

PROTECT AND ENHANCE THE RESOURCES BY USING ARTIFICIAL REEF AT COASTAL AREAS IN CENTRAL OF VIETNAM

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ABSTRACT

This study aims to protect and enhance the marine resources in coastal areas in the Central areas by artificial reef installations. The selected field was in Mui Ban Than, Quang Nam province has shown that the artificial reef models have operated effectively through restore, enhance and protect coastal resources. The marine resources restorations were illustrated not only by the quantity, from 44 marine species before reef installation up to 78 marine species after 12 months, but also by the density and frequency of found marine species as well. The resources enhancing is shown as longer time of reef installation as higher quantity and thicker density of marine species. The evaluation results also shown that the high value species and reef species have appeared in the research areas. In additional, the increasing of quantity and density are not only inside reef areas but also in the surrounding areas.

Key words: Artificial reefs, protect and enhance the fisheries resources, coastal resources

I. INTRODUCTION

The artificial reef is one of the technical solutions that have been applied widely in the world in order to protect and enhance the coastal marine resources. Many countries have been implemented artificial reefs in both offshore and near-shore areas. In Vietnam, artificial reef technology has been shown its advantages in the coastal resources protection [2]. Of which, the efficiency of artificial reef models have been concerned to archive following objectives: i) restore and protect the spawning areas; ii) create the nursery areas for marine species; iii) reduce the fishing pressure in the near-shore areas by reducing the fishing efforts of destructive fishing gears to seabed such as trawlers, bottom gillnet, near-shore purse seine... Beside that, the artificial reefs also create a new habitat and attract juveniles out of the predators and also from human's activities [3].

The coastal areas of Quang Nam province have evaluated as a high biodiversity, full of resources [1]. However, due to the pressure from populations, the demand of seafood products is higher and higher, thus, local fishers have increased the fishing efforts on

the coastal areas, the fishing pressure has increased in the near-shore areas, and even using destructive fishing gears, small mesh size and low selectivity fishing gears have been operating whole year-round. These activities are leading to reducing the coastal fishery resources, even destroying the coastal habitats such as coral reefs, sea grass, seaweed and disappear spawning & nursery areas, the coastal resources are facing to exhausted [9]. Therefore, study on implement the coastal fishery resources protection and enhancing models through artificial reef installation is an effective approach in this status. This article has shown the preliminary results of these models in coastal areas of Quang Nam province after one-year installation which is the basic steps to extend these models to the Central region of Vietnam in the near future.

II. MATERIALS AND METHODOLOGIES

1. Selecting the areas to install artificial reef/ Installation area of artificial reef

- The limited areas: 15°31'00"E - 15°31'30"E, 108°40'30"N - 108°41'30"N;
- The depth: 15 to 25m;
- The seabed: a simple seabed with flat shape, sandy and/or muddy;
- The salinity is 28 - 30‰, maximum of 34‰ in the sunny seasons;

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- The sea currents: In the winter, the coastal currents are from the Northern to the Southern with the speed of 50 - 70cm/s; In the summer, the coastal currents are from the Southern to the Northern with the speed of 30 - 60cm/s.

These coastal areas are the traditional fishing grounds of Tam Hai and Tam Quang communes, not from the other localities, not the army areas or not planned for eco-tourism areas. If so, the Ban Than areas belong to Tam

Hai commune, Nui Thanh district, Quang Nam province (Figure 1) are full fill all criteria about geography, weather condition, oceanography conditions, with many protected species, many high value species such as lobster, grouper, snapper, mollusks and maxima clam... [1] where is suitable for artificial reef installation to protect and enhance the coastal fishery resources in this areas as well as develop the social and economic in this locality.



Figure 1. The map of artificial reef installation areas

2. The structure of artificial reef

The artificial reefs have to adapt following technical indicators and suitable with the natural conditions in coastal areas of Quang Nam province such as:

The size:

- High: 1,500 mm
- The outside parameter: 1,200 mm
- The thick: 150mm

The material is concrete of cement ratio is 350, the steel of $\Phi 8$ CT3 and circle steel of $\Phi 12$. The weight of the artificial reef is 2,500 kg (equivalent of 1m³ concrete).

