

ORIGINAL PAPER

Distribution of *Chaetodon wiebeli*, a common ornamental fish, in Mu Ko Chumphon National Park

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Abstract. Coral reefs are an important natural asset for the tourism industry, contributing to the development of the national and local economy. Mu Ko Chumphon National Park is one of the most famous marine ecotourism destinations in the Western Gulf of Thailand because of its high coral and fish diversity. The blackcap butterflyfish, *Chaetodon wiebeli* is a common sight in the area, and due to its striking coloration, the fish is very attractive to SCUBA divers and snorkeling. The present study aimed to investigate the abundance and occurrence of *C. wiebeli* at two underwater pinnacles and ten islands of Mu Ko Chumphon National Park, using Underwater Visual Census Technique during 2018-2020. The results showed that *C. wiebeli* was found at all study sites except for Ko Kula. In addition, the blackcap butterflyfish was seen every year during the survey period. The high frequencies of occurrence were found at Hin Phae, Ko Kalok, Ko Rang Kachiu, Ko Lawa, Ko Ngam Yai, Ko Talu and Ko Raed with a range of 45-100% occurrence. The mean abundance of the fish varied spatially, ranging from 0.00 – 5.00 individuals per 100 m² and the highest one was found at Hin Phae, followed by Hin Lak Ngam, Hin Phae, Ko Kalok and Ko Talu. Overall, the mean abundance at offshore islands (2.99 individuals per 100 m²) was significantly higher than that at nearshore islands (1.26 individuals per 100 m²) (p<0.05). The abundance of *C. wiebeli* may link to the intensity of human activities and land-based pollution. This study serves as the valuable scientific information to be applied for effective marine protected area management and coastal management.

Keywords: distribution, butterflyfish, coral reef fish, gulf of Thailand.

1. Introduction

Coral reefs are highly productive ecosystems on earth, providing a high value of biodiversity, scientific and educational value, several services and opportunities to the society. Coral reefs are

also an important natural asset that generates a lot of revenues in over 100 countries worldwide, supporting economic development and livelihoods in many coastal communities (Cesar & van Beukering 2004; Brander et al. 2007; Cinner 2014; Spalding et al. 2017). For decades, coral reefs around the world have been welcoming a growing number of visitors, particularly snorkelers and SCUBA divers (Barker & Roberts 2004; Davenport & Davenport 2006; Roche et al. 2016). Although coral reefs cover less than 0.1% of the seafloor, they host the most diversity of fish on earth (Mathon et al. 2021). As they are the most biologically diverse marine communities, tropical coral reefs across the world have become popular recreational diving destinations where divers enjoy the beauty and diversity of coral reefs and marine life (Pyle 2000).

Fishes are the largest and most diverse of all groups of vertebrates on earth and more than half of them are found in marine habitats, particularly in tropical coral reefs where species richness exceeds 6000 species. Based on data synthesis over decades of surveys, the total number of coral reef fishes has been estimated in a range between 2,400 and 8,000 species among 100 families. However, fish diversity remains largely unexplored (Pyle 2000; Ravi & Venkatesh 2008); Eschmeyer et al. 2010; Duffy et al. 2016; Brandl et al. 2018; Mathon et al. 2021. Coral reef fishes are one of the major components of coral reef ecosystems and they are indicators of ecosystem health (Aminudin Afiq-firdaus et al. 2021).

Table 1. List of geographical coordinates, depth, sampling period, and estimated distance from mainland at each study site

