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THE DIVERSITY AND ABUNDANCE OF CHAETODONTIDAE FAMILY AND ITS RELATIONSHIP WITH LIVE CORAL COVER IN SPERMONDE ISLANDS, MAKASSAR

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Abstract: Coral fish are one of the marine biotas that are highly sensitive to changes in coral reef ecosystems. Therefore, the presence or absence of specific reef fish species can describe the condition of coral reefs. The objective of the current study is to investigate the relationship between the biodiversity and abundance of Chaetodontidae fish and the live coral cover at 13 locations in the Spermonde area, Makassar City. Reef fish were counted using the Underwater Visual Census method. Coral cover percentages were determined using the Underwater Photo transects method. The results found 348 individuals of the Chaetodontidae family, comprising 21 species from four genera. The mean live coral cover categories in Spermonde were in pretty good condition (27.83%). Chaetodontidae in Spermonde Island was not diverse (mean H = 1.74) and not abundant (mean abundant = 721 ind./ha). There was a weak correlation between the diversity of Chaetodontidae and live coral cover, and also weak correlation between the abundance of Chaetodontidae and live coral cover in Spermonde Island, with R^2 determination coefficient linear regression were 0.1697 and 0.0471, respectively.

Keywords: Butterflyfish, Linear Regression Analysis, Makassar, small islands, Underwater Visual Census.

Introduction

The coral reef ecosystem is one of the marine ecosystems with an essential function as a habitat for supporting marine biodiversity, feeding ground, and spawning ground. Coral reef ecosystems have many benefits, including supporting research and education activities (Giyanto *et al.,* 2017). Unfortunately, the condition of coral reefs in Indonesia is almost 71.0% heavily damaged, in moderately good condition about 22.5%, and in excellent condition only about 6.5% (Giyanto *et al.,* 2017). Most of the damage is due to the use of not environmentally friendly fishing equipment such as fish bombs and poisons (potassium and cyanide) (Mcmanus *et al.,* 1997; Mous *et al.,* 2000; Putra *et al.,* 2020a; 2021). In addition, several coastal communities also use coral for household purposes (Asian Development Bank, 2014; Putra *et al.,* 2020a).

Makassar is a city well-known for its considerable potential for marine tourism (Tahir *et al.,* 2019; Dahliah, 2021). However, the challenges and pressures on coral reef ecosystems in Makassar are very high. The coral reef ecosystems in Makassar have been degraded and live coral cover from 2008 to 2016 has decreased by 40%. Coral reef degradation in Makassar possibly has an impact on marine organisms. Degradations of coral in Makassar affect invertebrates and reef fish. Reef fish can be used as indicators of the degradation of coral because the presence and absence of certain species of these fish indicate certain conditions (Heenan & Williams, 2013; Putra *et al*., 2018; 2020a; 2020b).

The butterflyfishes (Chaetodontidae) family has the closest relationship to coral reefs and are indicators of coral health (Muis *et al*., 2019; Nugraha *et al.,* 2019; Hamuna *et al*., 2020). The presence of butterflyfishes indicates that the coral reef ecosystem has encountered several modifications such as habitat degradation, availability of preferred food (e.g., coral polyps, invertebrates, and small crustaceans), and changes in marine conditions (Cole *et al.,* 2008a; Kurniawan *et al.,* 2021).

Butterflyfishes also play a central role in advancing our understanding of behavioural ecology in the coral ecosystem because the feeding behaviour and food composition of butterflyfishes directly depend on the coral (Blowes *et al*., 2013; Pratchett *et al.,* 2013a; Noble *et al*., 2014). Two-thirds of all butterflyfish live in coral reef ecosystems and many fish species feed only on reef-building coral (Cole *et al.,* 2008b). Butterflyfish are known as a very diverse family of reef fish. In 1998, (Allen & Mohammed, 2003) this fish species comprised 128 species in 10 genera dominated by the Chaetodon genus. In 2010, Bellwood *et al.* reported that the fish family Chaetodontidae has more than 130 species with representatives in all coral reef areas. A recent report from Kulbicki *et al.* (2013) reported that in 175 sites distributed throughout the world, 134 species from 11 genera of Chaetodontidae have been found.

Butterflyfish are conspicuous and iconic inhabitants of coral reefs because most butterflyfish are active daily (Gregson *et al.*, 2008; Chandler *et al*., 2016). Based on their distribution, butterflyfish from Chaetodontidae are scattered in 19 regions: Nine regions in the Pacific Ocean, four regions in the Indian Ocean, five in the Atlantic Ocean, and one area in the Indian and Pacific Oceans. In the Pacific, there are three prominent clusters: The Indonesia cluster (Indonesia, the Philippines, Indochina, the Malacca Peninsula), the China-Japan cluster (China, Korea, Japan), and the Melanesia cluster (Papua New Guinea, Great Barrier Reef, Melanesia) (Kulbicki *et al.,* 2013).