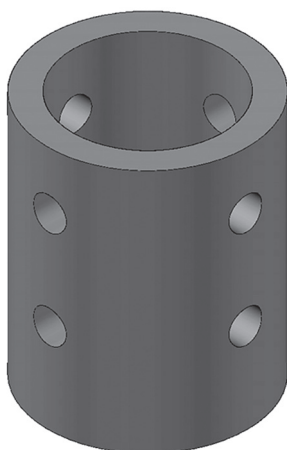


Figure 2. The structure of artificial reef



3. The map of artificial reef installation model

Based on the areas which approved by Nui Thanh District People Committee, the research team have designed the map of artificial reef installation areas in order to get advantages and archived objectives that the reef areas are in the approved areas and also maximized the approved square and ensure the effectiveness on the resources protection. Thus, the map of artificial reef is designed as figure 3.

3. Explanations for the designed map at figure 3.

- The points from D1 to D4 are the approved areas by Nui Thanh District People Committee with an area of 1,424,500m² and will be installed of 500 artificial reefs.

- The square of the artificial reef is 1,365,000m² (1,300m x 1,050m) in an approved area off 1,424,500m², accounted for 96% of approved squares.

- The model was installed of 25 groups; each group has 20 artificial reefs in a square of 5,000 m² (100m x 50m). The distance between each group is 200m through East – West and North – South direction.

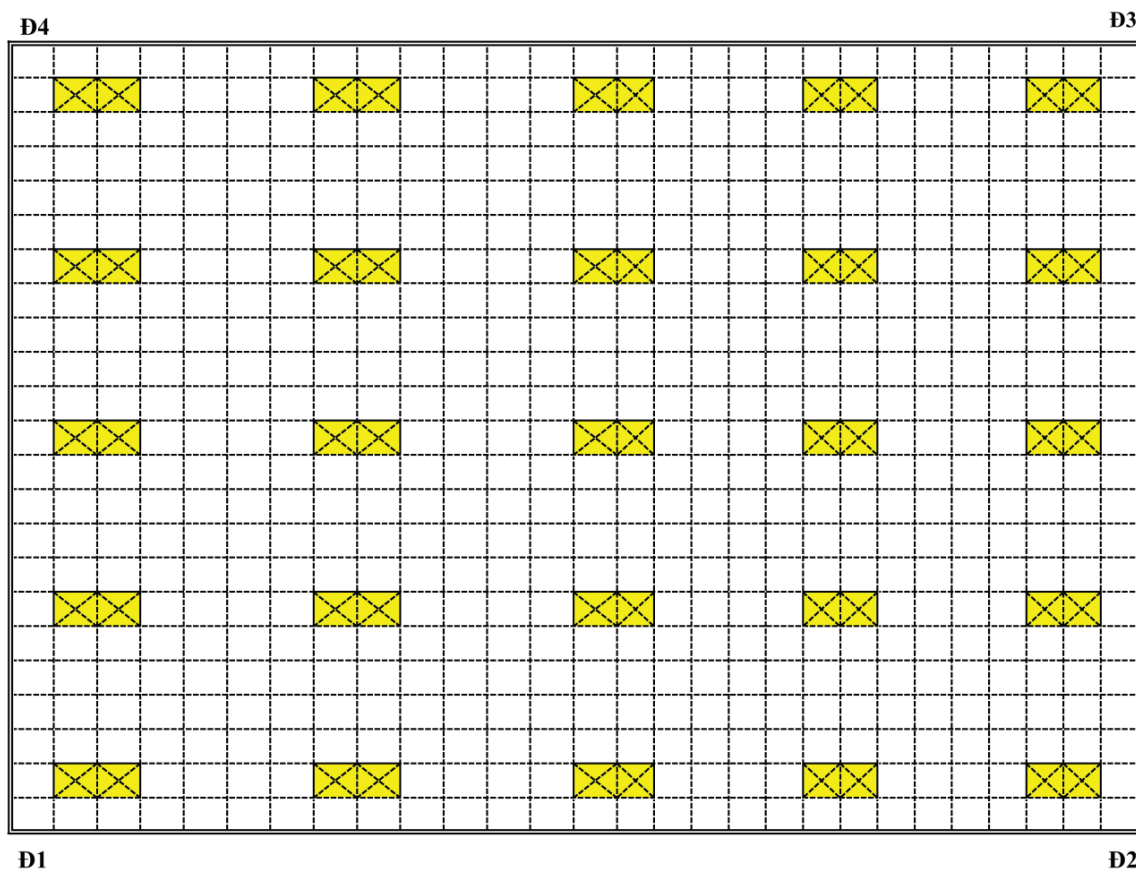


Figure 3. The map of artificial reef installation in the approved areas

4. The survey and evaluation methodologies

In order to evaluate the effectiveness of the models on resource protection, the study has used section scuba diving methods. The scuba divers will dive parallelly with the seabed to identify the species composition and the density of bottom species inside and outside of the designed areas. Scuba divers will survey at

