Benthic harmful dinoflagellate community dynamics:

A case study from Perhentian Islands (Malaysia)

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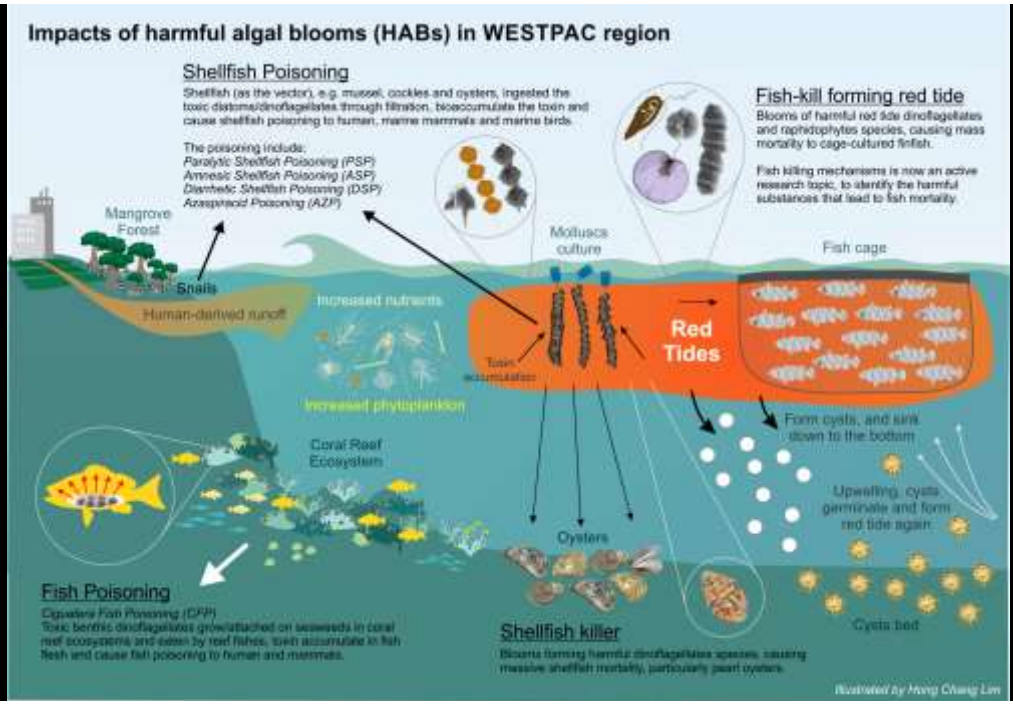

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Ciguatera Fish Poisoning

Source: Journal of American Medical Association

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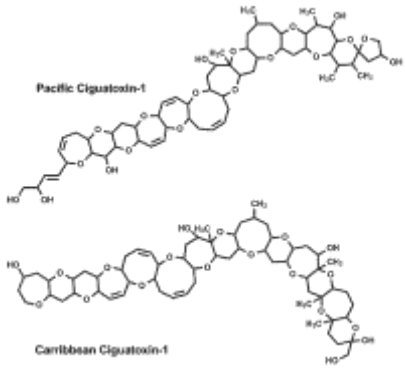
The toxins

- Maitotoxins and Ciguatoxins
- A class of lipid polyether compounds with low molecular weight.
- Clinical symptoms: gastrointestinal, neurological and cardiovascular. Recovery could take months to years.
- At present, there is no easy method to routinely measure the toxins.
- No antidote of CFP.
- Under-diagnosed, due to limitation in toxin analysis laboratory.



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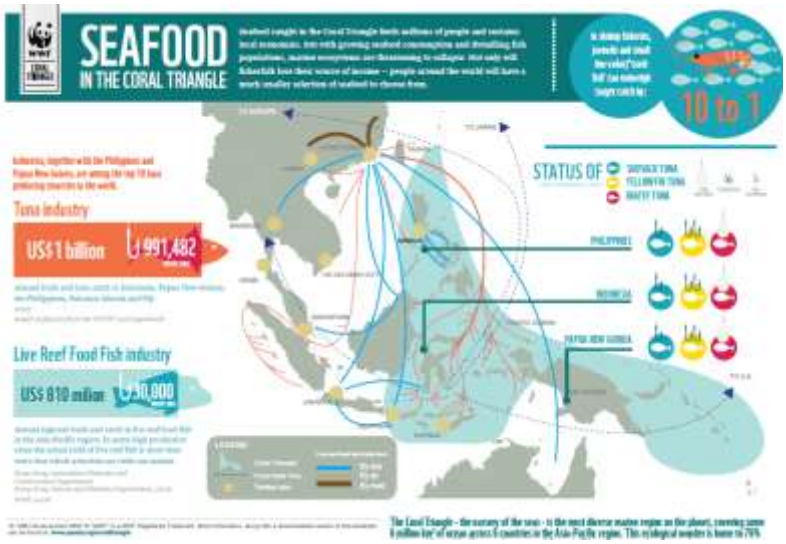
Live reef food fish trading: *Problem of ciguatera and its impacts*

Increase in demand for live reef fishes from SEA and Indo-Pacific regions has resulted in occurrence of **ciguatera** cases in areas far from the origin (Chen 2015).

2001: Malaysia supplied 10,000MT of live wild catch groupers.

Live fishes from Sabah have been reported to cause CFP in Hong Kong (Sadovy, 1997, 2001).