The Spermonde Archipelago is one of the most widespread coral reef distribution sites in Makassar, covering 150 km^2 and 120 islands (Rauf & Yusuf, 2004; Bara'langi' *et al.,* 2021). However, due to the uncontrolled exploitation of reef fish with explosives and poisonous chemicals (cyanide), the potential of the coral reef ecosystem in the Spermonde Island region is currently threatened and has sustained significant damage (Rauf & Yusuf, 2004). Therefore, the Spermonde is an especially suitable location for investigating the link between compositional changes in reef fishes and coral health. Furthermore, changes in the composition of coral reef ecosystems in the Spermonde Islands also impact several marine organisms associated with coral reefs, especially coral reef fish. Therefore, the parameters of diversity and abundance of butterflyfishes (Chaetodontidae) are used as indicators for assessing and monitoring coral reef health (Laikun *et al.,* 2015) and can evaluate coral reef health in Makassar. This research proposes investigating the relationship between species diversity and the total number of Chaetodontidae individuals with the percentage of live coral cover at observation stations in Spermonde Islands, Makassar.

Materials and Methods

Research Location

This research uses 13 sites in the Spermonde Islands, Makassar City. The selection of research sites is based on purposive sampling by identifying all representation areas in the Spermonde Islands, Makassar (Figure 1).

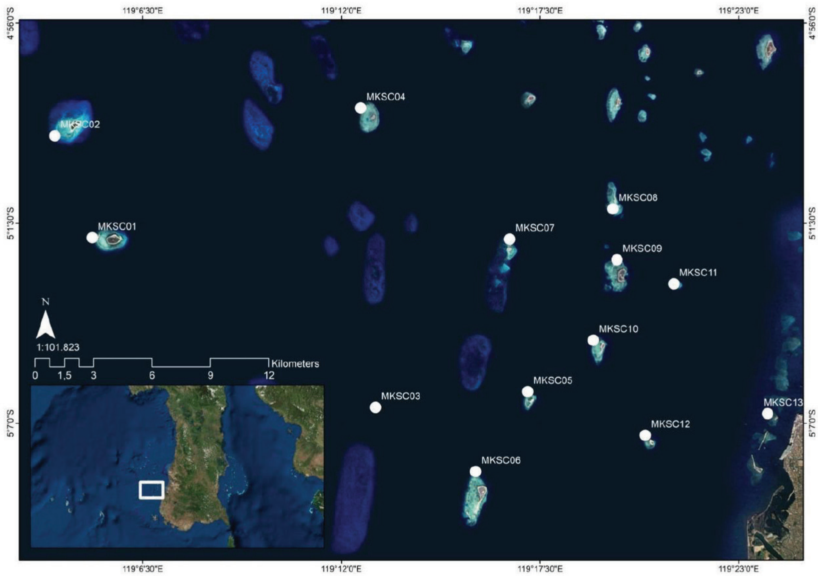

Figure 1: The research map shows 13 sites of the coral reef ecosystem in Spermonde

Chaetodontidae Data Collection

The Chaetodontidae fishes were counted using the Underwater Visual Census (UVC) (Giyanto *et al.,* 2014) based on a 70-meter transect lines, with an observation sweep of 2.5 meters to the left and right from the belt transect. The total area of research in each site was 350 m^2. To prevent and avoid recording the same fish species, reef fish were counted one at a time during sampling. Therefore, the experienced observer must collect fish data carefully and thoroughly to eliminate random counting/detection errors, double counting, and observer bias. The researcher counted the species and number of Chaetodontidae fish in the swept area and took underwater photos and videos to complete the data. To confirm the species, the photos and video of Chaetodontidae species were then compared with those published in the literature (Kuiter & Tonozuka, 2001; Allen, 2003; Kuiter, 2003).