2 groups of reef per day, in each group, divers will survey at 4 sections with the width of 5m and the length of 20m (5x20m each section). The distance from section to reef groups is 5m and the the duration for each diving section is from 30 to 40 minutes.

In order to evaluate the enhancing of the resources, we have implemented 3 survey after

the artificial reef was installed as follows:

- The first survey: in 4 days from 11th Mar, 2018 to 14th Mar, 2018;
- The second: in 4 days from 17th Jun, 2018 to 20th Jun, 2018;
- The third: in 4 days from 26th Sept, 2018 to 29th Sept, 2018;
- The fourth: in 4 days from 23rd Dec, 2018 to 26th Dec, 2018;

5. The fish species classification methods

The taxonomy methodologies most are based on the classification guides from R. F. Myers [13,14], Shen S. C. et al [16], R. H. Carcasson [12], G. R. Allen [11] and T. Nakabo [15]. Cross check & identify the Vietnamese names based on “The list of marine species in Vietnam water” of Nguyen Huu Phung at al [4-8]. Beside that, the study also uses the CASOV software version 3.0 from Fishery Information

Center under MARD to check and cross check the name & species [10].

III. RESULTS AND DISCUSSIONS

1. The status of coastal resources before artificial reef installation

Based on the results from 8 surveys by sections perpendicularly with the shorelines at the artificial reef installation areas on Mar 2017 before reefs were installed. The results were shown that the marine species were not found so much here with 44 species which mainly fish species, the other species were accounted for a minor portion.

The frequency to find marine species is low, there are 29 species were found only one time (accounted for 65.9% total), 7 species were found twice to five times and the remaining were found more than 5 times.

Table 1. The frequency found the marine species during observation by section

No	Frequency	Number of species	Proportion (%)
1	- (one time)	29	65,9
2	+ (twice to 5 times)	7	15,9
3	± (More than 5 times)	8	18,2
Total		44	100,0

Through the observations, we have recognized the density of marine species which can be divided by 3 groups as: fishes,

echinoderms and mollusks. The density of these groups are illustrated in table 2 bellows:

The observation results have shown that:

Table 2. The average density of found marine species at sections (fish per 200m²)

No	Groups	S1	Scale (%)	S2	Scale (%)	S3	Scale (%)	S4	Scale (%)	Total	Scale (%)
1	Fish species	89	69,5	78	63,4	65	58,6	71	64,5	303	64,2
2	Echinoderms	18	14,1	23	18,7	19	17,1	21	19,1	81	17,2
3	Mollusks	21	16,4	22	17,9	27	24,3	18	16,4	88	18,6
Total		128	100,0	123	100	111	100	110	100	472	100

The density of marine species at each section was fluctuated from 110 to 128 individuals per 200m². The total density for 4 sections was 472 individuals per 800m².

Most of the marine species were observed as small size, the big size species were found very occasionally.

2. The status of coastal resources after artificial reef installation

2.1. The quantity of marine species was found inside the artificial reef areas

Through 4 observations (Mar 2018, Jun 2018, Sept 2018 and Dec 2018) at 25 groups of artificial reefs corresponding with 128 sections, the results are illustrated at table 3 below:

Table 3. The frequency of found marine species through observations

No	Group of species	Mar 2018	Jun 2018	Sept 2018	Dec 2018
1	Fishes	59	61	61	62
2	Echinoderms	6	6	6	6
3	Mollusks	7	7	7	7
4	Crustaceans	3	3	3	3
Total		75	77	77	78

