rockcod	+	+, +*	+

Scientific name	Common name	Mermaid	Scott	Seringapatam
Cephalopholis microprion (Bleeker, 1852)	Dot-head Rockcod		+	
Cephalopholis miniata (Forsskål, 1775)	Coral Rockcod	+	+	+
Cephalopholis sexmaculata (Rüppell, 1830)	Sixband Rockcod	+		
Cephalopholis urodeta (Forster, 1801)	Flagtail Rockcod	+	+	+
Epinephelus caeruleopunctatus (Bloch, 1790)	Whitespottted Grouper		+	
Epinephelus fuscoguttatus (Forsskål, 1775)	Flowery Rockcod	+	+	+
Epinephelus maculatus (Bloch, 1790)	Highfin Grouper		+	+
Epinephelus merra Bloch, 1793	Birdwire Cod	+	+, +*	+
Epinephelus ongus (Bloch, 1790)	Specklefin Rockcod		+	+
Epinephelus polyphekadion (Bleeker, 1849)	Camouflage Grouper	+	+	+
Epinephelus tukula Morgans, 1959	Potato Rockcod	+		
Gracila albomarginata (Fowler and Bean, 1930)	Thinspine Grouper	+	+	+
Plectropomus areolatus (Rüppell, 1830)	Passionfruit Coral Trout	+	+	+
Plectropomus laevis (Lacépède, 1801)	Bluespotted Coral Trout	+	+	+
Plectropomus leopardus (Lacépède, 1802)	Common Coral Trout	+	+	
Plectropomus oligacanthus (Bleeker, 1854)	Vermicular Cod		+	+
Pseudanthias huchtii (Bleeker, 1857)	Pacific Basslet			+
Pseudanthias lori (Lubbock and Randall, 1976)	Lori's Basslet			+
Pseudanthias sheni Randall and Allen 1989	Shen's Basslet		+	
Pseudanthias squamipinnis (Peters, 1855)	Orange Basslet		+	
Pseudanthias tuka (Herre and Montalban, 1927)	Purple Queen	+	+	+
Variola albimarginata Baissac, 1953	White-edge Coronation Trout		+	+
Variola louti (Forsskål, 1775)	YellowedgeCoronation Trout	+	+	
Grammistidae	**Soapfishes**			
Belonoperca chabanaudi Fowler and Bean, 1930	Arrowhead Soapfish	+		
Pseudochromidae	**Dottybacks**			
Pictichromis paccnagellae (Axelrod, 1973)	Royal Dottyback	+	+	
Pseudochromis bitaeniatus (Fowler, 1931)	Slender Dottyback		+	+
Pseudochromis cyanotaenia Bleeker, 1857	Yellowhead Dottyback		+*	
Pseudochromis fuscus Müller and Troschel, 1849	Dusky Dottyback	+	+	+
Plesiopidae	**Prettyfins**			
Plesiops verecundus Mooi, 1995	Redtip Longfin		+*	
Apogonidae	**Cardinalfishes**			
Apogon coccineus Rüppell, 1838	Little Red Cardinalfish		+*	
Apogon compressus (Smith and Radcliffe, 1911)	Blue-eye Cardinalfish	+	+	
Apogon cyanosoma (Bleeker, 1853)	Orangelined Cardinalfish		+	+
Apogon exostigma (Jordan and Starks, 1906)	Oneline Cardinalfish	+	+	
Apogon kallopterus Bleeker, 1856	Spinyhead Cardinalfish		+	

Apogon leptacanthus Bleeker, 1856	Longspine Cardinalfish	+		
Apogon nigrofasciatus Lachner, 1953	Blackstriped Cardinalfish		+	
Apogon sealei (Fowler, 1918)	Cheekbar Cardinalfish			+
Apogon taeniophorus Regan, 1908	Pearly-line Cardinalfish		+, +*	+
Apogon timorensis Bleeker, 1854	Timor Cardinalfish		+	
Apogonichthys ocellatus? Weber, 1913	Ocellate Cardinalfish		+*	
Archamia fucata (Cantor, 1849)	Painted Cardinalfish		+	+
Archamia zosterophora (Bleeker, 1856)	Girdled Cardinalfish	+	+	
Cercamia eremia (Allen, 1987)	Glassy Cardinalfish		+*	
Cheilodipterus artus Smith, 1961	Wolf Cardinalfish	+	+	+
Cheilodipterus macrodon (Lacépède, 1801)	Tiger Cardinalfish		+	+
Cheilodipterus quinquelineatus Cuvier, 1828	Fiveline Cardinalfish	+	+	+
Rhabdamia cypselurus Weber, 1909	Schooling Cardinalfish		+	
Rhabdamia gracilis (Bleeker, 1856)	Slender Cardinalfish	+	+	+
Malacanthidae	**Tilefishes**			
Malacanthus brevirostris Guichenot, 1848	Flagtail Blanquillo		+	+
Malacanthus latovittatus (Lacépède, 1801)	Blue Blanquillo		+	
Echeneidae	**Remoras**			
Echeneis naucrates Linnaeus, 1758	Sharksucker	+	+	
Carangidae	**Trevallies**			
Carangoides fulvoguttatus (Forsskål, 1775)	Turrum	+		
Carangoides orthogrammus (Jordan and Gilbert, 1882)	Thicklip Trevally	+	+	
Carangoides plagiotaenia Bleeker, 1857	Barcheek Trevally		+	+
Caranx ignobilis (Forsskål, 1775)	Giant Trevally	+		+
Caranx lugubris Poey, 1860	Black Trevally	+	+	+
Caranx melampygus Cuvier, 1833	Bluefin Trevally	+	+	+
Caranx sexfasciatus Quoy and Gaimard, 1825	Bigeye Trevally	+	+	
Elegatis bipinnulata (Quoy and Gaimard, 1825)	Rainbow Runner		+	
Scomberoides commersonnianus Lacépède, 1801	Giant Queenfish	+		
Scomberoides lysan (Forsskål, 1775)	Lesser Queenfish	+		
Trachinotus blochii (Lacépède, 1801)	Snubnose Dart	+		
Lutjanidae	**Tropical Snappers**			
Aphareus rutilans Cuvier, 1830	Rusty Jobfish	+	+	+
Aprion virescens Valenciennes, 1830	Green Jobfish	+	+	+
Lutjanus biguttatus (Valenciennes, 1830)	Twospot Snapper			+
Lutjaus bohar (Forsskål, 1775)	Red Bass	+	+	+
Lutjanus decussatus (Cuvier, 1828)	Checkered Snapper	+	+	+
Lutjanus gibbus (Forsskål, 1775)	Paddletail	+	+	+
Lutjanus kasmira (Forsskål, 1775)	Bluestriped Snapper	+	+	+