Benthic Cover

Several methods have been used to examine benthic cover areas on coral reefs such as the Line Intercept Transect (LIT) method, Point Intercept Transect (PIT) (Giyanto *et al.,* 2014), and Underwater Photo Transect (UPT) (Ahmadia *et al.,* 2013; Kurniawan *et al.,* 2021). The current study used the underwater photo transect method to collect benthic cover areas based on the percentage of coral cover as previously described (Giyanto, 2013; Giyanto *et al.,* 2014). UPT utilizes technological developments for coral analysis, the digital camera and computer software. Benthic cover data were collected using a single frame measuring 58 x 44 cm^2 and placed on a roll meter as a reference for the shooting target area for the UPT method. The photo of the benthic cover starts from the first transect roll-meter placed on the left side of the transect line (the part closer to the mainland) as "Frame 1". The next photo shot was continued at the 2nd meter on the right side of the transect line (the part further from the mainland) as "Frame 2" and so on until the end of the 50-meter transect. The odd-numbered frames are recorded on the left side of the transect line and even-numbered frames are recorded on the transect line's right side (Giyanto, 2013; Giyanto *et al*., 2014).

Data Analysis

The photos from underwater photography transects along 50 meters were analyzed using Coral Point Count with Excel Extension (CPCe) software to get the percentage of live coral (LC) and Acropora (AC) cover. The distribution and abundance of reef fish of the Chaetodontidae family were recorded by analyses of the number of species and the abundance of fish (Giyanto *et al.,* 2014; Kurniawan *et al.,* 2021). The analysis of the relationship between the diversity of Chaetodontidae fish with coral cover and the abundance of Chaetodontidae fish with coral cover at each site was by using simple linear regression (Nurjirana & Burhanuddin, 2017; Titaheluw *et al.,* 2020).

Four indices of ecology were used for the assessment of coral reef fishes: Effective Number of Species (ENS), Shannon-Wiener Diversity Index (H) by (Shannon & Weaver, 1964), Simpson's Index (Simp.) (Whittaker, 1965), Pielou's Evenness Index (J) (Pielou, 1969), and the number of species. The Shannon-Wiener Diversity Index (H) ranged from 0 to 5 (Jorgensen *et al*., 2005), with the index criteria for reef fishes according to Brower and Zar (1977) and Eugene P. Odum (1913) are as follows: (a) $H \leq 2.30$ (low diversity; environment pressure very strong), (b) $2.30 < H \leq 3.30$ (moderate diversity; environment pressure is moderate), and (c) $H \geq 3.30$ (high diversity; ecosystem in balance). In contrast, Simpson's Pielou Evenness and Simpson's Index (Simp.) ranged from 0 to 1 (Whittaker, 1965). Furthermore, the evenness index based on Krebs (1989) is categorized as follows: (a) $0 < J \leq 0.4$ (low homogeneity; depressed community), (b) $0.4 < J \leq 0.6$ (moderate homogeneity; unstable community), and (c) $0.6 < J \leq 1$ (high homogeneity; stable community). The higher the value of the Shannon-Wiener Diversity Index (H) and Pielou's Evenness Index (J) index the higher the diversity of communities.

The Simpson's Index (Simp.) represents the higher index values that show less variation in communities with index criteria as follows: (a) $0 <$ Simp. < 0.5 (low dominance); (b) $0.5 <$ Simp. ≤ 0.75 (moderate dominance); and (c) $0.75 <$ Simp. ≤ 1.0 (high dominance). For a more comprehensive analysis, we also calculated species richness (SR) diversity for specific corallivore fish Chaetodontidae family categories of reef fish based on Giyanto *et al.* (2014), where the categories of species richness (SR) diversity for Chaetodontidae are as follows: (a) SR < 10 species (low diversity of Chaetodontidae); (b) $10 \leq$ SR ≤ 20 (moderate diversity of Chaetodontidae, and (c) SR ≥ 20 (high diversity of Chaetodontidae). The abundance and diversity of reef fishes with a coral cover were calculated with linear regression analysis.

Results and Discussion

The results showed that as many as 21 butterflyfish were found in Spermonde Islands, Makassar City. The butterflyfish consisted of 20 species from 4 genera, including the Chaetodon genus with 14 species, the Chelmon genus with one species, the Coradion genus with one species, and the Heniochus genus with four species (Table 1). Furthermore, the diet categories of butterflyfish in Spermonde Makassar are primarily included in the obligate and facultative categories. Only two species of butterflyfish are included in the Non-coral feeder category, particularly *Chelmon rostratus* and *Coradion melanopus* (Table 1).

Results of the current study showed that the majority of Chaetodontidae in Spermonde Island were facultative corallivores and only six species were obligate species, including *C. baronessa*, *C. lunulatus*, *C. ocellicaudus*, *C. octofasciatus*, and *H. singularis* (Table 1). In general, corallivorous butterflyfishes can be divided into obligate and facultative corallivores, which differ significantly in their dependence on coral resources (Cole *et al.,* 2008; Pratchett *et al.,* 2013). The obligate coral feeders are constrained by the availability of corals, as these form a major component of their diet. For example, most obligate coral feeders feed almost exclusively on corals and show strong preferences for particular coral species (Pratchett *et al*., 2013; Chandler *et al.,* 2016). On the other hand, the facultative corallivorous butterflyfishes opportunistically exploit corals but could equally survive without any coral in their diet.