Sites	Latitude	Longitude	Depth (m)	Estimated distance from mainland (km)
Offshore				
Hin Phae (HP)	10°30'4.00"N	99°25'26.15"E	18.33±2.89	17.00
Hin Lak Ngam (HL)	10°30'22.99"N	99°25'27.99"E	14.33±0.58	17.20
Ko Ngam Yai (NY)	10°29'40.55"N	99°25'10.98"	4.44±1.42	16.80
Ko Ngam Noi (NN)	10°29'8.58"N	99°25'3.51"E	7.13±0.99	16.90
Ko Kalok (KA)	10°28'35.69"N	99°22'10.15"E	5.67±2.08	12.20
Ko Talu (TL)	10°27'58.18"N	99°21'33.62"E	5.33±2.31	11.00
Nearshore				
Ko Mattra (MT)	10°23'51.94"N	99°20'55.08"E	3.10±1.52	7.30
Ko Raed (RA)	10°13'18.00"N	99°14'35.00"E	2.61±1.43	4.20
Ko Lawa (LW)	10°21'49.48"N	99°18'36.34"E	2.89±1.82	2.70
Ko Rang Kachiu (RK)	10°19'6.80"N	99°18'3.94"E	3.33±1.00	4.80
Ko Maphrao (MP)	10°23'31.14"N	99°17'38.95"E	4.56±1.86	1.30
Ko Kula (KU)	10°15'19.00"N	99°15'27.00"E	72±1.66	2.30

Butterflyfish of the family Chaetodontidae is one of the most distinctive coral reef fishes that mainly occur in tropical waters. They are well-known for their striking pattern and coloration. The family contains about 12 genera with 132 species, of which 33 species are found in Thailand (Froese & Pauly 2000). Members of this family have a variety of colors; however, they all share similar morphological characteristics, such as a compressed disclike body, small protractile mouths, continuous dorsal fins, and rounded to emarginate tails. Butterflyfishes are generally found solitary or in pairs, while some of them occasionally form a small group. Most species are diurnal. Their diet varies widely among the species. Many species feed on live coral polyps or tentacles, as well as a varied diet of small invertebrates, plankton, and algae (Allen 1997; Lieske & Myers 2001; Allen et al. 2003; McEachran & Fechhelm 2021).

Blackcap Butterflyfish, *Chaetodon wiebeli* Kaup, 1863, is a common sight in Mu Ko Chumphon National Park. They are easy to recognize with vivid yellow body, together with reddish-brown bands, black eye bar with the distinctive white bar behind, black saddle across upper nape, and bold black band on the caudal fin. Blackcap Butterflyfish usually migrate in pairs or small groups, distributed along with the depth of 4-25 m., and feed mainly on algae. They are found across the western Pacific, including the Ryukyu Islands, Taiwan, the South China Sea, and the Gulf of Thailand. (Allen &

Steene 1985; Lieske & Myers 1994; Kuitert & Tonozuka 2001.

Mu Ko Chumphon National Park, located in Chumphon Province, is one of the most famous ecotourism destinations in the Western Gulf of Thailand, coupled with high coral and fish diversity. The total area of Mu Ko Chumphon National Park is around 317 km² and more than 80.5% of which are marine, consisting of about 40 islands within the area. Coral reefs in the national park are fringing reefs with a depth of 1-8 m. Popular diving sites in the area include Ko Mattra, Ko Rang Kachiu, Ko Lawa, Ko Ngam Yai, and Ko Ngam Noi. *C. wiebeli* is frequently encountered around these sites, usually in pairs or small groups. However, the



Figure 1. Blackcap butterflyfish (*Chaetodon wiebeli*)

spatial distribution of the fish in this area is

unknown. The present study aims to determine the occurrence of *C. wiebeli* at the under pinnacles and islands in Mu Ko Chumphon National Park, the western Gulf of Thailand.

2. Materials and Methods

2.1 Study sites

The surveys were conducted at twelve different sites at Mu Ko Chumphon National Park, Chumphon Province, including and two pinnacles and ten islands, with an average depth of 4.8 ± 2.7 m. (Figure 2). Additionally, the study sites were also divided into two groups (nearshore and offshore) based on their distances from the mainland. The sampling took place in March and May during 2018 – 2020 (Table 1).

2.2 Field surveys

Field surveys were carried out by SCUBA diving. Together with a belt transect, Underwater Visual Census was used to observe the occurrence and abundance of *C. wiebeli*. At each site, A 100-

meter transect line was laid out in parallel to the shoreline and separated into three 30 m. replicates. The occurrence and abundance of *C. wiebeli*. were recorded at 1m intervals on both sides of the transect, which has an area of 60 m² per transect (30 m.). The record started after transects laying around 10 minutes to minimize the disturbance from divers. Geographical coordinates and depth were also recorded at each study site.

