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# CURRENT STATUS ON COMMUNITY STRUCTURE OF CORAL REEFS AROUND WEST COAST OF PENINSULAR MALAYSIA USING CORAL VIDEO TRANSECT TECHNIQUE

MOHD SAFUAN*[1], HIN BOO WEE[1], YUSOF SHUAIB IBRAHIM[2], IZWANDY IDRIS[2] AND ZAINUDIN BACHOK[2]

*[1]Institute of Oceanography and Environment, [2]School of Marine and Environmental Sciences, Universiti Malaysia Terengganu, Terengganu, Malaysia.*

**Corresponding author: mscd87@gmail.com*

**Abstract:** Underwater video techniques are more frequently being used in marine ecology studies. A technique called Coral Video Transect (CVT) was used to quantify percentage cover of benthic organisms within Sembilan Island Archipelago and Jarak Island, Malaysia in determining the coral community structure of the West Coast of Peninsular Malaysia. The survey was conducted in shallow water reef with a mean depth of 10.4±1.4 m deep. A total of 22 identified coral genera from 11 families were identified. A higher number of coral genera were found within Sembilan Island Archipelago (20 coral genera) as compared to Jarak Island (11 coral genera). The entire reefs were in 'poor' condition with mean total percentage coral cover ranging from 2.63%-23.84%. The reefs were dominated by massive and encrusting coral with decreasing order of percentage cover as followed; *Porites>Tubastrea>Diploastrea>Echinophyllia*. The use of CVT technique to describe the reef status was recommended as it can provide a permanent record for subsequent studies and for future comparison later on. The data presented might be useful for resources sustainability or coral reef management in Malaysia.

Keywords: Coral reef, community structure, Sembilan Island, Jarak Island, coral video transect.

## Introduction

Malaysia is one of the countries with a vast diversity of coral reef covering approximately 4000km$^2$ areas. Most of the reefs in Malaysia is a fringing reef and can be found along the mainland or around the islands. A study by Harborne *et al.* (2000) found a total of 323 species of coral within the Peninsular Malaysia which comprising approximately 80% of the number reported from the Coral Triangle. Assessment on reef health status found that most of the Malaysian coral reefs were in a 'fair' condition (Harborne *et al.*, 2000; Toda *et al.*, 2007; Reef Check, 2014) using the criteria of the ASEAN-Australia Living Coastal Resources project by Chou *et al.* (1994). However, within the West Coast of Peninsular Malaysia, some of the reefs were in a low coral cover and in a 'poor' condition due to strong current and high sedimentation (Toda *et al.*, 2007; Praveena *et al.*, 2012). This area was also being heavily exploited by shipping activities due to its function as important shipping route linking the Indian Ocean to South China Sea and Pacific Ocean (Thia-Eng *et al.*, 2000; Qu & Meng, 2012). Nevertheless, there are still limited studies on the coral reef communities in the West Coast of Peninsular Malaysia such as Aileen *et al.* (2008) and Toda *et al.* (2007) but more studies were focusing on corals at other side of Malaysia (Harborne *et al.*, 2000; Affendi *et al.*, 2005; Waheed & Hoeksema, 2014; Safuan *et al.*, 2015; Huang *et al.*, 2015).

In Malaysia, coral reef surveys were conducted using the Line Intercept Transect (LIT) method (English *et al.*, 1994) or the Point Intercept Transect (PIT) used in a rapid Reef check survey to quantify benthic cover in coral reef area. However, both diver based method depends largely on diver interpretation, hence,

accuracy of the data rest completely on the diver's expertise and experience (Liew *et al.* 2012). Recently, underwater video techniques are increasingly popular in coral monitoring program worldwide (Abdo *et al.*, 2004; Brown *et al.*, 2004; Houk & Woesik, 2006). A method called the Coral Video Transect (CVT) technique was adopted in Malaysia by Liew *et al.* (2012) and further being optimized by Safuan *et al.* (2015) to fit the reef system in Malaysia. This technique can provides a permanent record and greatly reduced field expense and time compared to standard visual transect methods.