Our research had different results from several studies that showed obligate corallivores also dominate butterflyfish assemblages at other coral reef habitats across the Indo-Pacific with three of four of the most abundant species (Emslie *et al.,* 2010; Pratchett *et al.,* 2013a; 2013b; 2014). The different composition of facultative and obligate species of corallivorous fish on Spermonde Island is strongly influenced by a limited coral resources available, resulting in a higher percentage of facultative species (Table 1).

On the other hand, the most populous obligate species on Spermonde Island was *C. octofasciatus* (Figure 2). Previous research showed that *C. octofasciatus* dominated certain seawater areas and indicates that coral reefs have changed (Iskandar *et al*., 2020). However, based on Maharbhakti (2009), the primary food of *C. octofasciatus*, mainly calcium carbonate substratum can no longer be identified or known as detritus. Therefore, this figure shows that the presence of this species cannot be used as an indication of good coral reef health because this species can survive without coral reefs. We also found several famous pair-sister taxa

Table 1: The species of Chaetodontidae fish in Spermonde Islands, Makassar City

Species	Diet	Fisheries	Aquarium	% Appearance
Chaetodon adiergastos	Facultative	-	Commercial	0.86
Chaetodon auriga	Facultative	Minor commercial	Commercial	0.86
Chaetodon baronessa	Obligate	-	Commercial	5.75
Chaetodon citrinellus	Facultative	Minor commercial	Commercial	1.72
Chaetodon kleinii	Facultative	Subsistence fisheries	Commercial	12.07
Chaetodon lineolatus	Facultative	Minor commercial	Commercial	1.15
Chaetondon lunula	Facultative	Minor commercial	Commercial	3.45
Chaetodon lunulatus	Obligate	-	Commercial	7.47
Chaetodon ocellicaudus	Obligate	-	Commercial	0.57
Chaetodon octofasciatus	Obligate	-	Commercial	27.59
Chaetodon oxycephalus	Facultative	-	Commercial	1.15
Chaetodon rafflesi	Facultative	Minor commercial	Commercial	3.16
Chaetodon speculum	Facultative	Minor commercial	Commercial	1.72
Chaetodon trifascialis	Obligate	-	Commercial	2.30
Chaetodon vagabundus	Facultative	Minor commercial	Commercial	6.03
Chelmon rostratus	Non-coral Feeder	Minor commercial	Commercial	9.48
Coradion melanopus	Non-coral Feeder	-	Commercial	4.31
Heniochus acuminatus	Facultative	Minor commercial	Commercial	0.57
Heniochus chrysostomus	Facultative	Minor commercial	Commercial	1.15
Heniochus singularis	Obligate	Minor commercial	Commercial	0.57
Heniochus varius	Facultative	Minor commercial	Commercial	8.05

Note: LC (Least Concern), DD (Data Deficient), NT (Near Threatened).

corallivorous species, including *C. lunulatus* and *C. baronessa.* Both species tend to be obligate corallivores and depend on healthy scleractinian corals for survival (Chandler *et al.,* 2016) and consuming a wide range of different corals (Bellwood *et al.,* 2010; Pratchett *et al.,* 2013b). As obligate coral corallivores, *C. lunulatus* and *C. baronessa* tends to form pairs and aggressively maintain distinct feeding territories (Pratchett *et al.,* 2014).

Of the 21 species of fish of the Chaetodontidae family in 13 sites, *Chaetodon octofasciatus* was the most common fish in Spermonde. 96 individuals of *C. octofasciatus* were found, twice that of *Chaetodon kleinii*, the second most populous fish in Spermonde with 42 individuals (Figure 2). Next was *Chelmon rostratus*, which had 33 individuals, followed by *Heniochus singularis*, with only 2 individuals (Figure 2).

The study results at 13 locations showed 21 species of indicator fish from the Chaetodontidae family representing four genera and 348 individuals (Figure 2). The diversity of Chaetodontidae fish species at the 13 sites ranged from 4 species to 12 species. Similar information was also found by Sari *et al*. (2017) that the diversity of Chaetodontidae fish species varies in Spermonde from 3 to 11. However, the number of species found in the Spermonde Islands, Makassar City differed from other studies. For example, research from Nurjirana and Burhanuddin (2017) found only one species in Lumu-lumu Island, three species in Lanjukang Island, and two species in Kodingareng Lompo Island.