2.3 Statistical analyses

The occurrence and abundance of *C. wiebeli* were expressed as percent and individuals per 100 m². One-way analysis of variance (ANOVA) was used to compare the differences in both the occurrence and the abundance of *C. wiebeli* among study sites. Student's t-test was used to compare the difference in the occurrence and abundance between nearshore and offshore sites. All analyses were performed using R version 4.0.5.

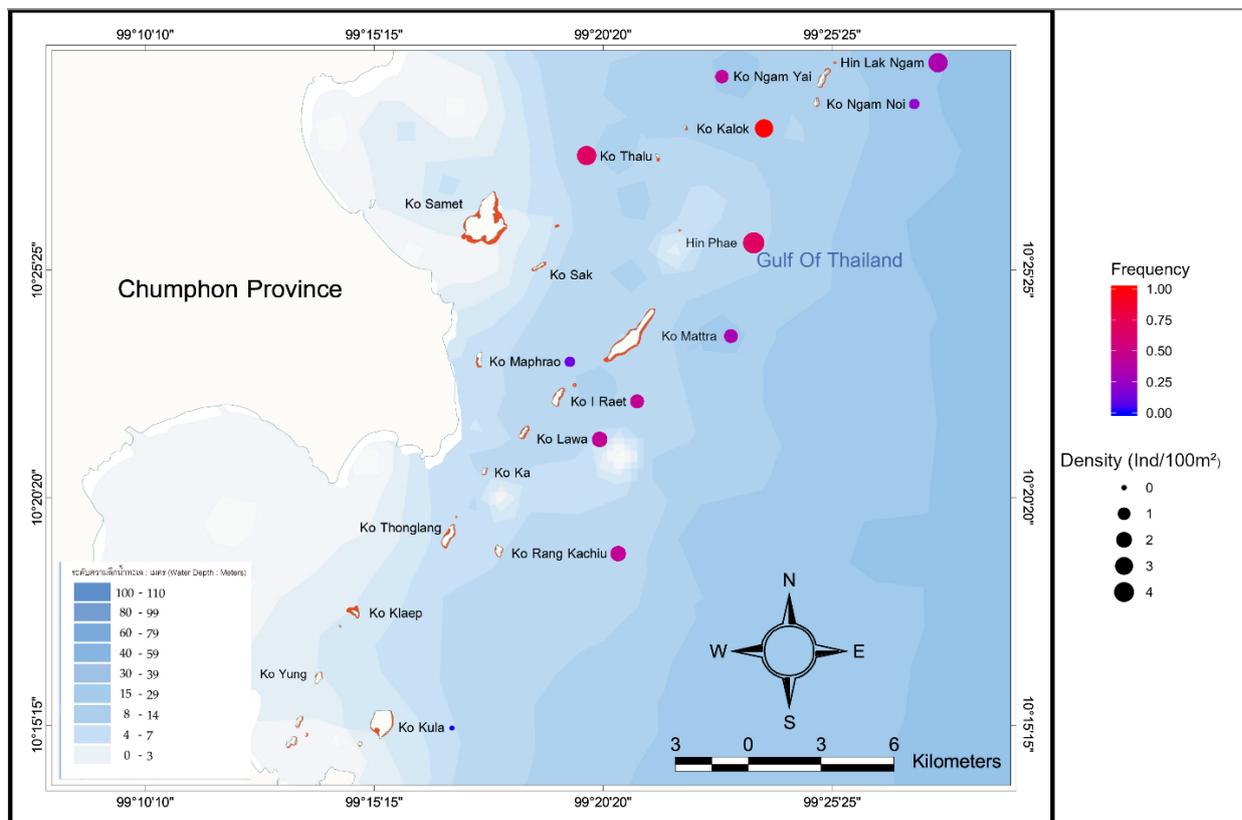


Figure 2. Map of study sites

3. Results

The results showed that *C. wiebeli* was found at all sites except for Ko Kula. The highest frequency of occurrence was found at Ko Kalok, with 100% of occurrence, followed by Hin Phae, Ko Talu, Ko Ngam Yai, Ko Raed, Ko Lawa, and Ko Rang Kachiu, varying from 44.44% to 66.67% of occurrence (Figure 3). The highest abundance was shown at Hin Phae, with five individuals per 100 m², followed by Hin Lak Ngam, Ko Talu, Ko Raed, and Ko Kalok, varying from 3.33 to 3.89 individuals per 100 m² (Figure 4).