Previous study by Safuan *et al.* (2015) focused on coral reef on the east coast of Peninsular Malaysia. This present study however is a first attempt using CVT method to survey coral reef in the west coast of Peninsular Malaysia. The aims of the study are 1) to evaluate the current coral condition and 2) to determine coral community structure in Sembilan Archipelago and Pulau Jarak. The findings could add to the current knowledge of the coral reef in Malaysia; specifically provide a general view on reef status and coral community structure at the west coast of Peninsular Malaysia.

## Methodology

### *Sampling Area*

Sampling was carried from 27 to 29 January 2015 at Sembilan Archipelago and Pulau Jarak located approximately at the central of Malacca strait (Figure 1). Sembilan Archipelago consist of a cluster of nine island namely Pulau Tukun Perak, Pulau Agas, Pulau Nipis, Pulau Payong, Pulau Rumbia, Batu Puteh, Pulau Lalang, Pulau Saga and Pulau Buluh. Meanwhile, Pulau Jarak is a small island located near the Malaysia-Indonesia border line. A total of nine survey stations were selected from Sembilan Archipelago and Pulau Jarak. In each survey station, a 100 m transect tape was overlay by following the reef contour and parallel with the coastline. A total of seven transects were survey during the sampling with a mean depth of 10.4±1.4 m deep. Details for all survey stations were listed in Table 1.

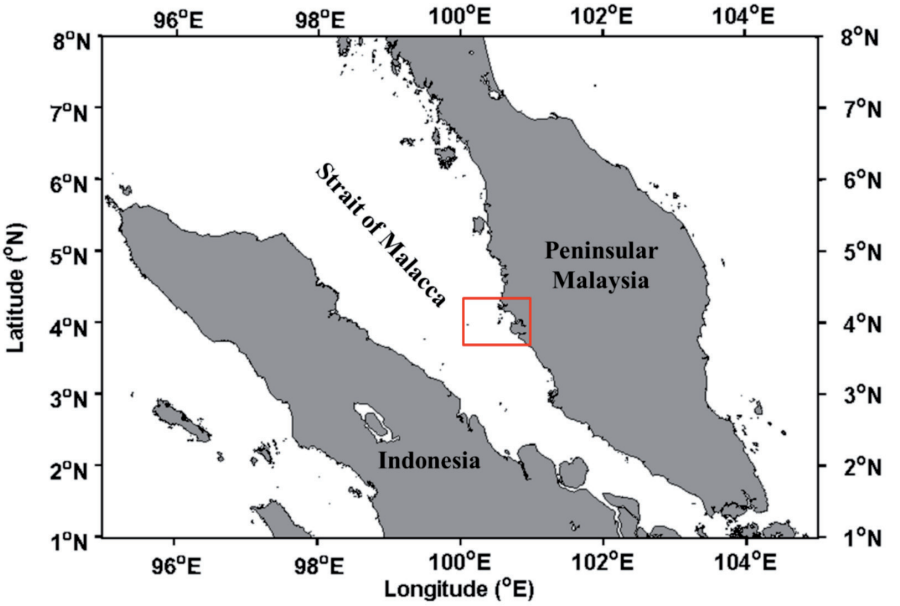


Figure 1: The Strait of Malacca is located in the middle of the Peninsular Malaysia and Indonesia. The survey stations (Sembilan and Jarak Island) are located at the centre of Malacca Strait as indicated in the square box.