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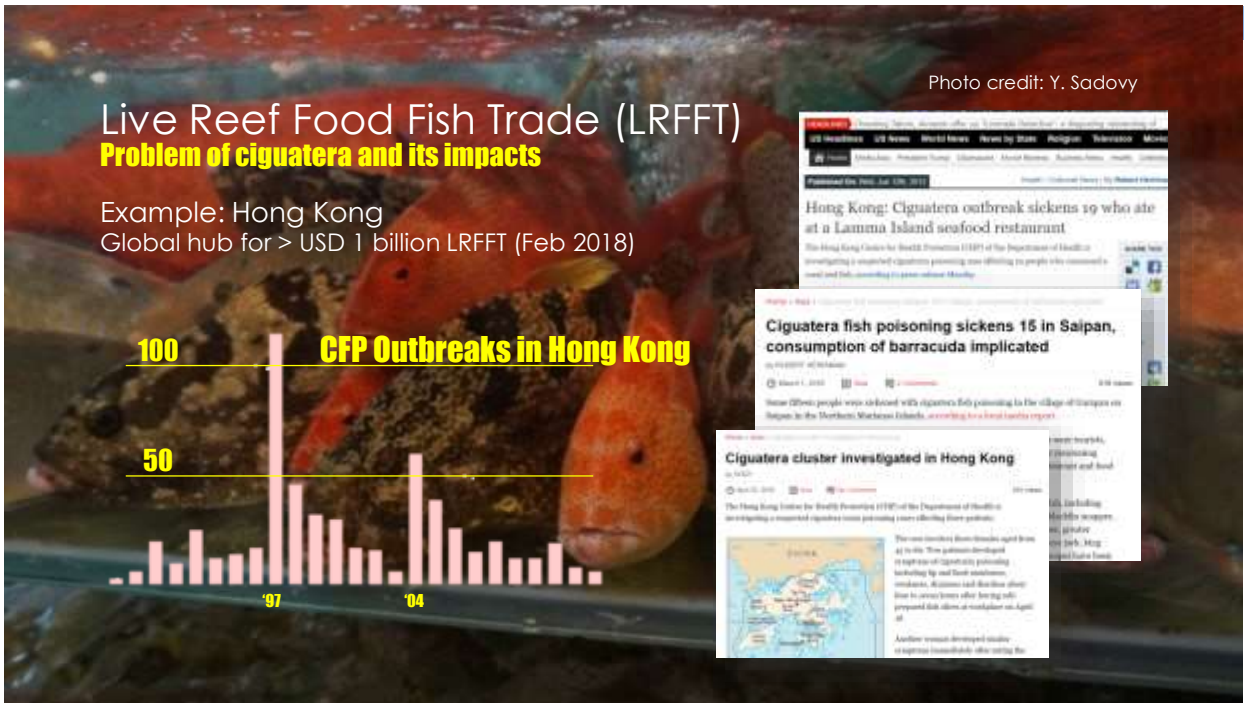

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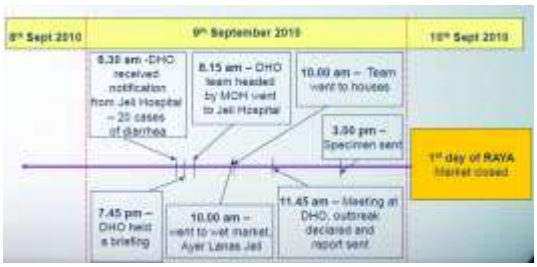
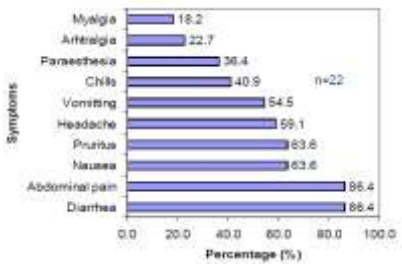
Malaysia: 2010 CFP Outbreak

22 (5 families) felt sick after consuming the red snapper on Sept 8, 2010; 11 were admitted to hospital.

Contaminated fish were bought from Jeli, which was bought from Far Frozen Fish Sdn Bhd, Pasir Puteh (red snapper, Batch no MRH-5000 25kg)





(adapted from Nik Khair0l Reza et al. 2011)

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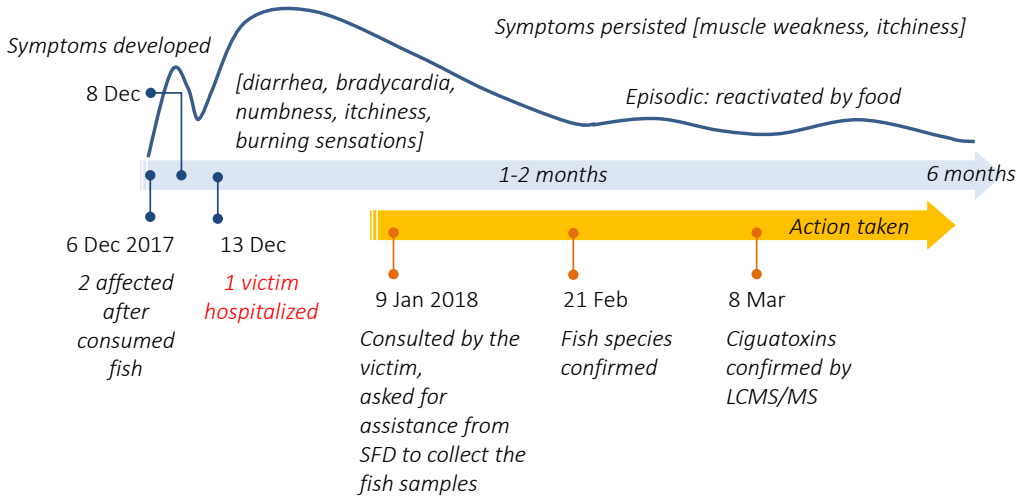
Malaysia: CFP in Sabah, December 2017