Scientific name	Common name	Mermaid	Scott	Seringapatam
Lutjanus rivulatus (Cuvier, 1828)	Maori Snapper	+	+	
Lutjanus russellii (Bleeker,1849)	Moses Seaperch	+	+	+
Macolor macularis Fowler, 1931	Midnight Snapper	+	+	+
Macolor niger (Forsskål, 1775)	Black-and-White Snapper	+	+	+
Symphorichthys spilurus (Günther, 1874)	Sailfin Snapper	+	+	+
Caesionidae	**Fusiliers**			
Caesio caerulaurea Lacépède, 1801	Goldband Fusilier		+	
Caesio cuning (Bloch, 1791)	Yellowtail Fusilier	+		
Caesio lunaris Cuvier, 1830	Lunar Fusilier	+	+	
Caesio teres Seale, 1906	Blue Fusilier	+	+	+
Pterocaesio pisang (Bleeker, 1853)	Banana Fusilier		+	+
Pterocaesio tile (Cuvier, 1830)	Neon Fusilier	+	+	+
Pterocaesio trilineata Carpenter, 1987	Threestripe Fusilier		+	+
Nemipteridae	**Threadfin Breams**			
Parascolopsis tosensis (Kamohara, 1938)	Yellowstripe Monocle Bream		+	
Scolopsis affinis Peters, 1877	Bridled Monocle Bream			+
Scolopsis bilineata (Bloch, 1793)	Two-line Monocle Bream	+	+, +*	+
Scolopsis margaritifer (Cuvier, 1830)	Pearly Monocle Bream		+	+
Haemulidae	**Grunter Breams**			
Plectorhinchus chaetodonoides (Lacépède, 1801)	Spotted Sweetlips	+	+	+
Plectorhinchus lineatus (Linnaeus, 1758)	Oblique-banded Sweetlips		+	
Lethrinidae	**Emperors**			
Gnathodentex aureolineatus (Lacépède, 1802)	Goldspot Seabream	+	+	+
Lethrinus atkinsoni Seale, 1910	Yellowtail Emperor		+	
Lethrinus erythropterus Valenciennes, 1830	Longfin Emperor	+	+	+
Lethrinus obsoletus (Forsskål, 1775)	Orangestriped Emperor	+	+	
Lethrinus olivaceus Valenciennes, 1830	Longnose Emperor	+	+	+
Lethrinus rubrioperculatus Sato, 1978	Spotcheek Emperor	+		
Lethrinus xanthochilus Klunzinger, 1870	Yellowlip Emperor		+	+
Monotaxis grandoculis (Forsskål, 1775)	Bigeye Seabream	+	+	+
Mullidae	**Goatfishes**			
Parupeneus barberinus (Lacépède, 1801)	Dot-and-Dash Goatfish	+	+	+
Parupeneus crassilabris (Valenciennes, 1831)	Doublebar Goatfish	+	+	+
Parupeneus cyclostomus (Lacépède, 1801)	Goldsaddle Goatfish		+	+
Parupeneus multifasciatus (Quoy and Gaimard, 1825)	Banded Goatfish	+	+	+
Parupeneus pleurostigma (Bennett, 1831)	Sidespot Goatfish	+	+	+
Pempheridae	**Bullseyes**			
Pempheris oualensis Cuvier, 1831	Oualan Bullseye	+	+	+

Kyphosidae	**Drummers**			
Kyphosus vaigiensis (Quoy and Gaimard, 1825)	Brassy Drummer	+		+
Ephippidae	**Batfishes**			
Platax pinnatus (Linnaeus, 1758)	Longfin Batfish	+	+	
Platax teira (Forsskål, 1775)	Roundface Batfish	+	+	
Chaetodontidae	**Butterflyfishes**			
Chaetodon adiergastos Seale, 1910	Philippine Butterflyfish	+	+	
Chaetodon auriga Forsskål, 1775	Threadfin Butterflyfish	+	+, +*	+
Chaetodon baronessa Cuvier, 1831	Triangular Butterflyfish		+	
Chaetodon bennetti Cuvier, 1831	Eclipse Butterflyfish	+	+	
Chaetodon citrinellus Cuvier, 1831	Citron Butterflyfish	+	+	+
Chaetodon ephippum Cuvier, 1831	Saddle Butterflyfish	+	+	+
Chaetodon kleinii Bloch, 1790	Klein's Butterflyfish	+	+	+
Chaetodon lineolatus Cuvier, 1831	Lined Butterflyfish	+	+	
Chaetodon lunula (Lacépède, 1803)	Racoon Butterflyfish	+	+	
Chaetodon lunulatus Quoy & Gaimard, 1824	Pinstripe Butterflyfish	+	+	+
Chaetodon melannotus Schneider, 1801	Blackback Butterflyfish		+	+
Chaetodon meyeri Bloch and Schneider, 1801	Meyer's Butterflyfish	+	+	
Chaetodon ornatissimus Cuvier, 1831	Ornate Butterflyfish	+	+	+
Chaetodon oxycephalus Bleeker, 1853	Spotnape Butterflyfish		+	+
Chaetodon punctatofasciatus Cuvier, 1831	Spotbanded Butterflyfish	+	+	+
Chaetodon rafflesi Bennett, 1830	Lattice Butterflyfish		+	
Chaetodon semeion Bleeker, 1855	Dotted Butterflyfish	+	+	+
Chaetodon speculum Cuvier, 1831	Ovalspot Butterflyfish	+	+	+
Chaetodon trifascialis Quoy and Gaimard, 1824	Chevron Butterflyfish	+	+	+
Chaetodon ulietensis Cuvier, 1831	Doublesaddle Butterflyfish	+	+	+
Chaetodon unimaculatus Bloch, 1787	Teardrop Butterflyfish	+	+	
Chaetodon vagabundus Linnaeus, 1758	Vagabond Butterflyfish	+	+	+
Coradion chrysozonus (Cuvier, 1831)	Orangebanded Coralfish		+	
Forcipiger flavissimus Jordan and McGregor, 1898	Forceps Fish	+	+	+
Forcipiger longirostris (Broussonet, 1782)	Longnose Butterflyfish	+	+	
Hemitaurichthys polylepis (Bleeker, 1857)	Pyramid Butterflyfish		+	
Heniochus acuminatus (Linnaeus, 1758)	Longfin Bannerfish	+		
Heniochus chrysostomus Cuvier, 1831	Pennant Bannerfish	+	+	+
Heniochus singularis Smith and Radcliffe, 1911	Singular Bannerfish	+	+	+
Heniochus varius (Cuvier, 1829)	Horned Bannerfish	+	+	+
Pomacanthidae	**Angelfishes**			
Apolemichthys trimaculatus (Cuvier, 1831)	Threespot Angelfish	+	+	+
Centropyge bicolor (Bloch, 1787)	Bicolor Angelfish	+	+	+