Table 1: Date of sampling, location and position of survey stations as well as survey's depth selected from Sembilan Archipelago and Pulau Jarak

| Survey Station (ST) | Date | Island | Island | Position | | Depth of Transect (m) |
|---|---|---|---|---|---|---|
| 1 | 27 Jan 15 | Sembilan Archipelago | Pulau Rumbia | N 04$^0$01'45.9" | E 100$^0$32'37.9" | 8.6 |
| 2 | 27 Jan 15 | | Pulau Saga | N 04$^0$00'26.1" | E 100$^0$32'07.7" | 11.3 |
| 3 | 27 Jan 15 | | Pulau Nipis | N 04$^0$03'23.9" | E 100$^0$32'32.7" | 9.2 |
| 4 | 28 Jan 15 | | Pulau Rumbia | N 04$^0$01'26.9" | E 100$^0$33'00.5" | 11.6 |
| 5 | 28 Jan 15 | | Pulau Lalang | N 04$^0$00'47.4" | E 100$^0$32'28.6" | 10.7 |
| 6 | 28 Jan 15 | | Pulau Buloh | N 03$^0$59'38.7" | E 100$^0$32'03.6" | 10.6 |
| 7 | 29 Jan 15 | Pulau Jarak | Pulau Jarak | N 03$^0$58'48.5" | E 100$^0$06'12.4" | 8.2 |
| 8 | 29 Jan 15 | | Pulau Jarak | N 03$^0$58'36.3" | E 100$^0$05'43.6" | 11.2 |
| 9 | 29 Jan 15 | | Pulau Jarak | N 03$^0$58'33.0" | E 100$^0$06'07.8" | 11.8 |

### *Coral Video Transect (CVT) Technique*

The CVT technique was conducted using an underwater camera (Panasonic LUMIX FT4 enclosed with LUMIX 40 m Marine Case). Video was recorded along the transect length by pointing down the lens at the vertical elevation of 0.5 m from the substrate (Safuan *et al.*, 2015). A reference bar attached to the underwater video housing was used to maintain the vertical elevation during video recording to minimize parallax error and to keep it in focus. Diver swam slowly at a speed of 5 m per minutes along the transect line during video recording. The videos were recorded along100 m transect as outlined by Liew *et al.* (2012). A 100 m measuring tape was divided into 4 x 20 m segments (replicates) with 5 m intervals used to guide the recording. In addition, corals nearby the survey transects were photographed to provide a general view of corals present in the survey area. Some complex forms of coral corallites and polyps were captured in close-up setting to facilitate identification.

### *Video Processing and Image Analysis*

Percentage cover of coral was estimated using point counting technique, an image-based method for identifying substrate types beneath random points from the videos or photos (Pante & Dustan, 2012). In this study, Coral Point Count with Excel Extension (CPCe) software was used to quantify benthic cover in coral reef (Kohler & Gills, 2006). All the videos taken were extracted into frames and transferred into CPCe software for further analysis as outlined by Safuan *et al.* (2015). A total of 50 frames were extracted and analyzed with 50 points per frames. High number of frames and points were used during analysis to characterize reefs with lower cover and more homogeneously distributed colony (Pante & Dustan, 2012) as compared to Brown *et al.* (2004), Abdo *et al.* (2006) and Houk & Woesik (2006). In total, 90,000 points were analyzed using the CPCe software.

### *Data Analysis*

All the corals images were identified up to genus level following Veron (1986, 2000) and cluster according to coral families. The results obtained from the image analysis were summarized as percentage cover of three categories: Coral ('C' live coral cover), Dead Coral (DC) and Other Invertebrates (OT). All Scleractinian corals were included in the live coral cover (C). In additional, DC includes dead coral with or without algae cover. Other Invertebrates (OT) consisted of solitary and slow moving invertebrates such as soft coral, sponges, sea urchin and zooanthids. The coral condition was indicated by percentage of live coral following Chou *et al.* (1994). This was categorized as excellent (>75%), good

(51%-75%), fair (26%-50%) and poor (<25%) conditions.

Survey transects with a similar coral community were grouped together by using cluster analysis (Bray & Curtis, 1957). Then, interaction resulting from the cluster analysis was graphically described using the MDS ordination. Analysis of similarities (ANOSIM) was also conducted to find any significant difference ($p< 0.05$) among the survey transects. All the percentage data were transformed into $\log_{10}$ (x+1) prior to statistical test. Highest percentage cover of coral genera represents dominant coral that form the community structure in the survey area.