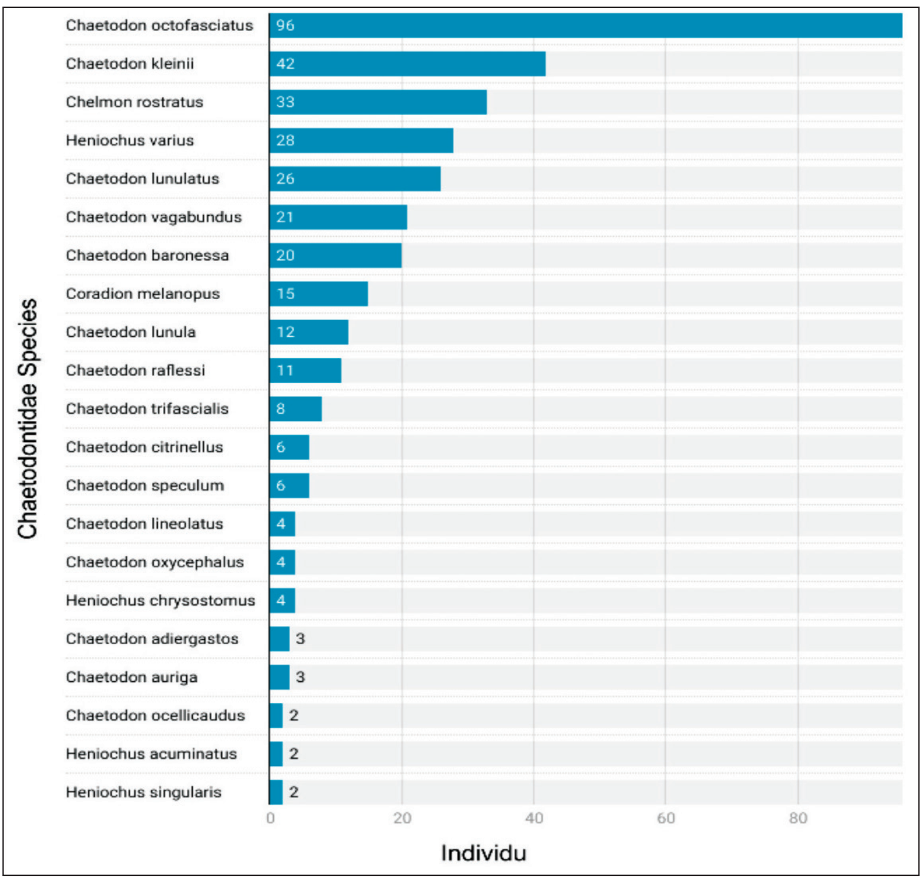

Figure 2: Chaetodontidae fish was found in the Spermonde seawaters area, Makassar

The highest number of species of butterflyfishes found at the 13 Spermonde Island sites was 12 and the lowest number was four (Figure 3). Based on analysis by index, the Shannon-Wiener Diversity Index (H) with categories for reef fishes from Brower and Zar (1977) and was from 1.29 (low diversity) to 2.40 (moderate diversity), the value of Pielou's Evenness Index categories from Krebs (1989) in Spermonde Island were 0.75 to 0.97 (high homogeneity; stable community), and the value of Simpson's Index was 0.10 to 0.35 (low dominance). Therefore, the mean ENS value of Chaetodontidae in Spermonde was 6.21, with the lowest ENS of 3.62 and the highest ENS value of 11.2 species (Figure 3).

Chaetodontidae species diversity at the 13 sites fluctuated from low to moderate species richness (SR), based on classification by Giyanto *et al.* (2014) for specific corallivore fish of the Chaetodontidae family. For example, MKSC06 Station (P. Kodingarenglompo) has the highest number of species with 12, and based on specific species richness (SR) for Chaetodontidae classification by (Giyanto *et al.*, 2014) is included in the moderate diversity of Chaetodontidae category. At the same time, MKSC08 Station (Gosong Bonebatang) has the least number of species, with only four. This indicates low diversity (Figure 4) indicating degradation of coral reef ecosystems due to the extraction of sea sand for building material. As a result, the coastline and mainland of Mount Bonebatang underwent many drastic changes that impacted the ecosystem for three years.