Lee et al., Medical Journal of Malaysia

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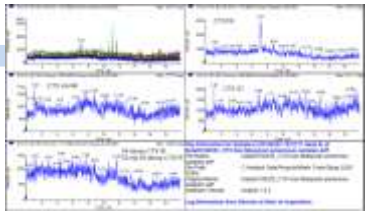
Malaysia: CFP in Sabah

The fish species were identified as *Lutjanus bohar* and *Lutjanus sebae*

Fishes collected from victim's home

We conducted species identification using molecular analysis



Ciguatoxin confirmation by LCMS/MS in *Lutjanus bohar* only.
(unpublished data)

Lee et al., 2019. Medical Journal of Malaysia,
Dao et al., In prep.

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Climate change and Benthic HABs

Global SST increases of 0.4–1.4°C by 2055 will promote growth rates of many BHABs (Tester et al. 2020).

Northward expansion of BHABs and CFP events.


In May 2017, a family of seven living near Adelaide, Australia, **went to the hospital** after one member of the household cleaned the family's tropical saltwater aquarium. The person reportedly removed and scrubbed some rocks or corals from the tank, presumably to remove unwanted, unattractive growths. This clean-up triggered the release of aerosolized palytoxin that caused everyone to struggle to breathe.


ARCHIVED - Toxic algal blooms likely to become increasing problem in Mediterranean as climate change warms the planet

Ostreopsis microalgae blooms have been called "the mother of all plagues".

The Spanish tourist industry is one of the sectors of the national economy which has been most dramatically affected by the coronavirus pandemic, but while there are hopes that progress can soon be made towards reactivating the sector another threat is being reported which could prove even more difficult to counter.

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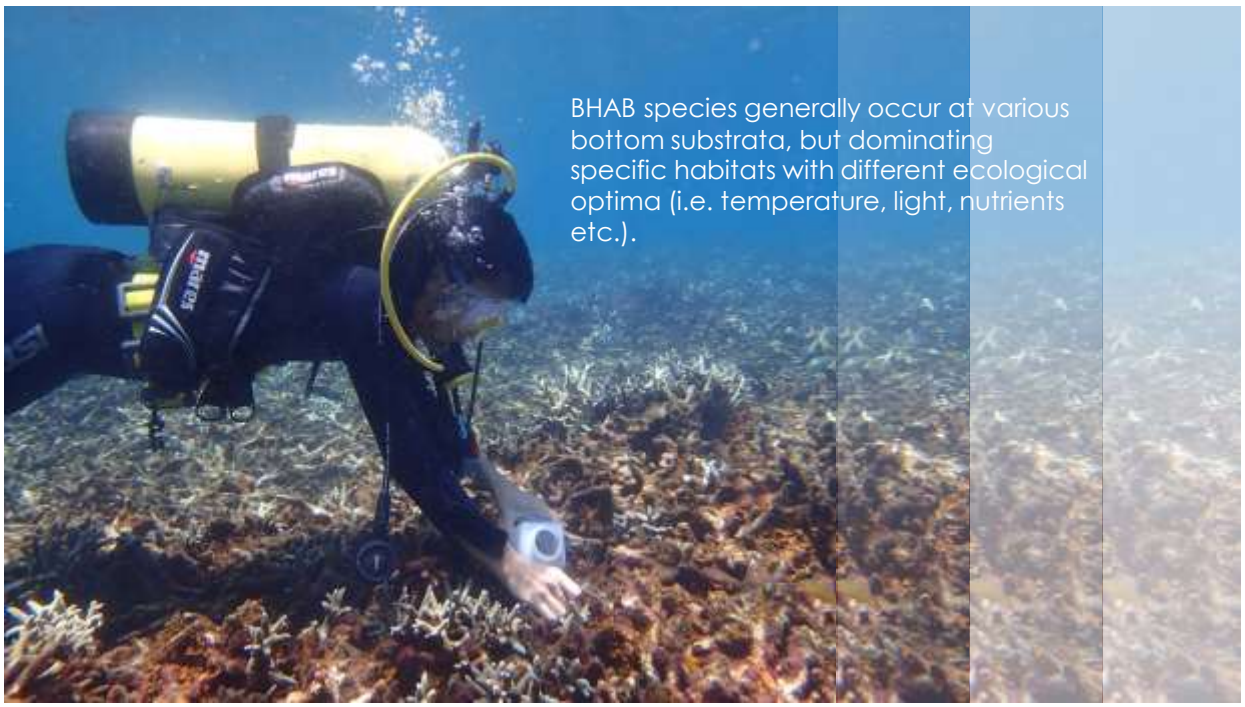