## Result and Discussion

### *Distribution of Coral in Sembilan and Jarak Island*

Based on photographs taken in all survey transects, 11 families of coral comprising of 22 identified coral genera were found within the survey transects. This constitutes 68.75% of the total recorded coral genera (32 coral genera) within the West Coast of Peninsular Malaysia as outlined by Affendi and Faedzul (2011). The corals are from the Acroporidae, Caryophyllidae, Dendrophyllidae, Faviidae, Fungiidae, Merulinidae, Mussidae, Pectinidae, Pocilloporidae, Poritidae and Siderastreidae families. Table 2 shows that more coral genera were present in Sembilan Archipelago (20 genera) compared to Pulau Jarak (11 genera). Some families, such as from families Caryophyllidae and Merulinidae, were not found at Pulau Jarak. None of the coral from family Pocilloporidae was found in Sembilan Archipelago. Only small colonies of *Pocillipora* sp. were found in Pulau Jarak. Among all the corals present, coral from genus *Diploastrea* can be found in in majority of the survey transects in a massive-encrusting form at ST1-ST6 and ST8 with a percentage cover ranged from 0.4%-2.62%.

Azooxanthellae coral, Tubastrea was found in most of the survey stations (except for ST1, ST7 and ST8) with a percentage cover ranging from 0.19%–10.41%. As for mushroom corals (family Fungiidae), our recent findings found only four individuals, at ST1,ST4 and ST7. This is an interesting findings becasue previous study by Aileen *et al.* (2008) found none of them in Pulau Jarak.

Meanwhile, previous study conducted at the nearby Pangkor Island found only 10 coral genera (Toda *et al.,* 2007), lower than our finding. Pangkor Island has been heavily impacted by the anthropogenic pressure than Sembilan Archipelago and Pulau Jarak. This is probably due to high human population with tourism as a major economic activities in the island and becoming threats to coral reef in the West Coast of Peninsular Malaysia (Praveena *et al.,* 2012).

Out of 22 coral genera,19 coral genera were recorded by CVT technique in all survey stations. This shows that the CVT technique is reliable for coral reef survey. The ability to determine the number of genera or species, as shown by this technique, is important for the selection of coral survey method (Leujak & Ormond, 2007). The video recorded by using CVT technique incorporates large spatial area (20 $m^2$ area covered by video recording) consequently capture higher benthic variation within the reef (Safuan *et al.,* 2015). Unrecorded coral from the videos was from the genus *Heterosammia, Goniastrea* and *Pachyseris*. However, the unrecorded genera using CVT technique were found far away from the line transect. Other advantages of using this technique is, it usefulness in variety of diving conditions including low visibility (Abdo *et al.*, 2004; Hill & Wilkinson, 2004) and strong current areas (Lam *et al.,* 2006). Therefore, it can be used as an alternative method to survey coral reef within the Strait of Malacca with its limited visibility and having a strong current area. Additionally, this technique also remains as simple and cost-effective method (Leujak & Ormond, 2007; Safuan *et al.*, 2015).

Table 2: The list of coral genera photographed around Sembilan and Jarak Island

| Family | Genera | Code | Sembilan Island | Jarak Island |
|---|---|---|---|---|
| ***Acroporidae*** | *Acropora* | ACP | X | - |
| | *Montipora* | MON | X | X |
| ***Caryophyllidae*** | *Heteropsammia* | HETERO | X | - |
| ***Dendrophyllidae*** | *Tubastrea* | TUBA | X | X |
| | *Turbinaria* | TURBI | X | - |
| ***Faviidae*** | *Cyphastrea* | CYPHA | X | |
| | *Diploastrea* | DIPLO | X | X |
| | *Favia* | FAV | X | - |
| | *Favites* | FAVI | X | X |
| | *Goniastrea* | GON | X | - |
| | *Leptastrea* | LEPTA | X | X |
| | *Platygyra* | PLATY | X | - |
| ***Fungiidae*** | *Fungia* | FUN | X | X |
| ***Merulinidae*** | *Hydnophora* | HYDNO | X | - |
| ***Mussidae*** | *Symphyllia* | SYMP | X | X |
| ***Pectinidae*** | *Echinophyllia* | ECHIP | X | - |
| ***Pocilloporidae*** | *Pocillopora* | POCL | | X |
| ***Poritidae*** | *Goniopora* | GONIO | X | - |
| | *Porites* | PORI | X | X |
| | *Pachyseris* | PACHY | - | X |
| ***Siderastreidae*** | *Pavona* | PAV | X | X |
| | *Psammocora* | PSAM | X | - |

