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Dispersal Potential Index (DPi) As Alternative Indicator for Coral Larvae Dispersal Potential

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Abstract: Dispersal of coral larvae is influence by combination of multiple factors, yet comparisons are commonly displayed on two- or three-dimensional charts (i.e.: pelagic larvae duration vs. distance). Therefore, the present study implies the application of Dispersal Potential Index (DPi) based on the factors which influence the dispersal range and potential such as pelagic larvae duration (PLD), adult coral cover, current speed and depth variations. Each factor was given score from 1 to 10 based on their influence towards dispersal potential. The DPi was able to describe dispersal potential of *Acropora* larvae from two separated reef sites (Bidong Island and Kuantan Coastal Waters) which share common hydrodynamic pattern. It is suggested that Acroporid larvae in Kuantan coastal waters has greater dispersal potential than Bidong Island. DPi for Kuantan coastal waters was classified as intermediate dispersal range while DPi and Bidong Island was categorized as short dispersal range. This approach is arguably the first of its kind in describing the multiple factors for dispersal of coral larvae. The application of DPi is important especially for reef managers to estimate dispersal range of coral for a better marine ecosystem management.

Keywords: Dispersal potential index, Coral larvae dispersal, Coral reef, Ecosystem management

INTRODUCTION

Connectivity plays a vital role in sessile marine invertebrate ecology. For non-migratory organisms such as coral reef which physically attached to the substrate, connectivity relies heavily on dispersal of coral larvae. Coral life cycle involves benthic polyp phase and planula larval phase. Broadcasting coral such as *Acropora*, which encompasses most coral species release larvae into the water column during mass spawning season. During this early life stage, most of the coral larvae are unable to swim horizontally to reach settlement sites and thus depend on the prevailing current as main dispersal transport. These larvae may dispersed in an extensive range of distance from a few meters to hundreds of kilometers before successful settlement depending on the current pattern during planktonic stage [1].

Simulating dispersal pattern for coral larvae requires an advanced biophysical modelling approaches such as those reported in Kuantan coastal region [2] and southern part of Singapore [3]. Such modelling approaches require high level of hydrodynamic modelling knowledge with advanced simulation software and tools. Therefore, a much simpler larvae dispersal estimation by using radar chart to describe coral larvae dispersal potential without having to undergone series of process to establish a larvae dispersal model is needed. This would give advantages to reef managers to plan for future ecosystem management based on the data available during their coral reef monitoring framework (coral distribution and depth estimation).

MATERIALS AND METHODS

Factors influencing dispersal potential

The distribution pattern of adult coral cover (%) is considered as one of important factors in influencing dispersal of coral larvae. The number of existing adult coral may reflect coral fecundity (the ability to produce an abundance of offspring) [4]. Therefore, ecological modelling suggested the abundance of adult coral (adult

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coral cover) shall be proportionate with the number of larvae release [3]. It is postulated that a higher coral cover might increase dispersal potential since more larvae would survive during larval transport.

The length of pelagic larvae duration (PLD) is thought to influence dispersal in which longer PLD may have greater dispersal distance. This has been initial assumption from the ecologist who conducted numerous experiments on pelagic larvae duration for estimating coral larvae dispersal potential [5,6]. For instance, it is suggested that *Acropora* could travel up to hundreds of kilometers from source reef due to its extensive dispersal potential [6]. Previous works on larval competency indicated that optimal PLD for broadcast spawning coral ranged between 2 – 20 days after spawning (DAS) [7].

Broadcasting coral such as *Acropora*, which encompasses most coral species release larvae into the water column during mass spawning season. During this early life stage, most of the coral larvae are unable to swim horizontally to reach settlement sites and thus depend on the prevailing current as main dispersal transport. These larvae may disperse in an extensive range of distance from a few meters to hundreds of kilometers before successful settlement depending on the current pattern during planktonic stage [1]. Higher current speed might result in greater dispersal distance. In this case, current speed was scored between 0.1 m/s until 0.5 m/s based on the current speed range from hydrodynamic model for Kuantan coastal waters [8]. This current speed range is comparable with current speed range model in the east coast Peninsular Malaysia [9];[10].

Lastly, depth variation also is being considered as factors since shallower reef area often have slower current speed due to higher bed-resistance and often subjected with higher local retention compared to deeper area. The influence of bathymetry on ocean circulation has been demonstrated by in tidally forced atoll in Australia [11]. In this case, the depth range considered was set between 2 to 20 m since this range is ideal for coral reef monitoring survey and recreational scuba diving.

DPi score chart

The summary of score for each factor is tabulated in Table 1. Based on the score given, three types of combination were suggested as the benchmark categories for dispersal potential (short, intermediate or long dispersal distance). The proposed score values and resulting dispersal potential index (DPi) are demonstrated in Table 2 and Figure 1 respectively.

RESULTS AND DISCUSSION

The proposed Dpi can be used by reef managers to assess dispersal potential capacity different targeted species or genus based on the criteria suggested. This index also can assess Dpi capacity for the same coral species but with different dispersal factors score. DPi for similar genus from different spatial setting and abundance would varies since adult percentage cover, current speed and depth might varies spatially. For comparison, DPi for *Acropora* from Kuantan coastal waters [2] were compared with Bidong Island [12] based on dispersal factors score (adult cover, current speed and depth) and demonstrated in Table 3.