Scientific name	Common name	Mermaid	Scott	Seringapatam
Centropyge bispinosa (Günther, 1860)	Coral Beauty	+	+	+
Centropyge eibli Klausewitz, 1963	Eibel's Angelfish	+		
Centropyge flavicauda Fraser-Brunner, 1933	Whitetail Angelfish		+	+
Centropyge tibicen (Cuvier, 1831)	Keyhole Angelfish		+	+
Centropyge vroliki (Bleeker, 1853)	Pearlscale Angelfish		+	+
Chaetodontoplus mesoleucus (Bloch, 1787)	Vermiculate Angelfish		+	
Pomacanthus imperator (Bloch, 1787)	Emperor Angelfish	+	+	+
Pomacanthus navarchus (Cuvier, 1831)	Bluegirdle Angelfish	+	+	+
Pomacanthus semicircularis (Cuvier, 1831)	Blue Angelfish	+		
Pomacanthus sexstriatus (Cuvier, 1831)	Sixband Angelfish	+	+	+
Pygoplites diacanthus (Boddaert, 1772)	Regal Angelfish	+	+	+
Pomacentridae	**Damselfishes**			
Abudefduf septemfasciatus (Cuvier, 1830)	Banded Sergeant		+	
Abudefduf vaigiensis (Quoy and Gaimard, 1825)	Indo-Pacific Sergeant	+	+, +*	+
Acanthochromis polyacanthus (Bleeker, 1855)	Spiny Puller	+		
Amblyglyphidodon aureus (Cuvier, 1830)	Golden Damsel		+	+
Amblyglyphidodon curacao (Bloch, 1787)	Staghorn Damsel	+	+	+
Amblyglyphidodon leucogaster (Bleeker, 1847)	Whitebelly Damsel	+	+	+
Amphiprion clarkii (Bennett, 1830)	Clark's Anemonefish	+	+	+
Amphiprion melanopus Bleeker, 1852	Blackback Anemonefish	+		
Amphiprion ocellaris Cuvier, 1830	Western Clown Anemonefish		+	
Amphiprion perideraion Bleeker, 1855	Pink Anemonefish	+		
Amphiprion sandracinos Allen, 1972	Orange Anemonefish		+	+
Chromis amboinensis (Bleeker, 1873)	Ambon Puller	+	+	+
Chromis atripectoralis Welander and Schultz, 1951	Blackaxil Chromis	+		
Chromis atripes Fowler and Bean, 1928	Darkfin Puller	+	+	+
Chromis fumea (Tanaka, 1917)	Smoky Puller		+	
Chromis lepidolepis Bleeker, 1877	Scaly Puller	+	+	
Chromis margaritifer Fowler, 1946	Whitetail Puller	+	+	+
Chromis opercularis (Günther, 1867)	Doublebar Chromis		+	+
Chromis ternatensis (Bleeker, 1856)	Swallowtail Puller	+	+	+
Chromis viridis (Cuvier, 1830)	Blue-green Puller	+	+	+
Chromis weberi Fowler and Bean, 1928	Weber's Puller	+	+	+
Chromis xanthochira (Bleeker, 1851)	Yellow-axil Puller	+	+	
Chromis xanthura (Bleeker, 1854)	Pale-tail Puller	+	+	+
Chrysiptera biocellata (Quoy and Gaimard, 1824)	Twospot Demoiselle	+	+, +*	+
Chrysiptera brownriggii (Bennett, 1828)	Surge Demoiselle	+	+, +*	+*
Chrysiptera cyanea (Quoy and Gaimard, 1824)	Blue Demoiselle	+	+, +*	