### *Coral Reef Condition*

Figure 2 showed mean percentage cover of coral (C), dead coral (DC) and other invertebrates (OT) in all survey transects. Highest coral cover was estimated at ST5 with a mean value of 23.84±9.95%. Lowest coral cover was found in ST4 (2.63±3.42%). The percentage cover of DC ranged from 0.78%–41.44%. Highest DC was estimated in ST9 (41.44±6.56%) in the form of coral rubble.

Meanwhile, OT exhibit percentage cover ranged from 8.12%–38.78%. ST7 was dominated by OT with a mean value of 38.78±13.96% with a dense mat of anemones can be found extensively in the area. Live coral cover (C) within all the study sites ranges from 2.63%–23.84% which indicate that the survey areas were in a 'poor' conditions as outlined by Chou *et al.* (1994). Sedimentation and high turbidity are the possible causes to low coverage of coral within the area. Long- lasting stress from sedimentation may resulting in mass coral mortality, changes in community structure and major decreases in density, diversity and coral cover of entire reef systems (Erftemeijer *et al.,* 2012). Turbidity and sedimentation also reduce the recruitment, survival and settlement of coral larvae (Erftemeijer *et al.,* 2012).

Additionally, low coverage of hard substrate to promote coral recruitment also contributing to the poor reef condition. Trash, discarded fishing lines and nets were found in some of the survey transects can threatened the reef. This is not suprising since previous studies also outlined that sedimentation caused the

reefs in the west coast of Peninsular Malaysia were in a state of poor and fair conditions (Toda *et al.,* 2007; Praveena *et al.,* 2012).

Several survey stations in this study (ST2, ST3, ST4 and ST6) were relatively similar with the survey sites by Reef Check (2014). Recent survey by Reef Check (2014) in Sembilan Archipelago indicates that 50% of their survey sites were in 'fair' condition and 38% was in 'poor' conditions. Surveys conducted by them were carried out at two depth contours (3-6 m and 6-12 m depth) as compared to our study (10.4±1.4 m). Technical and time constraints restricted the survey only a certain depth.

Nevertheless, higher coral cover as reported by Reef Check (2014) might be estimated from shallower contour (3-6 m) compared to much deeper transect employed by present study. Moreover, data from Reef Check (2014) will be based on PIT method which different from this study probably has a tendency toward overestimation of percentage coral cover, although in actual, the coverage is not extensive (Lam *et al.,* 2006). Besides, this study had observed 10,000 points per transect, as compared to PIT method (160 points per transect). Lesser number of points observed can lead to misinterpretation of coral cover (Brown *et al.,* 2004). Apart from that, survey method emplyed by Reef Check only identifies Scleractinian corals as 'Hard Coral' (Facon *et al.,* 2016) to accomodate non-scientist to contribute. On the other hand, data collected through CVT technique enables the analysis to be done ex-situ by the person who have knowledge in benthic taxonomy.