The changes in the composition of the butterflyfish recorded by Putra *et al.* (2018) were compared with the findings by Sari *et al.* (2017; 2018). It shows that during the four years of observation, the diversity of Chaetodontidae fish species in the Spermonde Islands increased yearly. For example, in 2015, 5 species of

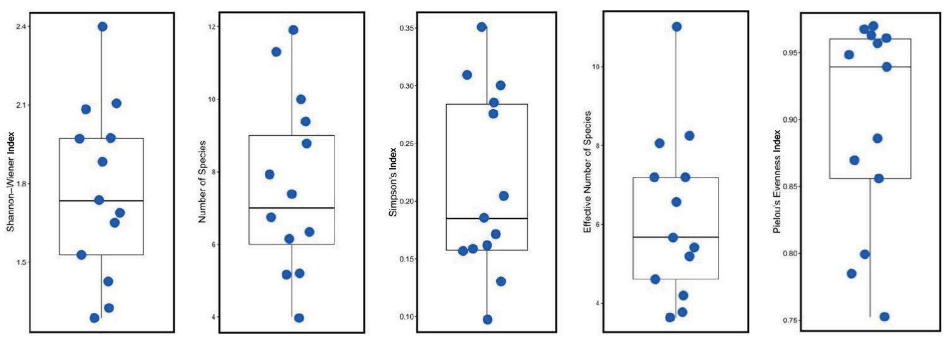

Figure 3: The several ecological indices of Chaetodontidae fish was found in the Spermonde seawaters area, Makassar

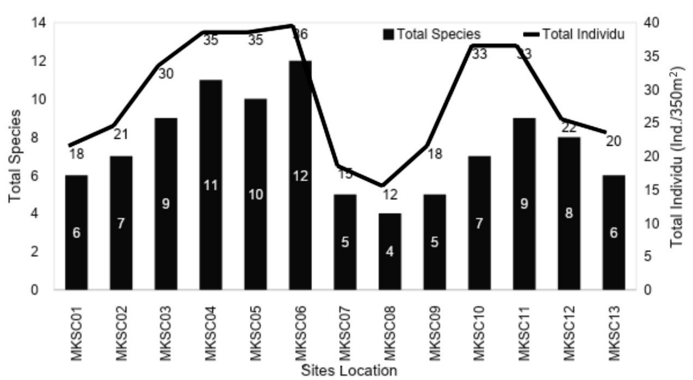

Figure 4: Abundance and species diversity of Chaetodontidae in Spermonde Islands, Makassar

Chaetodontidae were recorded (Sari *et al.,* 2017; 2018), 11 species in 2016, 19 species in 2017, and 21 species in 2018 (Putra *et al*., 2018) as presented in Figure 5. Giyanto *et al*. (2014) stated that the Chaetodontidae fish groups in coral reef ecosystems can be divided into three categories low species diversity where the number of H species is < 10 species, moderate species diversity (10 to 20 species), and high species diversity (H > 20 species).

Simple linear regression analysis between the number of Chaetodontidae fish species and live coral cover obtained an R^2 (determination) of 0.1697. This indicates that this study is only able to describe 16.97% of the actual conditions. The regression model between the number of Chaetodontidae fish species and the live coral cover showed a weak correlation, indicated by a low coefficient of determination R^2 (Figure 6).

The simple linear regression analysis results between the total number of individual Chaetodontidae fish and live coral cover obtained R^2 (determination) of 0.04713. These results indicate that this study is only able to describe 4.713% of the actual conditions. The regression model between the total number of Chaetodontidae fish and the live coral cover showed a weak correlation, indicated by a low coefficient of determination R^2 (Figure 6). The Spearman correlation test between the number of Chaetodontidae fish species and the percentage of live coral cover showed a value of 0.406, which indicates a value not significantly different. Furthermore, Nurjirana and Burhanuddin (2017) stated a weak correlation between live coral cover and the proportion and number of Chaetodontidae fish species. However, results from Badi Island showed a positive correlation between Chaetodontidae individuals and coral cover with specific growth, where the dominance of branching growth was 11.02%.

The regression results show a positive correlation between coral reef cover and corallivorous fish composition, indicating that several butterflyfishes (family Chaetodontidae) species in Spermonde Island are dependent on scleractinian corals for food (Pratchett *et al.,* 2013a). The results of this positive correlation show that the coral conditions on Spermonde Island still influence the composition of butterflyfishes as there is still a reliance on live coral for food (Wilson *et al*., 2006). Several factors influence the weak correlation between coral cover and butterflyfish composition in Spermonde, including the availability of food types or coral species that affect the composition of butterflyfishes. Previous studies have shown that butterflyfish favour *Acropora* (Pratchett, 2005; Brooker *et al.,* 2013) and *Pocillopora coral* species (Pratchett *et al.,* 2014).