Chrysiptera glauca (Cuvier, 1830)	Grey Demoiselle		+*	
Chrysiptera hemicyanea (Weber, 1913)	Azure Demoiselle	+	+	+
Chrysiptera rex (Snyder, 1909)	Pink Demoiselle		+	+
Chrysiptera rollandi (Whitley, 1961)	Bluehead Demoiselle	+		
Dascyllus aruanus (Linnaeus, 1758)	Banded Humbug	+	+	+
Dascyllus reticulatus (Richardson, 1846)	Headband Humbug	+	+	+
Dascyllus trimaculatus (Rüppell, 1829)	Threespot Humbug	+	+	+
Dischistodus perspicillatus (Cuvier, 1830)	White Damsel	+	+	+
Dischistodus prospotaenia (Bleeker, 1852)	Honeyhead Damsel	+	+	+
Hemiglyphidodon plagiometapon (Bleeker, 1852)	Lagoon Damsel	+	+	+
Lepidozygus tapeinosoma (Bleeker, 1856)	Fusilier Damsel			+
Neoglyphidodon melas (Cuvier, 1830)	Black Damsel		+	+
Neoglyphidodon nigroris (Cuvier, 1830)	Scarface Damsel		+	
Neopomacentrus azysron (Bleeker, 1877)	Yellowtail Demoiselle	+	+*	
Neopomacentrus cyanomos (Bleeker, 1856)	Regal Demoiselle	+		
Plectroglyphidodon dickii (Liénard, 1839)	Dick's Damsel	+	+	+
Plectroglyphidodon johnstonianus Fowler and Ball, 1924	Johnston Damsel	+	+	
Plectroglyphidodon lacrymatus (Quoy and Gaimard, 1824)	Jewel Damsel	+	+	+
Plectroglyphidodon leucozonus (Bleeker, 1859)	Whiteband Damsel	+		+*
Pomacentrus adelus Allen, 1991	Obscure Damsel	+	+	
Pomacentrus amboinensis Bleeker, 1868	Ambon Damsel		+	+
Pomacentrus auriventris Allen, 1991	Goldbelly Damsel		+	+
Pomacentrus bankanensis Bleeker, 1853	Speckled Damsel	+	+, +*	+
Pomacentrus chrysurus Cuvier, 1830	Whitetail Damsel	+	+	+
Pomacentrus coelestis Jordan and Starks 1901	Neon Damsel	+	+	+
Pomacentrus grammorhynchus Fowler, 1918	Bluespot Damsel	+		
Pomacentrus lepidogenys Fowler and Bean,1928	Scaly Damsel		+	+
Pomacentrus moluccensis Bleeker, 1853	Lemon Damsel	+	+	+
Pomacentrus nigromanus Weber, 1913	Goldback Damsel		+	
Pomacentrus nigromarginatus Allen, 1973	Blackmargin Damsel	+	+	+
Pomacentrus philippinus Evermann and Seale, 1907	Philippine Damsel	+	+	+
Pomacentrus vaiuli Jordan and Seale, 1906	Princess Damsel	+	+	+
Stegastes fasciolatus (Ogilby, 1889)	Pacific Gregory	+	+	+
Stegastes nigricans (Lacépède, 1801)	Dusky Gregory	+	+	+
Cirrhitidae	**Hawkfishes**			
Cirrhitichthys oxycephalus (Bleeker, 1855)	Spotted Hawkfish	+	+	+
Cirrhitus pinnulatus (Bloch & Schneider, 1801)	Whitespotted Hawkfish		+	
Oxycirrhitus typus Bleeker, 1857	Longnose Hawkfish		+	
Paracirrhites arcatus (Cuvier, 1829)	Ringeye Hawkfish	+	+	+

Scientific name	Common name	Mermaid	Scott	Seringapatam
Paracirrhites forsteri (Schneider, 1801)	Freckled Hawkfish	+	+	+
Sphyraenidae	**Pikes**			
Sphyraena barracuda (Walbaum, 1792)	Great Barracuda	+		
Labridae				
Anampses caeruleopunctatus Rüppell, 1829	Diamond Wrasse		+	
Anampses meleagrides Valenciennes, 1840	Speckled Wrasse	+	+	
Anampses twistii Bleeker, 1856	Yellowbreast Wrasse	+	+	+
Bodianus axillaris (Bennett, 1832)	Coral Pigfish	+	+	+
Bodianus diana (Lacépède, 1801)	Diana's Pigfish	+	+	+
Bodianus mesothorax (Bloch and Schneider, 1801)	Eclipse Pigfish	+		+
Cheilinus chlorurus (Bloch, 1791)	Floral Maori Wrasse	+	+	+
Cheilinus fasciatus (Bloch, 1791)	Redbreast Maori Wrasse	+	+	+
Cheilinus trilobatus Lacépède, 1801	Tripletail Maori Wrasse	+	+	+
Cheilinus undulatus Rüppell, 1835	Humphead Maori Wrasse	+	+	+
Cheilio inermis (Forsskål, 1775)	Sharpnose Wrasse		+	
Cirrhilabrus cyanopleura (Bleeker, 1851)	Blueside Wrasse	+	+	
Cirrhilabrus exquisitus Smith, 1957	Exquisite Wrasse		+	+
Cirrhilabrus randalli Allen, 1995	Randall's Wrasse	+	+	+
Conniella apterygia Allen, 1983	Connie's Wrasse	+	+	
Coris aygula Lacépède, 1801	Redblotched Wrasse	+	+	+
Coris caudimacula (Quoy and Gaimard, 1834)	Spot-tail Wrasse		+	+
Coris gaimard (Quoy and Gaimard, 1824)	Clown Wrasse	+	+	+
Coris batuensis (Bleeker, 1857)	Variegated Wrasse		+	+
Cymolutes praetextus (Quoy and Gaimard, 1834)	Knife Wrasse	+		
Epibulus insidiator (Pallas, 1770)	Slingjaw Wrasse	+	+	+
Gomphosus varius Lacépède, 1801	Birdnose Wrasse	+	+	+
Halichoeres biocellatus Schultz, 1960	False-eye Wrasse	+	+	
Halichoeres chrysus Randall, 1981	Golden Wrasse		+	+
Halichoeres hortulanus (Lacépède, 1801)	Checkerboard Wrasse	+	+, +*	+
Halichoeres margaritaceus (Valenciennes, 1839)	Pearly Wrasse		+*	+*
Halichoeres marginatus Rüppell, 1835	Dusky Wrasse	+	+	+
Halichoeres melanurus (Bleeker, 1851)	Hoeven's Wrasse	+	+	+
Halichoeres nebulosus (Valenciennes, 1839)	Cloud Wrasse			+
Halichoeres ornatissimus (Garrett, 1863)	Ornamental Wrasse	+		
Halichoeres prosopeion (Bleeker, 1853)	Twotone Wrasse		+	+
Halichoeres scapularis (Bennett, 1832)	Zigzag Wrasse			+
Halichoeres trimaculatus (Quoy and Gaimard, 1834)	Threespot Wrasse	+	+, +*	+
Hemigymnus fasciatus (Bloch, 1792)	Fiveband Wrasse	+	+	+