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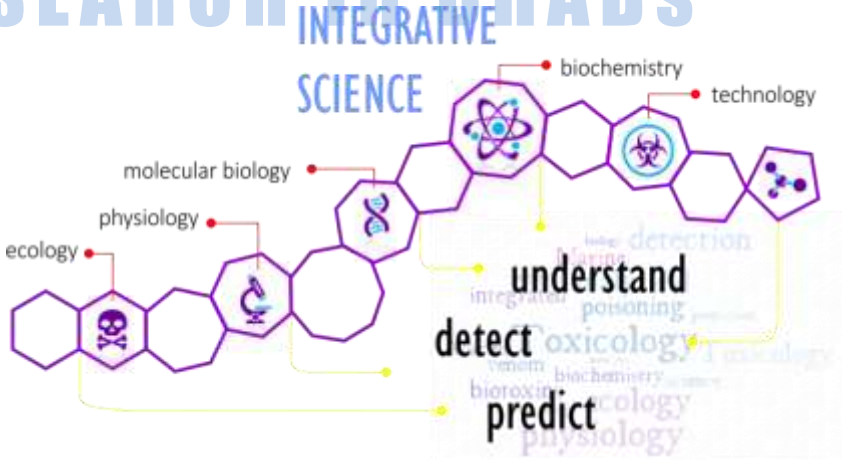
RESEARCH in BHABs

how fine-scale difference in substrates affects the distribution and abundance of BHABs, and by inference the local risk of toxicity



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Aim

To demonstrate an alternative sampling approach for BHAB studies,

To establish spatial and temporal patterns of BHAB assemblages and the associated environmental variables,

To assess the effect of reef degradation on BHAB communities.

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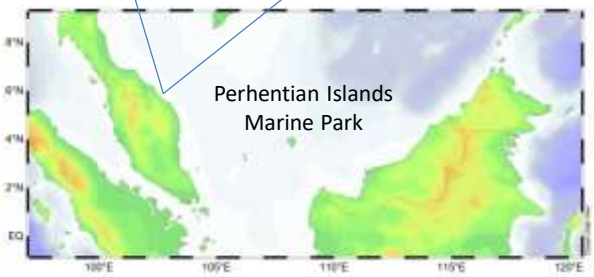
Study site



A reef flat of 100 × 180 m,
3 m depth.

April 2015- Jan 2016

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Non-destructive sampling approach

(Tester et al. 2012, 2014; Tan et al. 2013; Yong et al. 2018)

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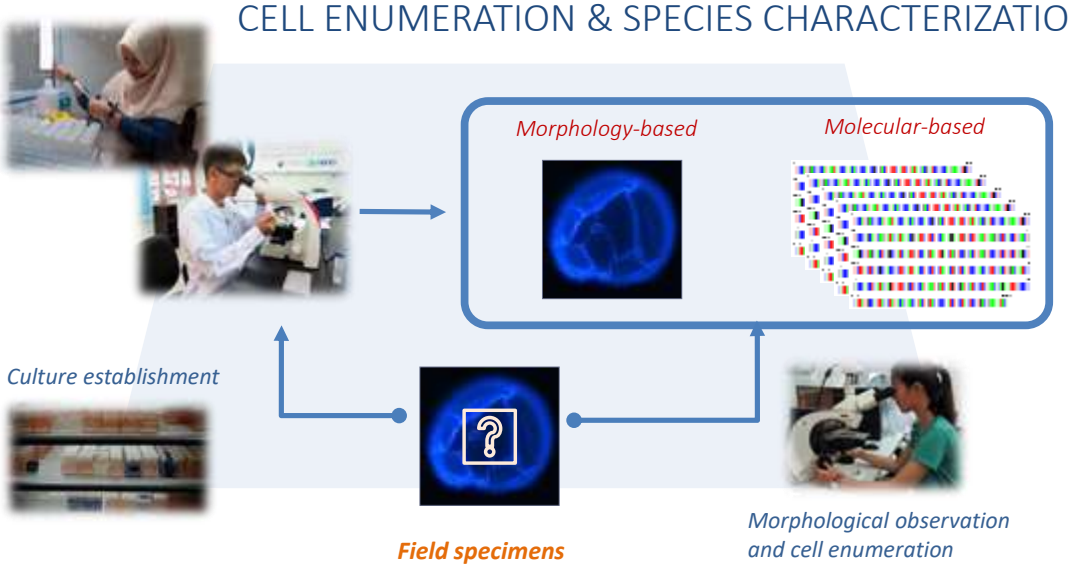
CELL ENUMERATION & SPECIES CHARACTERIZATION



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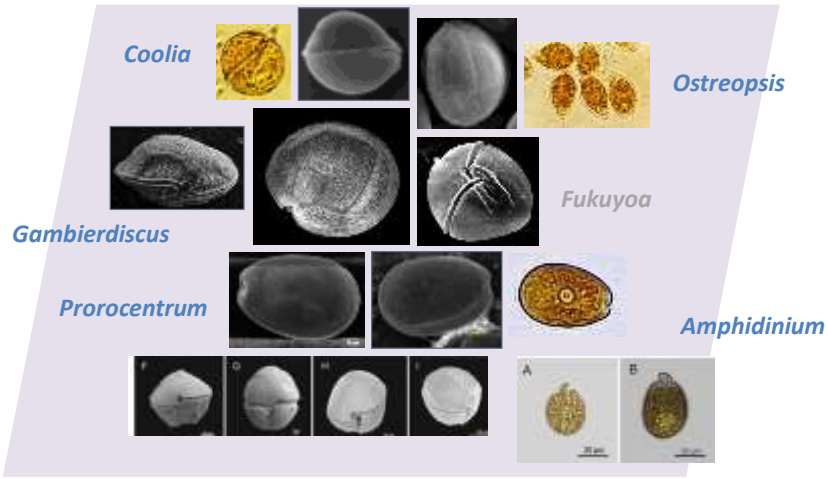
Five major taxonomic groups in the benthic harmful dinoflagellate assemblages