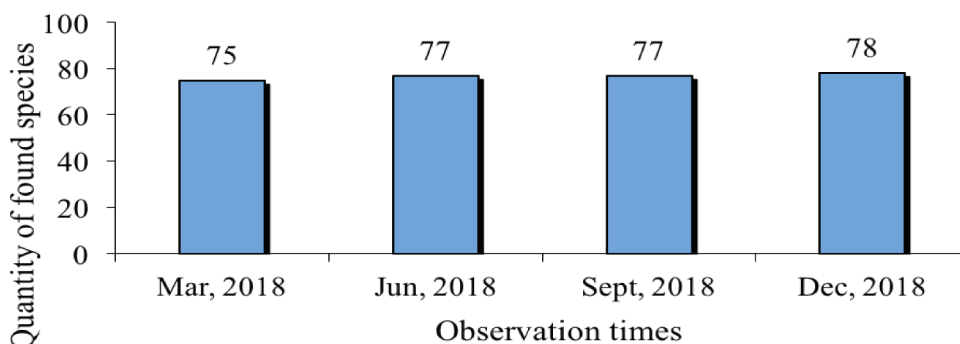


Figure 4. The quantity of found species through 3 observations

From Table 3 and Figure 4 have shown that: The number of marine species which mainly fishes have increased by the time, as long time as increased the number of marine species. In comparison with before artificial reef installation, after 12 months, the number

of marine species were increased from 44 to 78 species, corresponding with 77%. Fish species accounted for a significant number, other species were found occasionally. The observation results also shown that, the crustacean species were not found before

Table 4. The frequency found the marine species during observation by section

No	Frequency	Mar, 2018	Jun, 2018	Sept, 2018	Dec, 2018
1	Once	26	28	18	17
2	Twice to 5 times	16	17	19	14
3	More than 5 times	33	32	40	47
Total		75	77	77	78

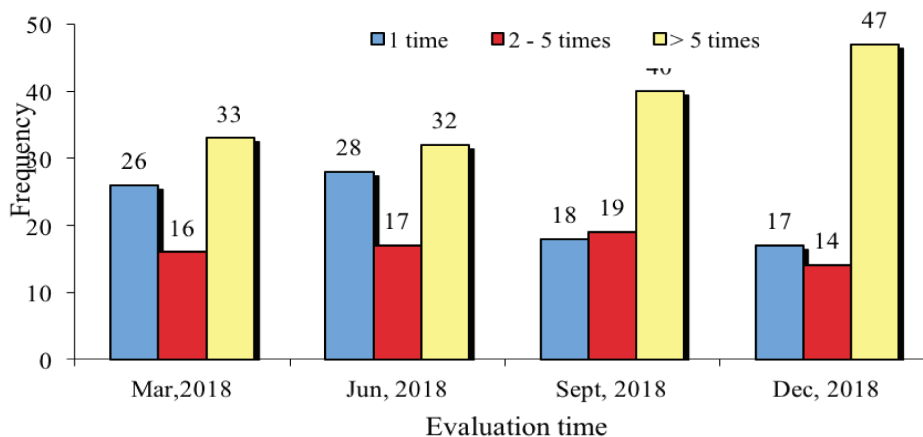


Figure 5. The frequency of found species through 3 observations

reef installation while 3 crustacean species were found after that. The frequency of found species is increased and increased by the time. As longer time as higher frequency and higher density. The frequency of species is illustrated in the table 4 below:

From Table 4 and Figure 5 have shown that:

The quantity of marine species inside the artificial reef areas is quite high, from 44 species before reef installation to 75 species after 3 months of installation and up to 78 species after 9 months, increased up 4.0% in quantity

in comparison with the first observation. The speed of increasing the quantity also high, from 44 species up to 78 species after 12 months of reef installation. The frequency of found species inside reef areas also higher and higher. In the first observation (Mar, 2018), 26 species were found only one time and 33 species were found more than 5 times. However, in the fourth observation (Dec, 2018) only 17 species were found one time while up to 47 species were found more than 5 times. In comparison with before reef installation, 29 species were