Hemigymnus melapterus (Bloch, 1791)	Thicklip Wrasse	+	+	+
Hologymnosus doliatus (Lacépède, 1801)	Pastel Slender Wrasse		+	+
Labrichthys unilineatus (Guichenot, 1847)	Oneline Wrasse	+	+	+
Labroides bicolor Fowler and Bean, 1928	Bicolor Cleanerfish	+	+	+
Labroides dimidiatus (Valenciennes, 1839)	Common Cleanerfish	+	+	+
Labroides pectoralis Randall and Springer, 1975	Breastspot Cleanerfish	+	+	+
Labropsis manabei Schmidt, 1931	Tailblotch Tubelip		+	
Labropsis xanthonota Randall, 1981	Yellowback Tubelip	+	+	+
Macropharyngodon meleagris (Valenciennes, 1839)	Leopard Wrasse	+	+	+
Macropharyngodon negrosensis Herre, 1932	Black Leopard Wrasse	+		
Macropharyngodon ornatus Randall, 1978	Ornate Leopard Wrasse	+	+	
Novaculichthys taeniourus (Lacépède, 1801)	Carpet Wrasse	+	+, +*	
Oxychelinus celebicus (Bleeker, 1853)	Slender Maori Wrasse	+	+	+
Oxycheilinus diagrammus (Lacépède, 1801)	Violetline Maori Wrasse	+	+	+
Oxycheilinus unifasciatus (Streets, 1877)	Ringtail Maori Wrasse	+	+	
Paracheilinus flavianalis Kuiter and Allen, 1999	Yellowfin Flasher Wrasse		+	
Pseudocheilinus evanidus Jordan and Evermann, 1903	Pinstripe Wrasse	+	+	+
Pseudocheilinus hexataenia (Bleeker, 1857)	Sixline Wrasse	+	+	+
Pseudocheilinus octotaenia Jenkins, 1901	Eightline Wrasse	+	+	+
Pseudodax moluccanus (Valenciennes, 1840)	Chiseltooth Wrasse	+	+, +*	+
Pterogogus cryptus Randall, 1981	Cryptic Wrasse		+	+
Stethojulis bandanensis (Bleeker, 1851)	Redspot Wrasse	+	+, +*	+
Stethojulis interrupta (Bleeker, 1851)	Brokenline Wrasse	+	+	
Stethojulis strigiventer (Bennett, 1832)	Silverstreak Wrasse	+	+	+
Thalassoma amblycephalum (Bleeker, 1856)	Bluehead Wrasse	+	+, +*	+
Thalassoma hardwicke (Bennett, 1829)	Sixbar Wrasse	+	+	+
Thalassoma janseni (Bleeker, 1856)	Jansen's Wrasse		+	
Thalassoma lunare (Linnaeus, 1758)	Moon Wrasse	+	+	+
Thalassoma quinquevittatum (Lay and Bennett, 1839)	Red-ribbon Wrasse	+	+	+
Thalassoma trilobatum? (Lacépède, 1801)	Ladder Wrasse			+*
Wetmorella albofasciata Schultz and Marshall, 1954	Doubleline Wrasse		+	
Pinguipedidae	**Grubfishes**			
Parapercis clathrata Ogilby, 1910	Spothead Grubfish		+	+
Parapercis hexophtalma (Cuvier, 1829)	Blacktail Grubfish		+	
Parapercis millepunctata (Günther, 1860)	Thosand-spot Grubfish		+	+
Parapercis multiplicata Randall, 1984	Doublestitch Grubfish	+	+	
Parapercis sp.	Grubfish			+
Trichonotidae	**Sand Divers**			
Trichonotus elegans Shimada and Yoshino, 1984	Elegant Sand Diver			+
Blenniidae	**Blennies**			

Scientific name	Common name	Mermaid	Scott	Seringapatam
Aspidontus dussumieri (Valenciennes, 1836)	Lance Blenny			+
Atrosalarias sp.	Blenny		+*	
Atrosalarias fuscus (Rüppell, 1835)	Dusky Blenny			+
Blenniella periophthalmus (Valenciennes, 1836)	Bluestreaked Rockskipper		+*	+*
Cirripectes sp.	Tidepool Blenny	+	+	
Cirripectes filamentosus (Alleyne & Macleay, 1877)	Filamentous Blenny		+*	
Ecsenius alleni Springer, 1988	Allen's Combtooth Blenny	+	+	+
Ecsenius bicolor (Day, 1888)	Bicolor Combtooth Blenny	+	+	
Ecsenius schroederi McKinney and Springer, 1976	Schroeder's Combtooth Blenny	+	+*	+
Ecsenius sp.	Combtooth Blenny	+		
Meiacanthus atrodorsalis (Günther, 1877)	Eyelash Fangblenny	+	+	+
Meiacanthus grammistes (Valenciennes, 1836)	Linespot Fangblenny	+	+	+
Petroscirtes breviceps (Valenciennes, 1836)	Shorthead Sabretooth Blenny	+		
Plagiotremus rhinorhynchos (Bleeker, 1852)	Bluestriped Fangblenny	+	+	+
Plagiotremus tapeinosoma (Bleeker, 1857)	Piano Fangblenny	+	+	+
Rhabdoblennius sp.	Rockskipper Blenny			+*
Salarias sp.	Blenny	+		
Salarias fasciatus (Bloch, 1786)	Banded Blenny	+	+, +*	
Salarias cf. *patzneri* Bath,1992	Patzner's Blenny		+*	
Salarias sinuosus? Snyder, 1908	Fringelip Blenny		+*	+*
Trypterygiidae	**Triplefins**			
Enneapterygius larsonae Fricke, 1994	Blackhead Threefin		+*	
Enneapterygius nanus? Schultz, 1960	Pygmy Threefin		+*	
Helcogramma chica? Rosenblatt, 1960	Little Hooded Threefin			+*
Callionymidae	**Dragonets**			
Neosynchiropus ocellatus (Pallas, 1770)	Marble Dragonet		+*	
Gobiidae	**Gobies**			
Amblyeleotris guttata (Fowler, 1938)	Blackchest Shrimpgoby		+	
Amblyeleotris steinitzi (Klausewitz, 1974)	Steinitz' Shrimpgoby	+	+	
Amblyeleotris wheeleri (Polunin and Lubbock, 1977)	Burgundy Shrimpgoby	+	+	+
Amblygobius decussatus (Bleeker, 1855)	Crosshatch Goby			+
Amblygobius nocturnus (Herre, 1945)	Pyjama Goby		+	+
Amblygobius rainfordi (Whitley, 1940)	Old Glory Goby	+	+	+
Amblygobius phalaena (Valenciennes, 1837)	Whitebarred Goby	+	+	+
Asterropteryx semipunctatus Rüppell, 1830	Starry Goby		+	
Bryaninops natans Larson, 1985	Purple-eye Goby		+	
Bryaninops sp.?	Sea Whip Goby		+	+
Cabillus sp.	Cabillus Goby		+*	