### *Coral Community Structure*

To understand the coral community structures around West Coast of Peninsular Malaysia, all study sites were divided into four groups at 60% similarity level using cluster analysis (Figure 3), whilst the MDS plot illustrated similarity interactions in Figure 4. Group A consists of ST2 and ST5. Group B consists of four survey stations from ST6-ST9. Group C only contains one survey station (ST1). The remaining survey transects (ST3, ST4) were clustered in Group D. Higher number of coral genera was recorded from Group D (11 genera), followed by Group C with nine corals genera. Both Group A and C recorded seven genera per group. Analysis of Similarities (ANOSIM) indicated significant different in the percentage coral cover between the survey stations (Global R= 0.351, $p < 0.001$). The results from MDS plot were compared with the pairwise test by the ANOSIM. In group A, no significant was found between ST2 and ST5 (R = 0.01, p = 0.457). No significant different was found in all survey stations within Group B (R value between -0.063 - 0.26, ρ in each case > 0.057). In the group C, pairwise comparison shows that ST1 was significantly different from ST2, ST5, ST6, ST7 and ST9 (R value between 0.545 and 0.917, ρ in each case = 0.029) but

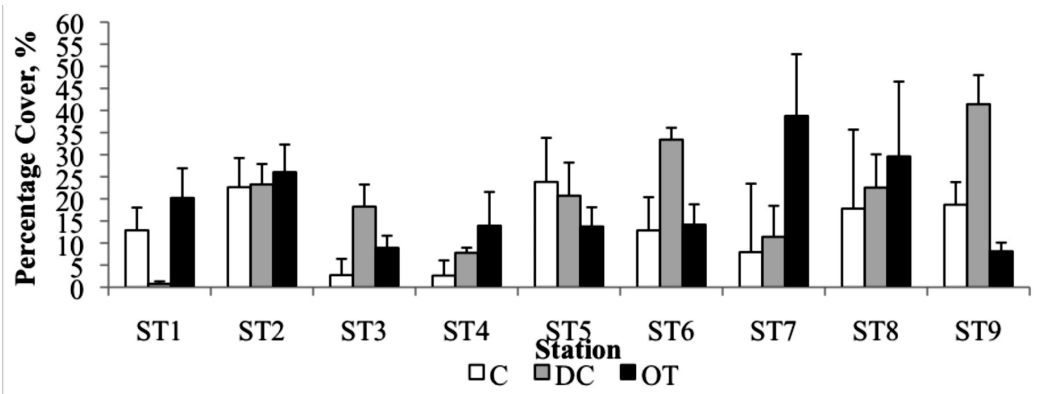


Figure 2: Mean percentage cover of C (Live Coral), DC (Dead Coral) and OT (Other Invertebrates) in all survey stations. Values are mean±SD

no clear different was found between ST1 with ST3, ST4 and ST8 (R value between 0.167 - 0.542, p in each case > 0.057). Group D shows no significant different between ST3 and ST4 (R = -0.214, p = 1.000).

Coral community structure was determined from the dominant coral present in each group as shown in Figure 6. Four types of corals were found to be dominating the study areas namely the hermatypic (*Diploastrea, Echninophyllia* and *Porites*) and ahermatypic (*Tubastrea*) coral.

Group A was dominated by Diploastrea. Group B was dominated by massive Porites. Group C was dominated by Echinopyllia and *Diploastrea.* Meanwhile, Group D was dominated by *Porites, Tubastrea* and *Diploastrea* corals. Present findings indicated that the coral community structure in West Coast of Peninsular Malaysia was formed by *Porites, Tubastrea, Diploastrea* and *Echninophyllia* coral. *Porites* was the most dominant coral in the study area with a percentage cover ranging from 7.23%-18.38%. This was followed by *Tubastrea* coral with a percentage cover ranging from 0.015%-10.41%. Meanwhile, both *Diploastrea* and *Echninophyllia* only cover less than 3%.