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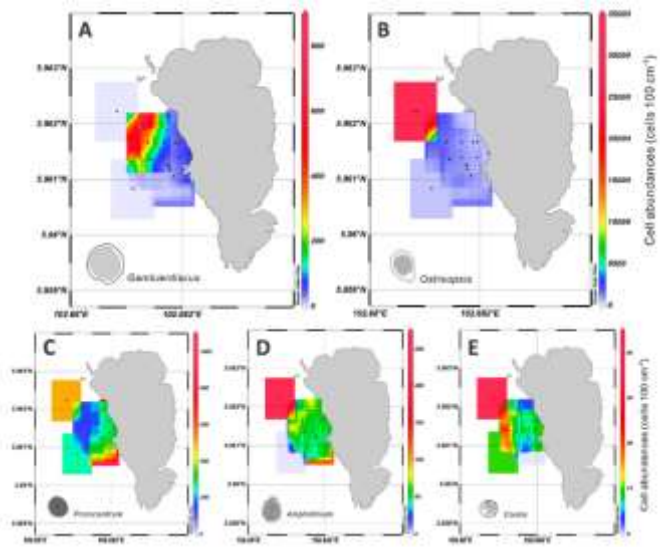
BHAB spatial distribution



feasibility of the artificial substrate method as an alternative sampling approach in BHAB studies.

Yong et al. (2018) *Harmful Algae*

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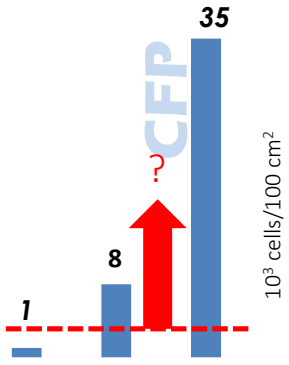
Implication in CFP risk assessment

The data obtained with this method can be used to establish a baseline in assessing the risk of CFP.

Because Rawa Island has not experienced a CFP event, it is suggested that *Gambierdiscus* abundance **<1000 cells/100 cm^2** may serve as the lowest threshold, i.e. low risk of CFP.

While regulatory decisions to limit or close fishing are not based on cell abundances of *Gambierdiscus*, these dataset suggests that CFP risk is low when cell abundances are consistently below <1000 cells/100 cm^2.



Yong et al., 2018; Lee et al., 2020.

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Reef microhabitats play an important role in structuring the benthic harmful dinoflagellate communities, but there are few that provide statistically robust studies with well-defined **habitat characterization**.

An underwater photoquadrat survey was performed simultaneously at each sampling point to record the percent coverage and variety of benthic substratum and the biotic inhabitants.

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BENTHIC MICROHABITAT CHARACTERIZATION

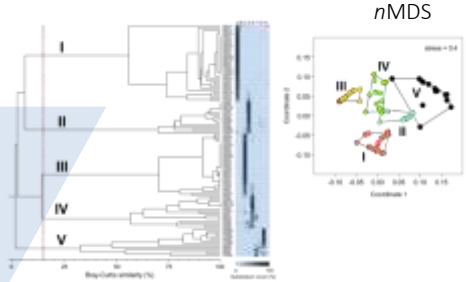
Underwater
Photoquadrat survey

Image analyses

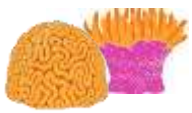
ImageJ / Coralnet

percent coverage,
variety of benthic substratum

*n*MDS



Multivariate analyses



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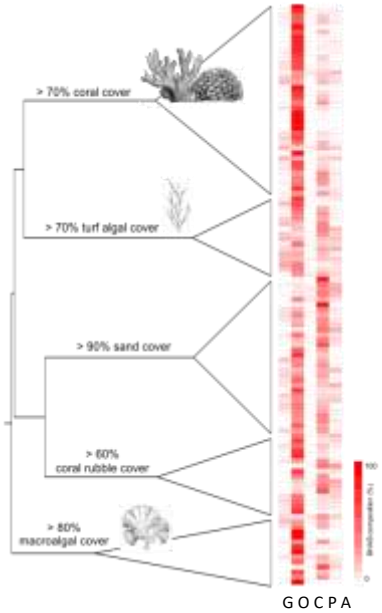
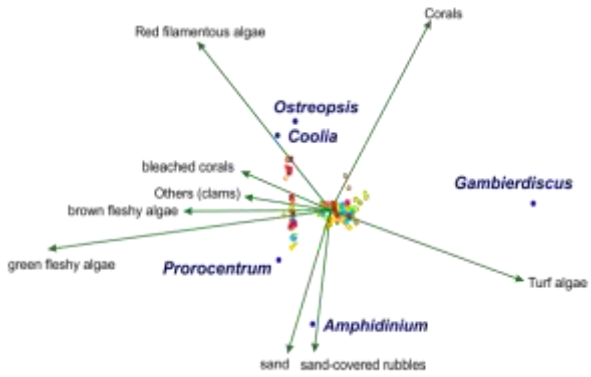