Fusigobius signipinnis Hoese and Obika, 1988	Flasher Sandgoby	+	+	
Cryptocentrus caeruleomaculatus (Herre, 1933)	Bluespotted Shrimpgoby			+
Cryptocentrus cinctus (Herre, 1936)	Yellow Shrimpgoby		+	
Cryptocentrus fasciatus (Playfair and Günther, 1867)	Y-bar Shrimpgoby			+
Ctenogobiops maculosus (Fourmanoir, 1955)	Silverspot Shrimpgoby	+	+	
Ctenogobiops feroculus Lubbock and Polunin, 1977	Fierce Shrimpgoby			+
Ctenogobiops tangaroai Lubbock and Polunin, 1977	Tangaroa Shrimpgoby		+	
Eviota prasites Jordan and Seale, 1906	Hairfin Eviota			+
Eviota queenslandica Whitley, 1932	Queensland Eviota		+*	+*
Eviota sp.	Eviota		+*	
Fusigobius sp.	Sandgoby		+	+
Gnatholepis sp.	Sandgoby		+*	
Gnatholepis anjerensis (Bleeker, 1851)	Shoulderspot Sandgoby		+	+
Gobiodon okinawae Sawada, Arai and Abe, 1972	Yellow Coralgoby	+	+	+
Gobiodon quinquestrigatus (Valenciennes, 1837)	Fiveline Coralgoby	+		
Gobiodon spilophthalmus Fowler, 1944	Whitelined Coralgoby	+		
Istigobius rigilius (Herre, 1953)	Orangespotted Sandgoby	+	+	+
Lotilia graciliosa Klausewitz, 1960	Whitecap Shrimpgoby		+	
Paragobiodon echinocephalus (Rüppell, 1830)	Redhead Stylophora Goby		+*	
Pleurosicya sp.	Ghostgoby		+	
Priolepis semidoliata (Valenciennes, 1837)	Halfbarred Reefgoby		+*	
Signigobius biocellatus Hoese and Allen, 1977	Crab-eye Goby		+	
Trimma okinawae (Aoyagi, 1949)	Orange-red Pygmygoby		+*	
Valenciennea longipinnis (Lay and Bennett, 1839)	Ocellate Glidergoby		+	
Valenciennea sexguttata (Valenciennes, 1837)	Sixspot Glidergoby		+	
Valenciennea strigata (Broussonet, 1782)	Blueband Glidergoby	+	+	+
Xenisthmidae	**Wrigglers**			
Xenisthmus clarus (Jordan & Seale, 1906)	Clear Wriggler		+*	
Microdesmidae	**Dartfishes**			
Nemateleotris magnifica Fowler, 1938	Red Firegoby	+	+	+
Ptereleotris evides (Jordan and Hubbs, 1925)	Arrow Dartgoby	+	+	+
Ptereleotris heteroptera (Bleeker, 1855)	Tailspot Dartgoby		+	+
Ptereleotris microlepis (Bleeker, 1856)	Greeneye Dartgoby	+		+
Ptereleotris zebra (Fowler, 1938)	Zebra Dartgoby	+	+	
Acanthuridae	**Surgeonfish**			
Acanthurus blochii Valenciennes, 1835	Dark Surgeonfish	+	+	+
Acanthaurus dussumieri Valenciennes, 1835	Pencil Surgeonfish	+	+	
Acanthurus leucosternon Bennett, 1832	Powder-blue Surgeonfish		+	
Acanthurus lineatus (Linnaeus, 1758)	Bluelined Surgeonfish	+	+	+