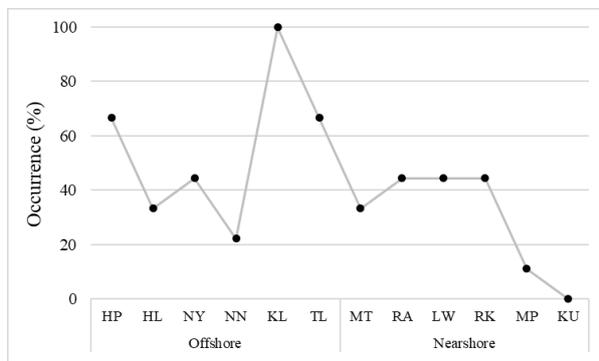


Figure 3. Occurrence of *C. wiebeli* in the study sites

High variation of occurrence and abundance of *C. wiebeli* were found among study sites. Based on the result of one-way ANOVA, no significant difference in the occurrence among study sites due to its high variation. In terms of abundance, there is a significant difference in abundance of *C. wiebeli* among study sites ($p=0.049$).

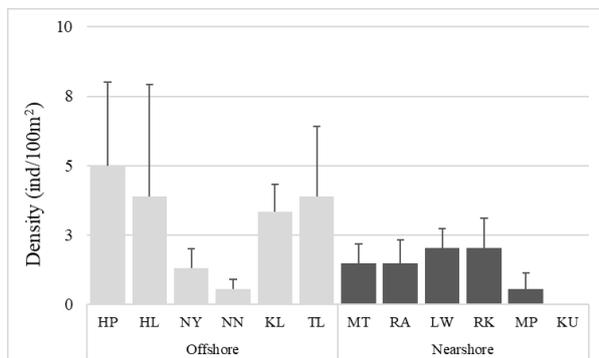


Figure 4. Densities of *C. wiebeli* in the study sites

The abundance of *C. wiebeli* at Ko Ngam Noi was significantly different from those observed at Hin Phae ($p=0.024$), Hin Lak Ngam

($p=0.035$), Ko Kalok ($p=0.042$), and Ko Talu ($p=0.035$). For Ko Maprao, it was significantly different from those observed at Hin Phae ($p=0.024$), Hin Lak Ngam ($p=0.031$), Ko Kalok ($p=0.042$), and Ko Talu ($p=0.039$). For Ko Kula, it was significantly different than those in Hin Phae ($p=0.011$), Hin Lak Ngam ($p=0.027$), Ko Kalok ($p=0.038$), and Ko Talu ($p=0.020$) (Table 3).

Considering between offshore and inshore sites, the study sites located offshore presented a higher average frequency of occurrence (55.56%) compared to nearshore areas (29.63%); however, no difference in the occurrence of *C. wiebeli* between them. In terms of the abundance, the mean abundance at offshore islands (2.99 individuals per 100 m²) was significantly higher than that at nearshore islands (1.26 individuals per 100 m²) ($p<0.05$). (Table 4)

4. Discussion

Tourism and fishing activities may also affect the abundance of *C. wiebeli*. For example, we observed that Ko Ngam Yai and Ko Ngam Noi showed a low density of *C. wiebeli* even though they are located offshore. Diving activities, both snorkeling/scuba diving and fishing activities, are commonly found in these locations. The activities may disturb or lessen the abundance and occurrence of *C. wiebeli* and other reef fishes. Several reports exhibit that recreational diving and snorkeling affect the distribution and abundance of reef fishes. For instance, Shaban et al. (2020) exhibited the abundance of surgeonfishes was negatively correlated to the numbers of divers and snorkelers in the Egyptian Red Sea northern islands. There is a concern of mass recreational diving that may have effects on aggregating and spawning fishes (Heyman et al. 2010). In terms of fisheries, driftnets, traps, poles and lines are the common fishing gears used in these areas and other parts of Thai Waters. Fishing activities are a form of natural exploitation that magnifies the fluctuation in fish abundance and overexploitation may degrade the size structure of coral reef fish communities (Anderson et al. 2008; Robinson et al. 2017).