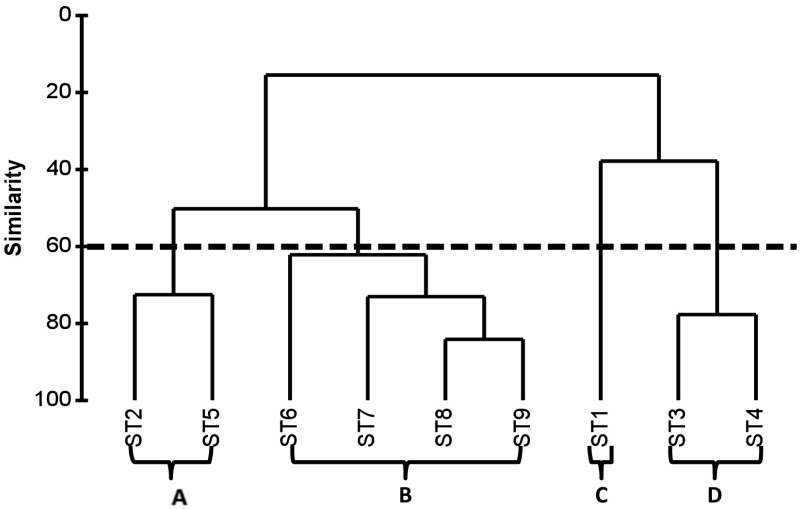


Figure 3: Cluster analysis of all survey transects with four groups (group A, B, C and D) were clustered at 60% similarity of coral community structure

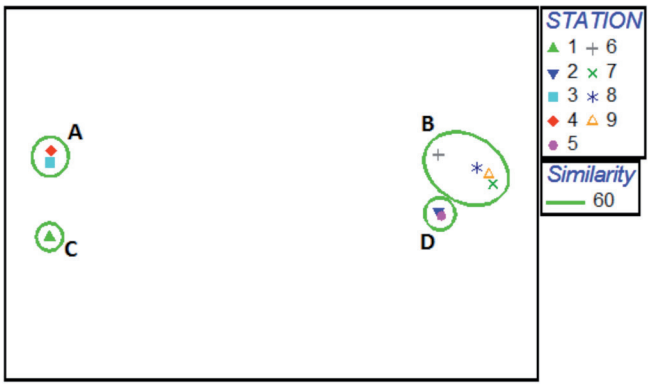


Figure 4: Graphical illustration of four groups of survey transect with respect of 60% similarity derived from cluster analysis

Massive corals are more stress tolerant to natural and anthropogenic stress (Meij *et al.*, 2010). Many poritids coral are tolerant to sedimentation (Stafford-Smith, 1993). Porites dominating the coral community structure in west coast of Peninsular Malaysia as it has the ability to tolerate high sedimentation in the area (Toda *et al.,* 2007). Corals such as *Porites, Diploastrea* and *Echninophyllia* can be found in massive and encrusting growth form. Hemispherical and columnar species (such as *Porites* sp.) can efficiently remove accumulate sediment (Stafford-Smith, 1993). Turbidity and sedimentation can significantly affect the coral growth form (Erftemeijer *et al.,* 2012). Acropora and Montipora dominating the east coast of Peninsular Malaysia (Toda *et al.,* 2007) as compared to the west coast area. High sedimentation and turbidity are likely to restrict the growth of Acropora and Montipora in the West Coast of Peninsular Malaysia. The hydrodynamic factors also contribute the formation of coral reef (Sheppard *et al.,* 2009). Strong current can influenced the growth of the corals, hence, massive-encrusting form is much suitable to survive in this environment.

Besides that, azooxanthellae coral called *Tubastrea* has the ability to adapt with the low light condition as high sedimentation can reduce the sunlight penetration. This ahermatypic coral depends entirely on zooplankton captured by their tentacles as a food source instead of taking food derived from symbiotic algae (zooxanthellae) like common hermatypic corals do (Sheppard *et al.,* 2009). This types of adaptation give the Tubastrea to survive in the west coast of Peninsular Malaysia.

## Conclusion

This study has provided current condition and coral community structure formed at the west coast of Peninsular Malaysia. Poor reef condition recorded in the present study probably caused by anthropogenic stressor such as sedimentation that limit the growth of the corals. Masive-encrsuting and ahermatypic coral has the ability to adapt and survive in high sedimentation area, hence, able to dominating the reefs in the study areas. Apart from that, this study has shown the CVT technique is suitable for coral reef assessment as it can provides a permanent record for subsequent studies and flexible to conduct in the variety of reef conditions. Therefore, it will be useful as a research tool for long-term and continuous analysis of coral reef benthic cover around Malaysia's water.