GOCPA



Microalgae-habitat interactions

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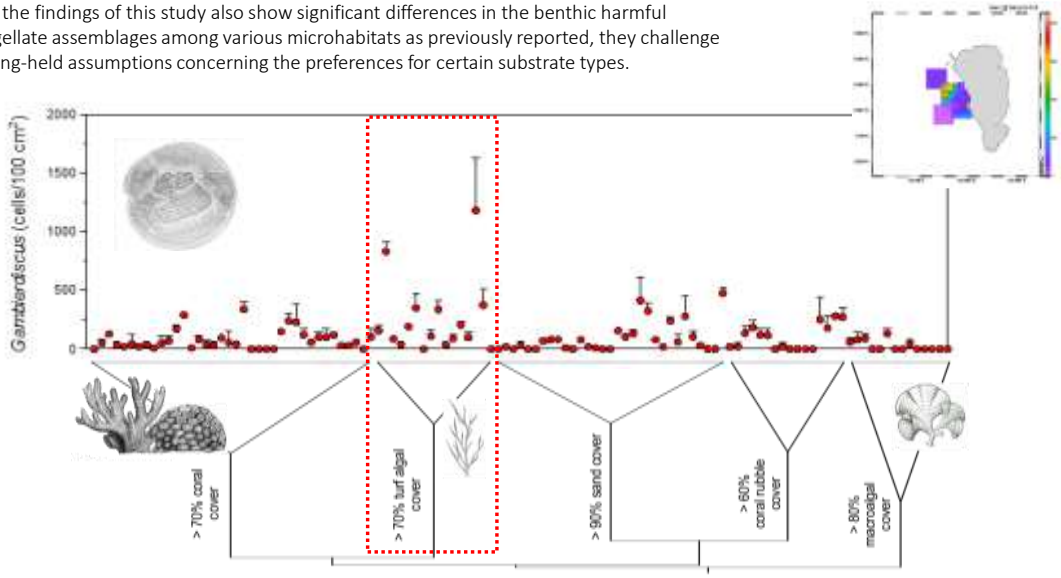
Microhabitat heterogeneity affects the BHAB assemblages

Though the findings of this study also show significant differences in the benthic harmful dinoflagellate assemblages among various microhabitats as previously reported, they challenge some long-held assumptions concerning the preferences for certain substrate types.



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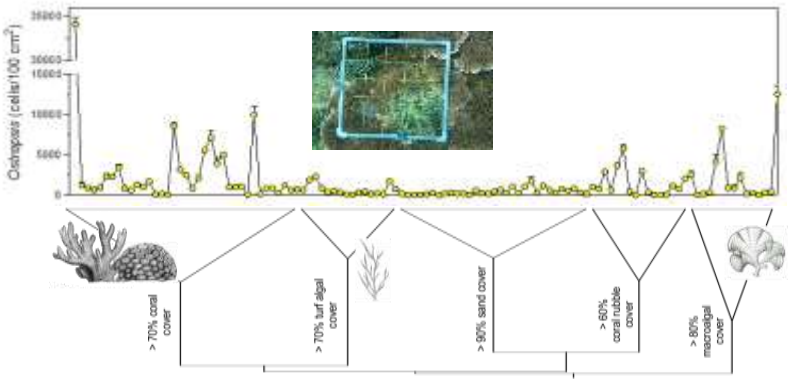
In contrast, *Ostreopsis* did not show the same substrate preferences as *Gambierdiscus*. It was found on nearly all substrate types, but maximum cell abundance was detected in **microhabitats with high coral cover,** and to a lesser extent, high filamentous algal cover.



Ostreopsis is known as an **opportunistic** group adapted to broad ranges of environmental conditions (Tindall and Morton, 1998; Vila et al., 2001).

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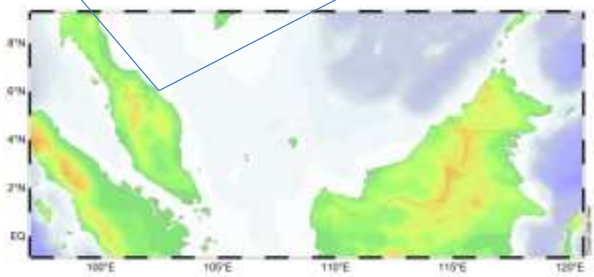
Study site



Reefs cover different depths (1 - 25 m).

Total screen samplers deployed = **234**

April 2016 - May 2017

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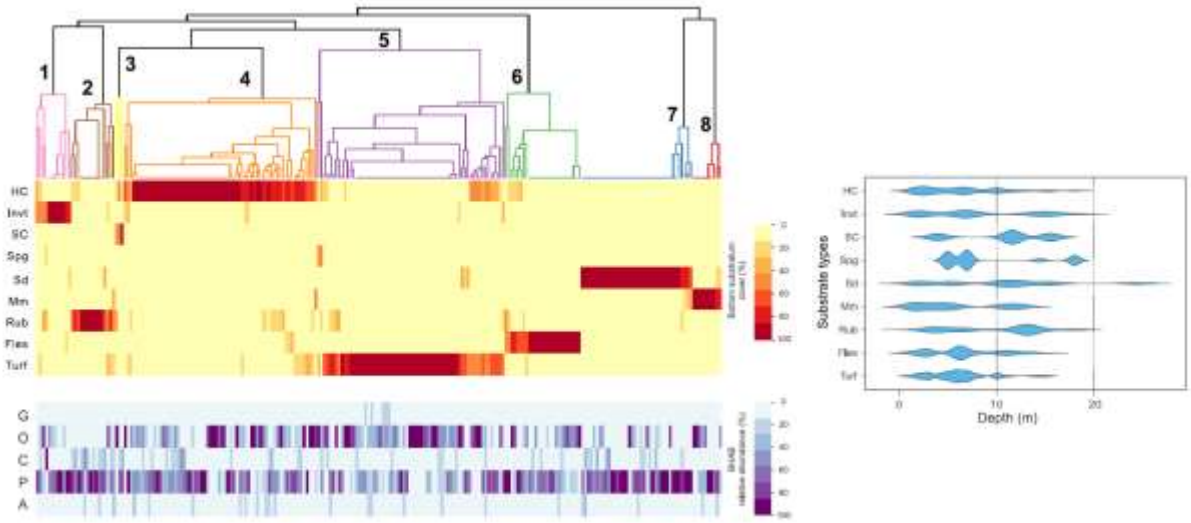