Scientific name	Common name	Mermaid	Scott	Seringapatam
Acanthurus nigricans (Linnaeus, 1758)	Velvet Surgeonfish	+	+	+
Acanthurus nigricauda Duncker and Mohr, 1929	Eyeline Surgeonfish	+	+	+
Acanthurus nigrofuscus (Forsskål, 1775)	Dusky Surgeonfish		+	+
Acanthurus olivaceus Forster, 1801	Orangeblotch Surgeonfish	+	+	+
Acanthurus pyroferus Kittlitz, 1834	Mimic Surgeonfish	+	+	+
Acanthurus thompsoni (Fowler, 1923)	Night Surgeonfish	+	+	+
Acanthurus triostegus (Linnaeus, 1758)	Convict Surgeonfish	+	+, +*	
Ctenochaetus cyanocheilus Randall and Clements, 2001	Yelloweye Bristletooth		+	+
Ctenochaetus striatus (Quoy and Gaimard, 1825)	Lined Bristletooth	+	+	+
Naso brachycentron (Valenciennes, 1835)	Humpback Unicornfish		+	
Naso brevirostris (Valenciennes, 1835)	Spotted Unicornfish	+	+	+
Naso caesius Randall and Bell, 1992	Silverblotched Unicornfish	+	+	+
Naso hexacanthus (Bleeker, 1855)	Sleek Unicornfish		+	+
Naso lituratus (Forster, 1801)	Clown Unicornfish	+	+	+
Naso thynnoides (Valenciennes, 1829)	Onespine Unicornfish		+	
Naso tuberosus Lacépède, 1801	Humphead Unicornfish	+	+	
Naso unicormis (Forsskål, 1775)	Bluespine Unicornfish	+	+	+
Naso vlamingii (Valenciennes, 1835)	Bignose Unicornfish	+	+	+
Zebrasoma scopas (Cuvier,1829)	Brown Tang	+	+	+
Zebrasoma veliferum (Bloch, 1797)	Sailfin Tang	+	+	+
Zanclidae	**Moorish Idols**			
Zanclus cornutus (Linnaeus, 1758)	Moorish Idol	+	+	+
Siganidae	**RabbifishesRabbitfishes**			
Siganus argenteus (Quoy and Gaimard, 1825)	Forktail Rabbitfish		+	
Siganus corallinus (Valenciennes, 1835)	Coral Rabbitfish	+	+	+
Siganus doliatus Cuvier, 1830	Bluelined Rabbitfish	+	+	
Siganus puellus (Schlegel, 1852)	Masked Rabbitfish	+	+	+
Siganus punctatissimus Fowler and Bean, 1929	Finespotted Rabbitfish		+	+
Siganus punctatus (Schneider, 1801)	Spotted Rabbitfish	+	+	+
Siganus vulpinus (Schlegel and Müller, 1845)	Foxface	+	+	+
Scombridae	**Mackerels**			
Acanthocybium solandri (Cuvier,1831)	Wahoo		+^	
Grammatorcynus bilineatus (Rüppell, 1836)	Scad Mackerel		+	
Gymnosarda unicolor (Rüppell, 1836)	Dogtooth Tuna	+	+	
Thunnus albacares (Bonnaterre, 1788)	Yellowfin Tuna	+^	+^	
Istiophoridae	**Marlins**			
Istiophorus platypterus (Shaw and Nodder, 1792)	Sailfish		+^	
Bothidae	**Lefteye Flounders**			

Bothus mancus Broussonet, 1782	Flowery Flounder			+*
Balistidae	**Triggerfishes**			
Balistapus undulatus (Park ,1797)	Orangestripe Triggerfish	+	+	+
Balistoides conspicillum (Bloch and Schneider, 1801)	Clown Triggerfish		+	
Balistoides viridescens (Bloch and Schneider, 1801)	Titan Triggerfish	+	+	+
Canthidermis maculatus (Bloch, 1786)	Whitespotted Triggerfish		+	
Melichthys niger (Bloch, 1786)	Black Triggerfish	+	+	+
Melichthys vidua (Richardson, 1845)	Pinktail Triggerfish	+	+	
Odonus niger (Rüppell, 1837)	Redtooth Triggerfish		+	+
Pseudobalistes flavimarginatus (Rüppell, 1829)	Yellowmargin Triggerfish	+		
Rhinecanthus aculeatus (Linnaeus, 1758)	Hawaiian Triggerfish	+	+	
Sufflamen bursa (Bloch and Schneider, 1801)	Pallid Triggerfish	+	+	+
Sufflamen chrysopterum (Bloch and Schneider, 1801)	Eye-stripe Triggerfish		+	+
Monacanthidae	**Leatherjackets**			
Aluterus scriptus (Osbeck, 1765)	Scrawled Leatherjacket	+	+	+
Cantherhines pardalis (Rüppell, 1837)	Honeycomb Leatherjacket	+	+	
Paraluteres prionurus (Bleeker, 1851)	Blacksaddle Filefish		+	
Oxymonacanthus longirostris (Bloch and Schneider, 1801)	Harlequin Filefish	+	+	
Ostraciidae	**Boxfishes**			
Ostracion cubicus Linnaeus, 1758	Yellow Boxfish	+	+	
Ostracion meleagris Shaw, 1796	Black Boxfish	+	+	
Tetraodontidae	**Toadfishes**			
Arothron nigropunctatus (Bloch and Schneider, 1801)	Blackspotted Puffer	+	+	+
Arothron stellatus (Bloch and Schneider, 1801)	Starry Puffer	+	+	
Canthigaster valentini (Bleeker, 1851)	Blacksaddle Toby			+
Canthigaster solandri (Richardson, 1844)	Solander's Toby	+	+	+
Diodontidae	**Porcupinefishes**			
Diodon liturosus Shaw, 1804	Blackblotched Porcupinefish		+	
Total number of species per atolls		**293**	387	267
Total number of species over all atolls			**461**	

Guide to Authors

Subject Matter

Original research, reviews and observations in all branches of natural science and human studies will be considered for publication. However, emphasis is placed on studies pertaining to Western Australia and neighbouring regions. Longer papers will be considered for publication as Supplements to the *Records of the Western Australian Museum*. Such publications may attract charges to the authors to offset the costs of printing — authors should consult the editors before submitting large manuscripts. Short communications should not normally exceed three typed pages and this category of paper is intended to accommodate observations, results or new records of *significance*. All material must be original and not have been published elsewhere.

Presentation

Authors are advised to follow the layout and style in the most recent issue of the *Records of the Western Australian Museum* including headings, tables, illustrations and references. When in doubt, use a simple format that is easily edited. Please provide line numbers throughout the MS (e.g. in Word go to File » Page Setup » Layout (tab) » Line Numbers (button), add line numbers and click on "continuous" numbering).

The title should be concise, informative and contain key words necessary for retrieval by modern searching techniques. An abridged title (not exceeding 50 character spaces) should be included for use as a running head.

An abstract must be given in full length papers but not short communications, summarizing the scope of the work and principal findings. It should normally not exceed 2% of the paper and be suitable for reprinting in reference periodicals. At the end of the abstract, provide several keywords not already included in the title.

The International System of units should be used. Spelling should follow the *Concise Oxford Dictionary*. Numbers should be spelled out from one to nine in descriptive text; figures used for 10 or more. For associated groups, figures should be used consistently (e.g. "5 to 10", not "five to 10").