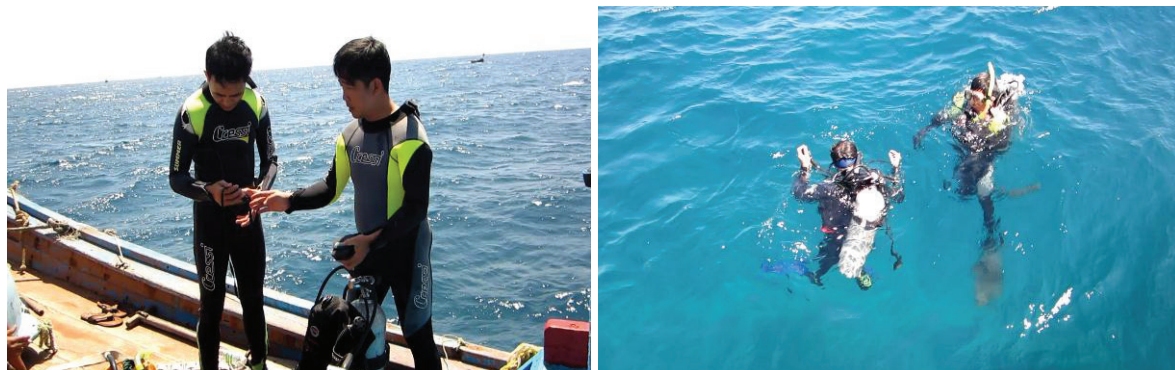


Figure 6. The preparations and scuba diving for resources evaluations



Figure 7. The marine species inside artificial reef



Figure 8. The new habitats on the artificial reefs

found 1 time and 8 species were found more than 5 times.

However, after 12 months of reef installation, species that found more than 5 times have increased up to 47 species and species that found 1 time have decreased down to 18 species. This is a very good indicator in term of marine conservation & resources protection. The low frequency species are normally high value species such as groupers, snappers, pompano...etc. In the contrast, the lower value species have higher frequency. However, these low value species also have a significant role in the habitats and ecosystem. The results also shown the appearances of

many species that have not found before reef installation in research areas. This is also a good indicator to artificial reef models in Quang Nam, based on this indicator, bottom & reef habitats can be restored, enhanced and protected for the coastal resources.

2.2. The quantity of marine species was found surrounding the artificial reef areas

The quantity of marine species not only increased inside the artificial reef areas but also increased at surrounding areas. Through 3 observations at surrounding areas with 18 sections at distances of 50m, 100m and 200m respectively with reef areas. The results are shown in table 5 and figure 9 below:

Table 5. The quantity of found species through observation & by distance

No	Group of species	Mar, 2018			Jun, 2018			Sept, 2018			Dec, 2018		
		50 (m)	100 (m)	200 (m)	50 (m)	100 (m)	200 (m)	50 (m)	100 (m)	200 (m)	50 (m)	100 (m)	200 (m)
1	Fishes	51	48	42	57	50	41	57	51	43	58	51	52
2	Echinoderms	5	4	5	5	5	4	3	4	5	6	6	5
3	Mollusks	8	7	3	8	7	3	8	8	6	8	8	7
4	Crustaceans	3	3	2	3	3	3	3	3	3	3	3	3
Total		67	62	52	73	65	51	71	66	57	75	68	52

- Notes: - 0m: The results inside reef areas;
- 50m: The distance of 50m
- 100m: The distance of 100m
- 200m: The distance of 200m

From table 5 and figure 9 have shown that: as nearer to reef areas as higher of marine species density as each section of 50m, 100m and 200m respectively. Similarly, with inside reef areas, fish species also accounted for a

significant proportion in comparison with other species. As longer of reef installation as higher quantity & density of surrounding areas. The differences of density and quantity inside and surrounding reef areas are not much, especially after a long time of reef installation. The frequency of found species has been increased with very positive directions as illustrated in table 6 below:

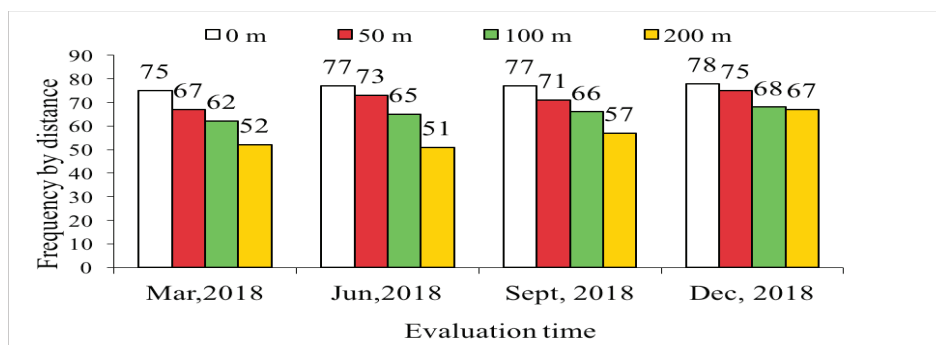


Figure 9. The number of found species inside & outside reef areas

Table 6. The frequency found the marine species during observation by distance

No	Frequency	Mar, 2018			Jun, 2018			Sept, 2018			Dec, 2018		
		50 (m)	100 (m)	200 (m)	50 (m)	100 (m)	200 (m)	50 (m)	100 (m)	200 (m)	50 (m)	100 (m)	200 (m)
1	Once	35	43	37	32	41	35	25	38	36	16	28	32
2	Twice to 5 times	22	15	12	29	14	11	24	10	14	30	18	28
3	Over 5 times	10	4	3	12	10	5	22	18	7	29	22	7
Total		67	62	52	73	65	51	71	66	57	75	68	67

From table 6 has shown that: The frequency of found species in surrounding areas has increased by the time. As longer of installation time as higher quantity of found species in surrounding areas, except some species only stay around reefs.

In conclusion, artificial reefs not only enhance and protect the coastal resources but also restore the resources in surrounding areas. Once the density of marine species in the reef areas become high, they will expand to surrounding areas due to high demand of food & space. This is the most important role of artificial reefs on create a habitat to recover, enhance and protect coastal resources.

IV. CONCLUSIONS

- The results from evaluations / observations at artificial reefs areas have shown that the

artificial reef models have operated effectively through restore, enhance and protect coastal resources.

- The quantity of marine resources has increased by the time, as longer time of reef installation as higher quantity of marine species. The quantity has increased from 44 species before reef installation up to 77 species after 9 months.

- Simultaneously with quantity, the density also has a significant increasing.

- High value species have appeared such as lobsters, groupers...and some other of reef species.

- The increasing of quantity and density are not only inside reef areas but also in the surrounding areas.

REFERENCES

1. Nguyen Van Luc (2005), The status of coastal fishery resources in Quang Nam province - Nha Trang Oceanography Institute.
2. Nguyen Trong Luong (2013), Apply artificial reefs in protect and enhance fishery resources - Fishery Science & Technology Magazine, p190-195

3. Nguyen Trong Luong, Tran Duc Phu, Nguyen Phi Uy Vu (2015), The effectiveness of artificial reef models on restore coastal resources in Quang Nam province - Agriculture & Rural Development Magazine - p103-111.
4. Nguyen Huu Phung (1999), List of marine fishes in Vietnam - Ver5 - Agriculture Publication.
5. Nguyen Huu Phung, Tran Hoai Lan (1994), List of marine fishes in Vietnam Ver1 - Sciences & Technology Publication.
6. Nguyen Huu Phung, Le Trong Phan, Nguyen Nhat Phi, Nguyen Phi Dinh, Do Thi Nhu Nhung, Nguyen Van Luc (1999), List of Marine fishes - Ver 4, - Sciences & Technology Publication.
7. Nguyen Huu Phung, Nguyen Nhat Thi (1994), List of Marine fishes - Ver 4, - Sciences & Technology Publication.
8. Nguyen Huu Phung, Le Trong Phan, Nguyen Nhat Phi, Nguyen Phi Dinh, Do Thi Nhu Nhung, Nguyen Van Luc (1997), List of Marine fishes - Ver 3, - Sciences & Technology Publication.
9. Nguyen Trong Thao (2018), Study on status of fishing operation in coastal areas of Quang Nam provinve & surrounding areas - Fishery Science & Technology Magazine - p63-70
10. Fishery Information Center (2003), CASOV software.
11. Gerald R Allen, Roger Steene (1994), Indo-Pacific coral reef field guide, Tropical Reef Research Singapore.
12. Robert Herbert Carcasson (1977), A field guide to the coral reef fishes of the Indian and West Pacific Ocean.
13. Ewald Lieske, Robert Myers (2001), Coral reef fishes: Indo-pacific and Caribbean, Harper Collins London.
14. Robert F Myers (1999), Micronesian reef fishes.
15. Tetsuji Nakabō (2002), Fishes of Japan: with pictorial keys to the species, Tokai University Press.
16. Shen Chih Shin, Chyng Shyan Tzeng (1993), Fishes of Taiwan, Department of Zoology, National Taiwan University.