BENTHIC MICROHABITAT CHARACTERIZATION

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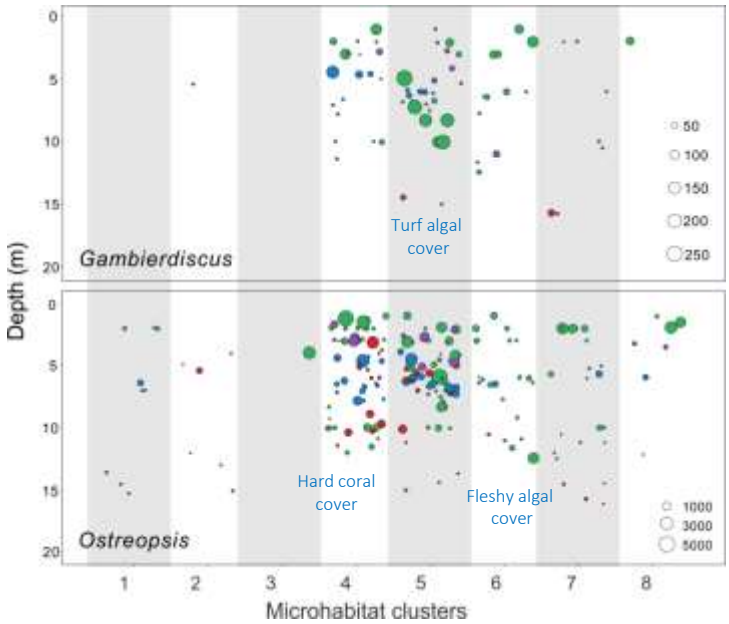
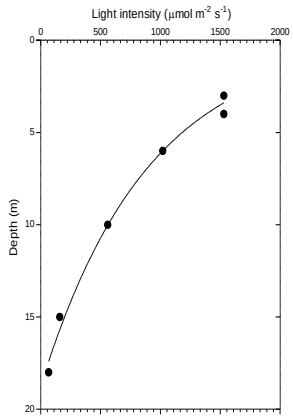


Depth distribution of BHAB assemblages



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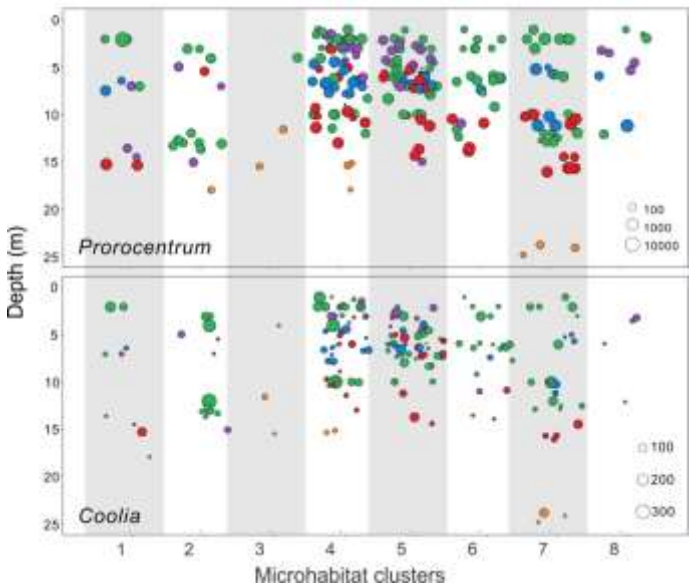

Prorocenrum and *Coolia* have a broader range of depth distribution, can be found in deeper waters.

This suggested that, depending on the substrate suitability and availability, the variation in BHAB adaptability to different depth is likely influence by other driving factors such as light intensity and exposure to water disturbance.

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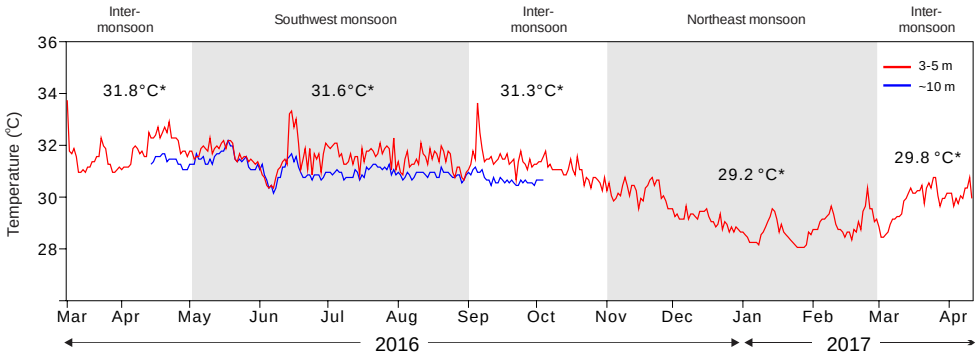
Physical measurements of the temperature and light were obtained by deploying data loggers.