Therefore, the presence of *Acropora* and *Pocillopora* species in a reef significantly influences the composition of butterflyfishes dependent on the two species. Research by Yusuf *et al.* (2021) stated that scleractinian coral diversity in Spermonde was dominated by the three genera, Fungia, Montipora, and Porites, accounting for nearly half (48.64%) of all colonies and 20% of all species recorded. This coral composition also causes a weak correlation between butterflyfish composition

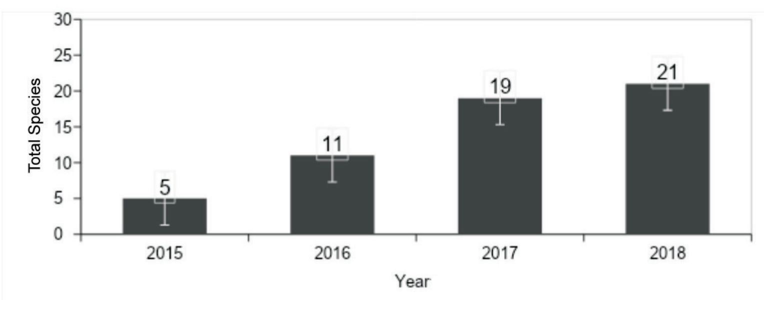

Figure 5: Comparison of the number of species of Chaetodontidae in Spermonde from 2015 to 2018

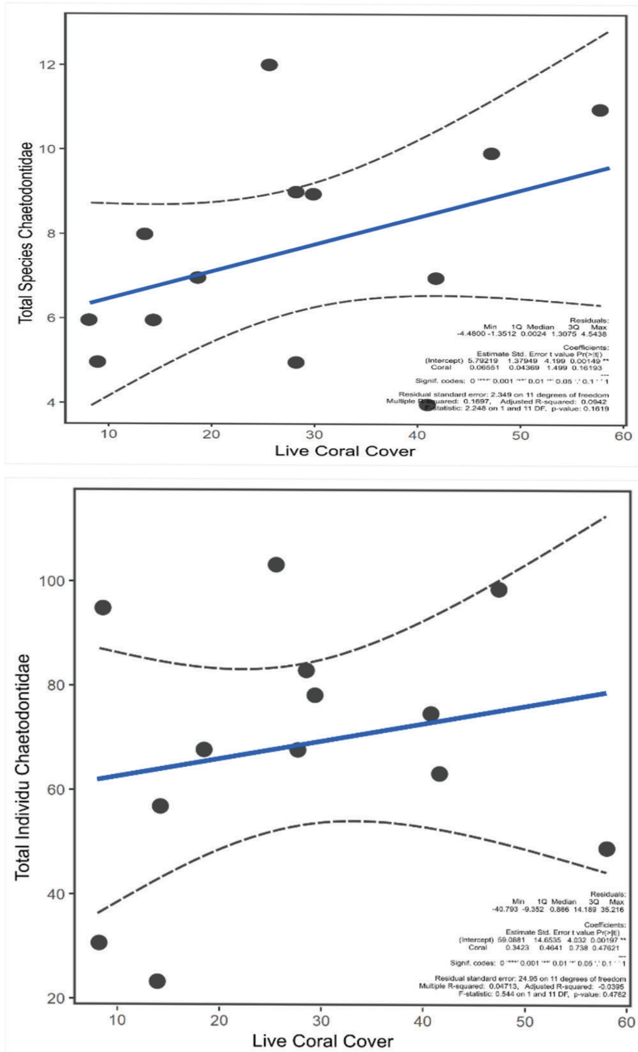

Figure 6: Relationship between species diversity and total individual of Chaetodontidae with the percentage of live coral cover at observation stations in Spermonde Islands, Makassar

and coral reef cover in Spermonde. This agrees with the study by Berumen and Pratchett (2006) that butterflyfishes might increase the range of coral prey consumed when preferred prey is unavailable.

Previous studies reported that the butterflyfish clade contains 103 species and approximately 80% of the species of similar groups are strongly associated with coral reefs (Bellwood *et al.,* 2010). The number of butterflyfish species that feed at least in part on live corals are about 78% in a specific location (Cole *et al.,* 2008; Pratchett *et al*., 2014). Several type of butterflyfishes are very selective of their food, nonetheless, many species are obligate (Pratchett *et al.,* 2014). However, the dominance of facultative species may affect the result of the correlation levels. Moreover, fish found in the study site of Spermonde Islands are mostly facultative species.