Table 2. Result of one-way analysis of variance (ANOVA) testing the difference in the occurrence of *C. wiebeli*, among study sites

Source of Variation	SS	df	MS	F	P-value
Between Groups	2016.461	1	2016.461	3.450704	0.092879
Within Groups	5843.621	10	584.3621		
Total	7860.082	11			

Table 3. Result of one-way analysis of variance (ANOVA) testing the difference in abundance of *C. wiebeli*, among study sites

Source of Variation	SS	df	MS	F	P-value
Between Groups	8.967	1	8.967	4.993	0.049
Within Groups	17.957	10	1.796		
Total	26.924	11			
Ko Ngam Noi vs Hin Phae					0.024
Ko Ngam Noi vs Hin Lak Ngam					0.035
Ko Ngam Noi vs Ko Kalok					0.042
Ko Ngam Noi vs Ko Talu					0.035
Ko Maprao vs Hin Phae					0.024
Ko Maprao vs Hin Lak Ngam					0.031
Ko Maprao vs Ko Kalok					0.042
Ko Maprao vs Ko Talu					0.039
Ko Kula vs Hin Phae					0.011
Ko Kula vs Hin Lak Ngam					0.027
Ko Kula vs Ko Kalok					0.038
Ko Kula vs Ko Talu					0.020

Table 4 Result of student’s t-test on the mean occurrence and abundance of *C. wiebeli*, between offshore and nearshore study sites

Student’s t-test		Mean	SD	Mean difference	t	df	P-value
Occurrence	Offshore	55.5550	28.1111	25.9283	1.8578	10	0.0929
	Nearshore	29.6267	19.4557				
Abundance	Offshore	2.9900	1.7000	1.7300	2.2452	10	0.0486
	Nearshore	1.2600	0.8200				

Fish trap is the most frequent fishing gear found on/near coral reefs, even though they are in the MPAs. Generally, fishermen deploy fish traps on/near coral reefs to catch reef fishes. The operation of this fishing gear may generate physical damages on coral reefs and reef fish biodiversity (Suebphala et al. 2021). Thus, controlling such activities should be done to reduce negative impacts on reef fish communities.

Distance from the mainland is one of the factors influencing reef fish abundance due to the variation of the exposure to land-based pollution. Nearshore coral reefs often showing signs of health decline represented the impacts of the

cumulative effects from natural and anthropogenic disturbances (Smith et al. 2008). Based on our findings, most study sites which are nearshore islands had lower abundance of *C. wiebeli*, specifically Ko Maprao and Ko Kula. These islands are located near the mainland and they are influenced by freshwater discharge with degraded water quality and high sedimentation. In addition, tourism and fishing activities can also be found at Ko Kula. Boating between Ko Maprao and the mainland is relatively frequent because the island has been granted for a bird's nest concession and it is open for tourists to visit.



Figure 5. *Chaetodon wiebeli* in the fish trap found at study site



Figure 6. *Chaetodon wiebeli* at study sites

The combination of these human activities typically increases the influx of nutrients into coral reefs, which theoretically impedes normal coral growth and can eventually result in coral reef deterioration in various ways (D'Angelo & Wiedenmann 2014; Guo et al. 2019), eventually affecting the abundance of reef fish. Importantly, water quality plays a vital role as a limiting factor for various aquatic organisms. Pollution, and other drivers, can contribute to changes in fish biomass, particularly polluted water with high nutrients (Foo et al. 2020). It is important that coastal zone management is highly required to reduce land-based pollution and mitigate its impacts on coral reefs and reef fishes located near the coast.

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