Systematic papers must conform with the International Codes of Botanical and Zoological Nomenclature and, as far as possible, with their recommendations.

Synonymies should be given in the short form (taxon, author, date, page) and the full reference cited at the end of the paper. All citations, including those associated with scientific names in taxonomic works, must be included in the references.

Manuscripts

Manuscripts should be submitted electronically as PDF's or Word files to the editors (listed below). For manuscripts with large image files, submission of a CD is acceptable. Manuscripts must be 1.5 or double-spaced throughout. All margins should be at least 25 mm wide. Tables plus headings, and Figure legends should be on separate pages. Tables should be numbered consecutively, have headings which make them understandable without reference to the text, spell out generic names and be referred to in the text.

Figures

Lower resolution images can be inserted into a PDF or Word document for review. Upon acceptance, high resolution (6–10 Mb) images in TIFF or JPEG format can be e-mailed or burned to CD and posted to the editors. We prefer TIFF files for figures. For Adobe Illustrator and Sigmaplot, save in .eps (encapsulated postscript) format; for PowerPoint, save in .wmf (windows metafile format); for Excel, save as Excel 97 worksheet (must contain spreadsheet and embedded chart); and for CorelDraw, save as an .eps file that may be opened by Adobe Illustrator.

Scanned photographs should be saved as TIFF files. All TIFF files should be compatible with Adobe Photoshop. If figures are prepared in a paint program, for black-and-white line art save at 600 dpi as a black-and-white bitmap (not greyscale or colour), and greyscale and colour line art at 300 dpi.

Scale must be indicated on illustrations. Use arrows or other aids to indicate specific features mentioned in the text. All maps, line drawings, photographs and graphs should be numbered in sequence and referred to as "Figure" (no abbreviation) in the text and captions. Each figure should have a brief, fully explanatory caption.

References

In the body of the text, references should be cited as follows:

> McKenzie and colleagues (McKenzie 1999, 2000; McKenzie *et al*. 2000) found that bat frequencies were highest on full moons, contra previous workers (Smith and Jones 1982; Berman 1988; Zucker *et al*. 1992).

For citing taxonomic groups and the author, a comma occurs between them:

> The family Carphodactylidae consists of *Carphodactylus* Smith, 1999, *Nephrurus* Jones, 1999, *Orroya* Couper, Covacevich and Hoskin, 2001, *Phyllurus* Sprong, 1888 and *Saltuarius* Hammond, 1901.

All references must be cited in the text by author and date and all must be listed alphabetically at the end of the paper. The names of journals are to be given in full. Consult a recent edition of the *Records* for style. For taxonomic papers, include full references for all taxonomic groups mentioned in the text. In manuscripts dealing with historical subjects references may be cited as footnotes.

Processing

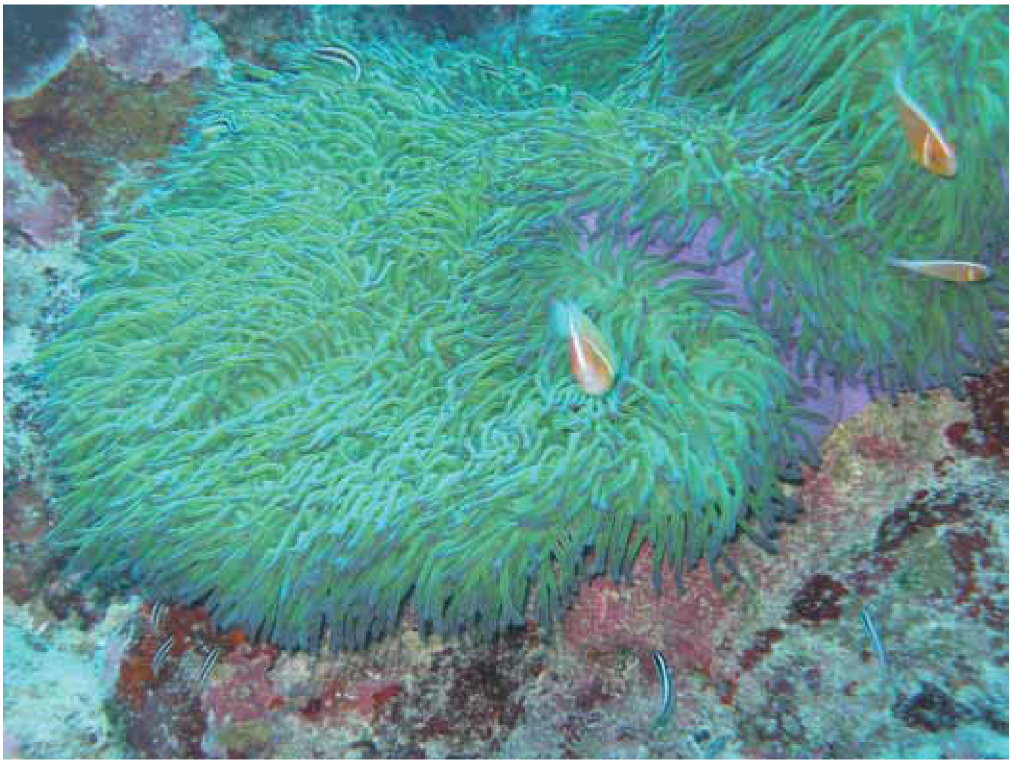
All manuscripts are reviewed by at least two referees whose reports assist the editors in making their decision whether to accept the paper. The review process usually takes from two to three months, although the review process and typesetting for longer manuscripts and supplements are usually longer.

The corresponding author is sent one set of page proofs electronically which must be returned within one week after receipt.

All authors will receive a PDF of their papers and a print copy of the entire issue.

Editors

Manuscripts can be submitted to either Paul Doughty (paul.doughty@museum.wa.gov.au; human studies [anthropology, archaeology or history] and vertebrate animals) or Mark Harvey (mark.harvey@museum.wa.gov.au; invertebrate animals).



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