Based on the ecological assessment of Chaetodontidae, fish species were classified based on the scoring value of the abundance/ number of Chaetodontidae fish species, (McMellor, 2007). The results of the scoring assessment at 13 sites indicate that five stations are classified as a very good condition with a score of "5", three stations are classified as good with a score of "3", and four stations are classified as poor with a score of "1." In addition, one site was classified as extremely poor with a score of "0" (Table 2).

The results of the scoring assessment at Lumu-lumu Island and Kodingarenglompo Island showed the highest scores among other islands included in the research location. Based on these results, the abundance and diversity of Chaetodontidae were classified as very good at both site locations. Every organism has its ecological niche (Moore, 2013; González *et al.,* 2017). Chaetodontidae fish feed on corals in reefs with many crevices resembling small caves to hide, find food or a place to live (Pratchett & Berumen, 2008). The abundance of Chaetodontidae fish in the Spermonde Islands was positively correlated with branching coral and live coral cover. For example, 12 out of 13 sites had an abundance of Chaetodontidae fish < 40 individuals with branching coral cover of less than 15% and one site with branching coral cover reaching 30% with the individual abundance of Chaetodontidae only 12 individuals.

The appearance at MKSC08 site (G. Bonebatang) was due to the coral reef ecosystem there being in a state of recovery. Therefore, the presence and absence of several types of Chaetodontidae fish can describe the marine condition of Spermonde. However, the presence of Chaetodontidae fish does not always indicate good coral reef conditions. Several species of Chaetodontidae indicate degraded or damaged coral reefs.

Our study found that the *Chaetodon kleinii* species was the second most populous (Figure 1). The presence of *C. kleinii* in the Spermonde Islands shows that the branching corals at the site were in good condition. Based on our evaluation research, the *C. kleinii* was found with a base substrate of branched coral. *C. kleinii* was schooling and feeding on coral species in several conditions. Previous studies by Nurjirana and

Table 2: The condition of Chaetodontidae fish was based on the scoring criteria for the ecological assessment of reef fish at the research station in Spermonde Islands, Makassar City
(Based on McMellor, 2007)

Sites Code	Total Species	Abundance Standard	Scoring	Criteria
MKSC01	6	> 4	**1**	Poor condition
MKSC02	7	> 6	**3**	Good condition
MKSC03	9	> 8	**5**	Very good condition
MKSC04	11	> 8	**5**	Very good condition
MKSC05	10	> 8	**5**	Very good condition
MKSC06	12	> 8	**5**	Very good condition
MKSC07	5	> 4	**1**	Poor condition
MKSC08	4	< 4	**0**	Extremely poor condition
MKSC09	5	> 4	**1**	Poor condition
MKSC10	7	> 6	**3**	Good condition
MKSC11	9	> 8	**5**	Very good condition
MKSC12	8	> 6	**3**	Good condition
MKSC13	6	> 4	**1**	Poor condition

Burhanuddin (2017) affirmed from six sites that *C. kleinii* was found in areas with branching corals on the base substrate. Another study by Pratchett *et al.* (2013b) also reports that *C. kleinii* were facultative corallivores that supplemented consumption of Scleractinia corals.

The weak relationship between *C. octofasciatus* and the live coral cover was seen at MKSC01, MKSC04, and MKSC08 with a live coral cover of > 40% and a low abundance of Chaetodontidae. The contrast was shown at site locations MKSC10, MKSC11, MKSC09, and MKSC07, with live coral cover of < 40% and high fish abundance. MKSC10 (P. Barrangcaddi) and MKSC11 (G. Bonelola) had the highest abundance of 17 individuals, indicating that both sites have changed. Research from the MSDC UNHAS Professional Institute also shows that there has been a 35% decline in live coral cover over the last five years and Barrangcaddi Island had a 7% decline in live coral cover since 2017 (Sari *et al.,* 2017). The changes in coral reef composition were initially dominated by algae or others, which will considerably influence fish.

Conclusion

The mean live coral cover categories in Spermonde were in pretty good condition (27.83%). The diversity index (H) of reef fishes in Spermonde in 13 sites located on Spermonde Island was from 1.29 (low diversity) to 2.40 (moderate diversity) with a mean diversity index of 1.74, which indicated low diversity. The Chaetodontidae in Spermonde were also not abundant (mean abundance = 721 ind./ha). The ecological assessment of Chaetodontidae shows one site in extremely poor condition, four sites in poor condition, three sites in good condition, and five sites in very good condition. There was a weak correlation between the diversity of Chaetodontidae with live coral cover and the abundance of Chaetodontidae with live coral cover in Spermonde Island with R2 determination coefficient linear regression of 0.1697 and 0.0471, respectively.

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Conflict of Interest Statement

The authors declare that they have no conflict of interest.

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