Turbidity and latitude determine distribution of *Symbiodinium* spp. in Vietnam

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Background

Reef building corals rely on a nutritional partnership with endosymbiotic dinoflagellates of the genus *Symbiodinium*. In an era of global climate change, maximum Sea Surface Temperature (SST) is regarded as the main predictor of symbiont distribution on local and regional scales. Only recently has this paradigm been challenged.

Objectives

- To study (in progress) on the **symbiont distribution** in relation to a range of **environmental factors** within 50+ coral species along Vietnam's coastline spanning 3200 km and 11 degrees of latitude
- To examine in detail the **distribution of symbionts** in a subset of samples within the brooding coral *Pocillopora damicornis* and the spawning coral *Galaxea fascicularis*.

Methods

- Symbiont **ITS2** (rDNA) genotypes were characterized by PCR and direct sequencing
- 406 coral samples collected from **50+ coral species** along 5 meter transects Additionally 302 samples of the *G. fascicularis* and 216 samples of *P. damic*ornis
- 4 regions , 11 sites
- **Inshore sites (Sites 1, 2, 5 and 7)** → **strong anthropogenic activities**
- **Offshore sites (Sites 3, 4, 6, 8-11)** → **further away from human impact.**
- Environmental measurements**: Turbidity** (Chl *a*) and **SST measurements** (average, min, max and range) from satellite data (**MODIS Aqua** 4km) and local data
- **PCA** → relationship environmental variables

RESULTS

- 17 clade C types, 2 clade D types and 1 clade A type found (Fig. 1)
- Offshore sites dominated by **clade C** and have higher diversity compared to inshore sites (Fig. 1)
- The spawning coral showed higher diversity of symbionts compared to the brooding one. (Fig. 1)
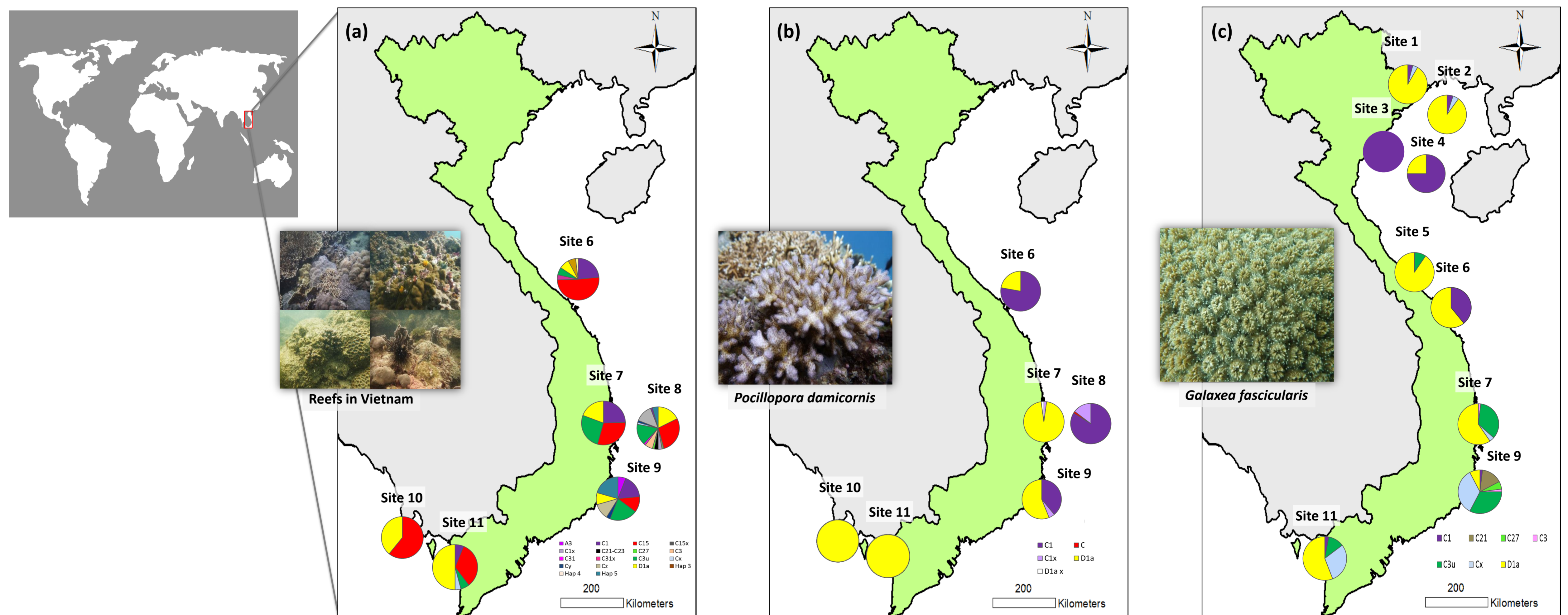

Fig. 1. The observed geographical distribution of *Symbiodinium* types (ITS2) across regions and sites along Vietnam's coastline – (a) Symbiont from 50+ host spp.; (b) *Pocillopora damicornis;* and (c) *Galaxea fascicularis*. Each section pie chart represents a type of *Symbiodinium* and the **yellow sections are Clade D1a**.