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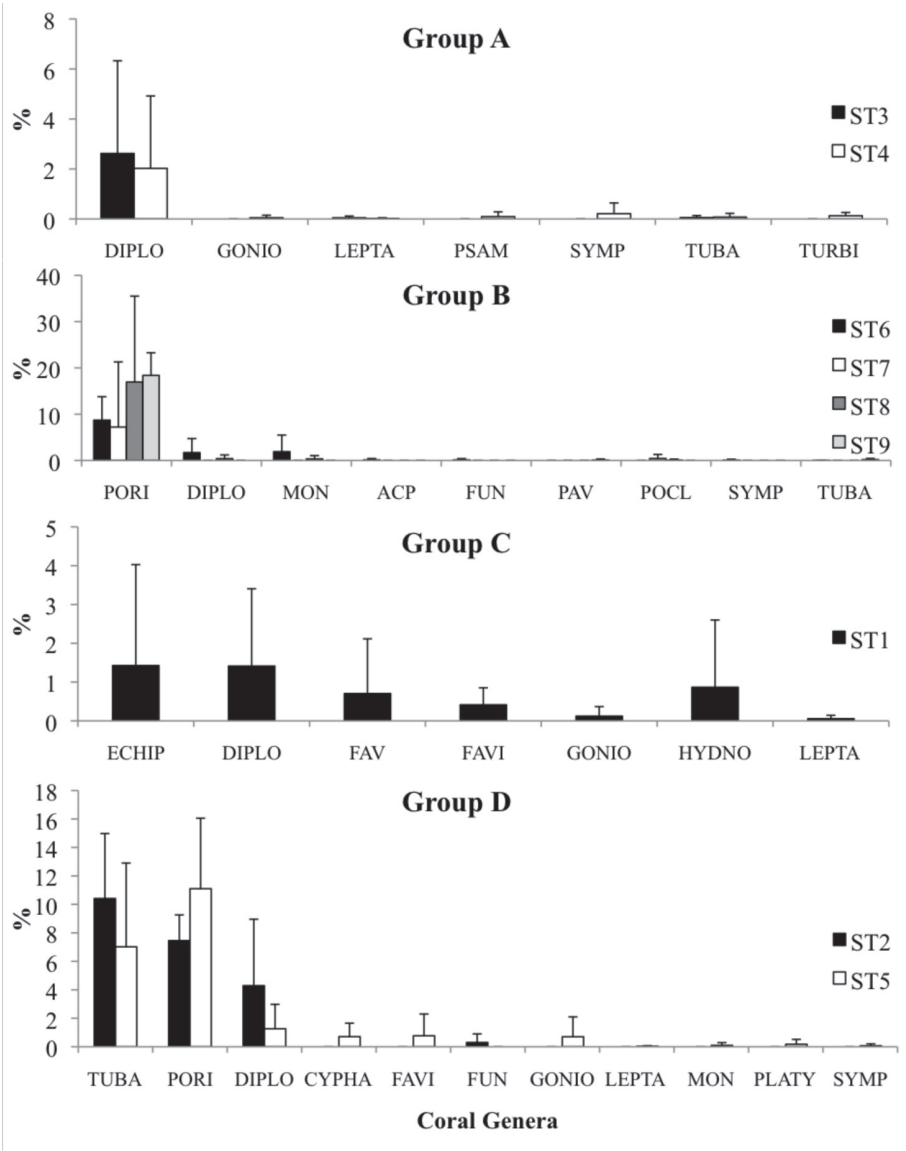


Figure 5: Mean percentage cover of coral genera estimated in all surveys stations and were clustered at 60% similarities forming four different group with similar coral community structure. Values are mean±SD

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