Based on the present DPi, it is suggested that Acroporid larvae in Kuantan coastal waters has greater dispersal potential than Bidong Island. DPi for Kuantan coastal waters was classified as intermediate dispersal range category as shown in Figure 2a. It can be postulated that most of the larvae will be dispersed far from natal reef. On the contrary, Dpi for Acroporid in Bidong Island was classified as short dispersal range in Figure 2b. Therefore, it can be generally assumed that larvae from this location could have shorter dispersal range and some of them might recruits near natal reef although without applying dispersal model. While estimation of dispersal potential based on the proposed DPi may have its own limitations, this approach still able to produce general idea on the dispersal capacity of coral larvae especially along the coastal area in the east coast of Peninsular Malaysia which share similar hydrodynamic regime. The influence of dispersal factors (adult abundance, PLD, current speed and depth variation) towards dispersal capacity is well described throughout dispersal of coral larvae study in Kuantan coastal waters [2].

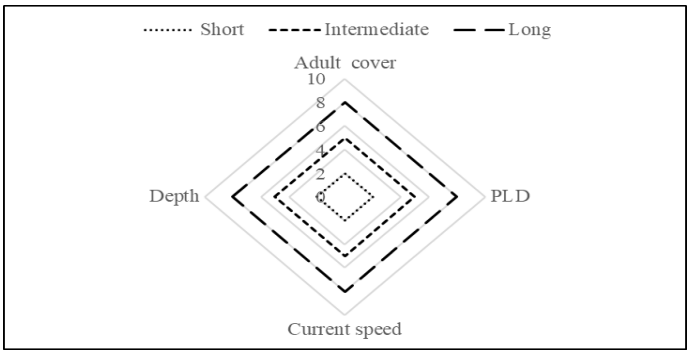

Figure 1: Dpi range proposed in this study

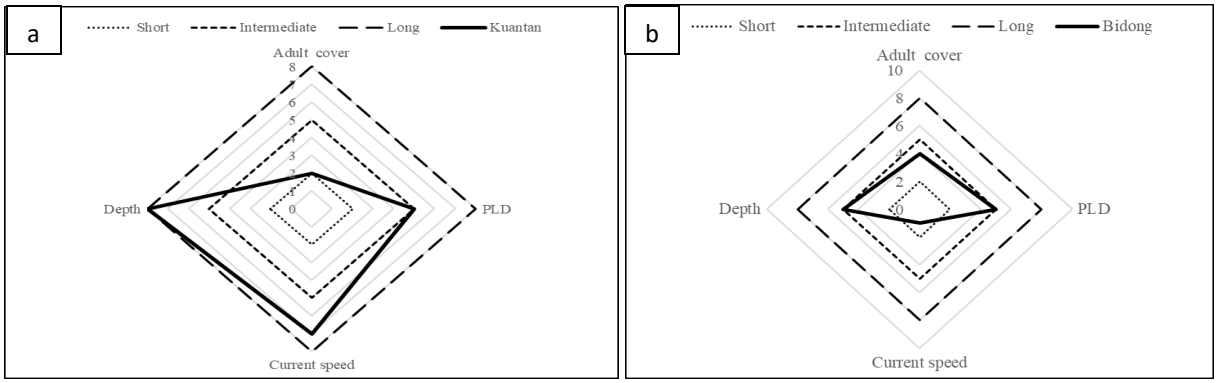

Figure 2: DPi score of *Acropora* in a) Kuantan coastal waters and b) Bidong Island

Table 1: Summary of score for factors considered in DPi

Scale	Adult cover (%)	PLD (Day)	Current speed (m/s)	Depth (m)
1	0 – 10	<2	<1	2
2	11 – 20	2	0.1	4
3	21 – 30	4	0.15	6
4	31 – 40	6	0.2	8
5	41 – 50	8	0.25	10
6	51 – 60	10	0.3	12
7	61 – 70	12	0.35	14
8	71 – 80	14	0.4	16
9	80 – 90	16	0.45	18
10	90 – 100	18	0.5	20

Table 2: Proposed score value for DPi range

Factors	Short	Intermediate	Long
Adult cover	2	5	8
PLD	2	5	8
Current speed	2	5	8
Depth	2	5	8

Table 3: DPi factor score comparison between Kuantan coastal waters and Bidong Island

Reef Location	Kuantan coastal water		Bidong Island	
Factors	*Acropora*	Score	*Acropora*	Score
Adult cover	16.6	2	32.9	4
PLD	8	5	8	5
Current speed	0.35	7	0.06	1
Depth	16	8	10	5

CONCLUSION

The DPi introduced in this study can emerge as reliable guideline in estimating dispersal pattern along the coastal region. This approach is arguably the first of its kind in describing the multiple factors for dispersal of coral larvae. The application of DPi is important especially for reef managers to estimate dispersal range of coral for a better marine ecosystem management. Nevertheless, further validation of the DPi estimation using actual larvae dispersal modelling is needed especially in other reef locations.

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