Seasonal variation in water temperature

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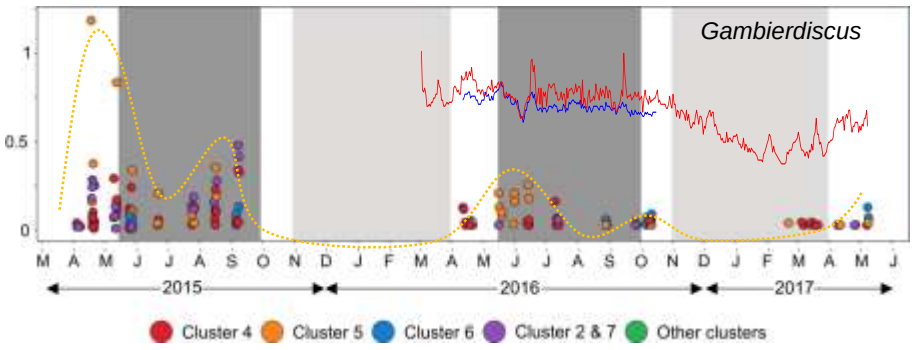
Temporal variability

Changes in temperature and associated climatic conditions profoundly affect the abundance and distribution of species across microhabitat types.



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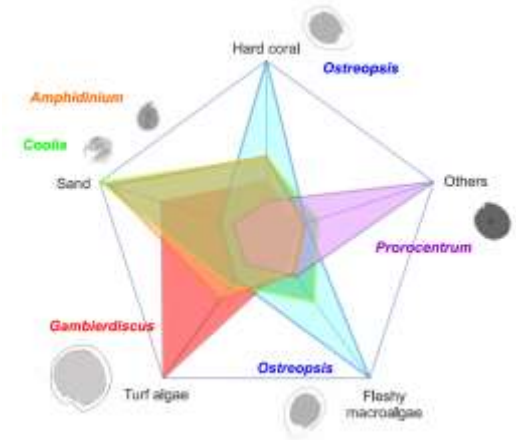
CONCLUDING REMARKS

- This study highlights the variability of benthic substrate types influence the distribution of BHAB taxa in complex ways that interact with other environmental driving factors.
- The artificial substrate method coupled with benthic habitat characterization could serve as an alternative tool to study *in situ* BHABs abundance and distribution.
- These datasets could serve as a basis for comparison and of consideration in BHAB monitoring strategy in CFP prone areas.



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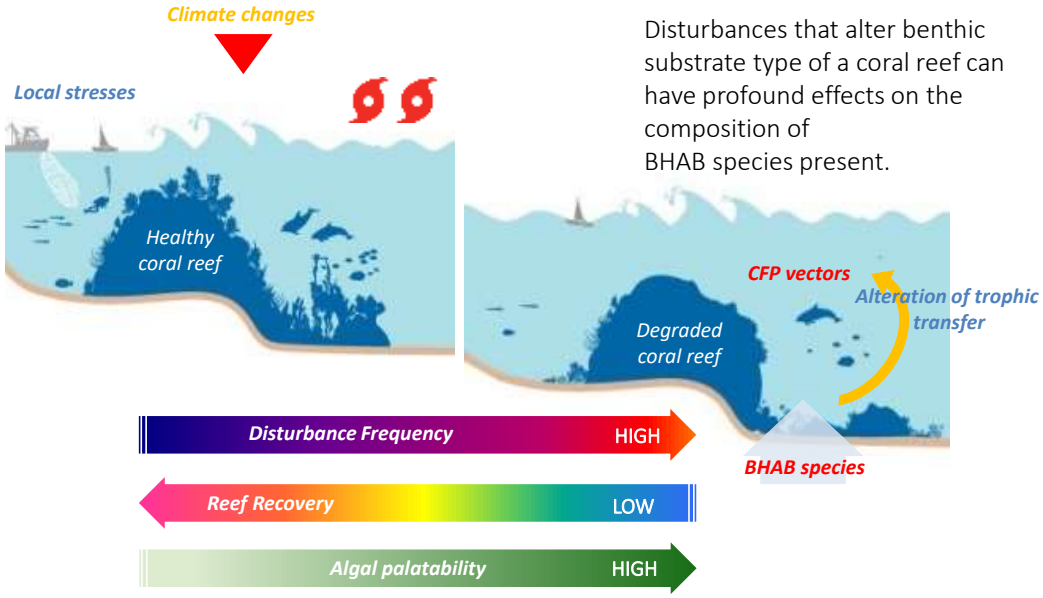

Disturbances that alter benthic substrate type of a coral reef can have profound effects on the composition of BHAB species present.

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Climate change and Benthic HABs

Global SST increases of 0.4–1.4°C by 2055 will promote growth rates of many BHABs (Tester et al. 2020).

Northward expansion of BHABs and CFP events.

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UN IPCC Special Report on the Ocean and Cryosphere in a Changing Climate (SROCC, September 2019) was the first IPCC report to directly link **HABs to climate change**.

The following declarations were included in the Summary for Policy Makers:

- Harmful algal blooms display range expansion and increased frequency in coastal areas since the 1980 in response to both climatic and non-climatic drivers such as increased riverine nutrients run-off.
- The observed trends in HABs are attributed partly to the effects of ocean warming, marine heatwaves, oxygen loss, eutrophication and pollution.
- Harmful algal blooms have had negative impacts on food security, tourism, local economy, and human health.

(Gobler 2021 *Harmful Algae*)

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Acknowledgements
MESTECC & MOE Research funds
WESTPAC HAB for travel support
Protect our coral reefs
prevent CIGUATERA

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Deploying substrate

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