Conclusions

- **Surprisingly low symbiont diversity**, we expect to find more types by the end of the study
- **Clade D** (mainly D1a) is more abundant in South China Sea than previously reported as inshore sites were included in the study.
- First discovery of **clade A** in South China Sea
- Strong Inshore-Offshore zonation (Fig. 1)
- The spawning coral showed higher diversity of symbionts compared to the brooding one.
- Yearly **SST range** (not SST$_{max}$) and **turbidity** were the main predictors of symbiont distribution (Fig. 2 and 3). Symbiont types are good predictors of the state of the reef.
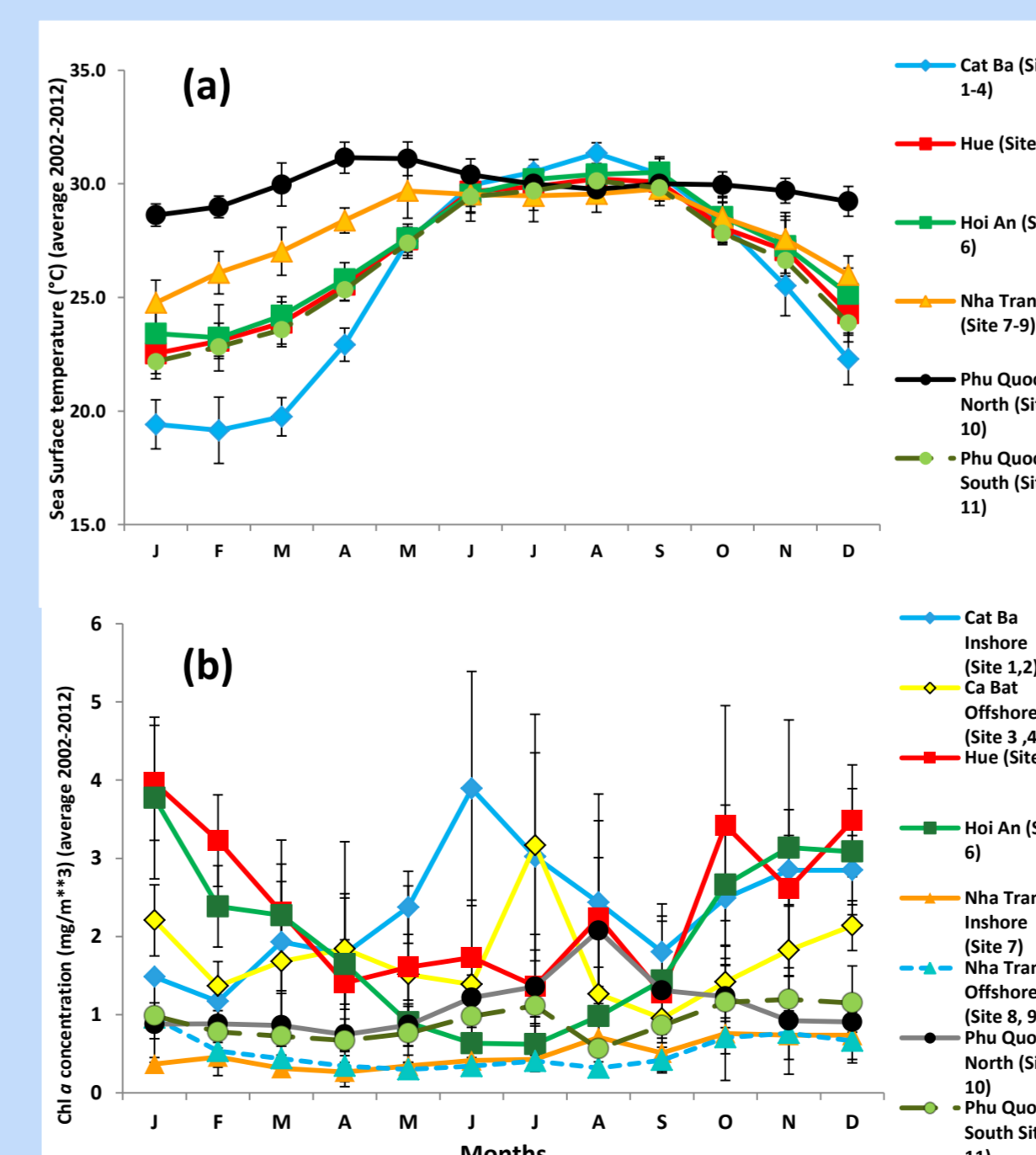

Fig. 2. Average monthly values (± S.D.) of (a) sea surface temperatures (SSTs) and (b) chlorophyll *a* (Chl *a*) concentrations from 2002 to 2012 (until May).
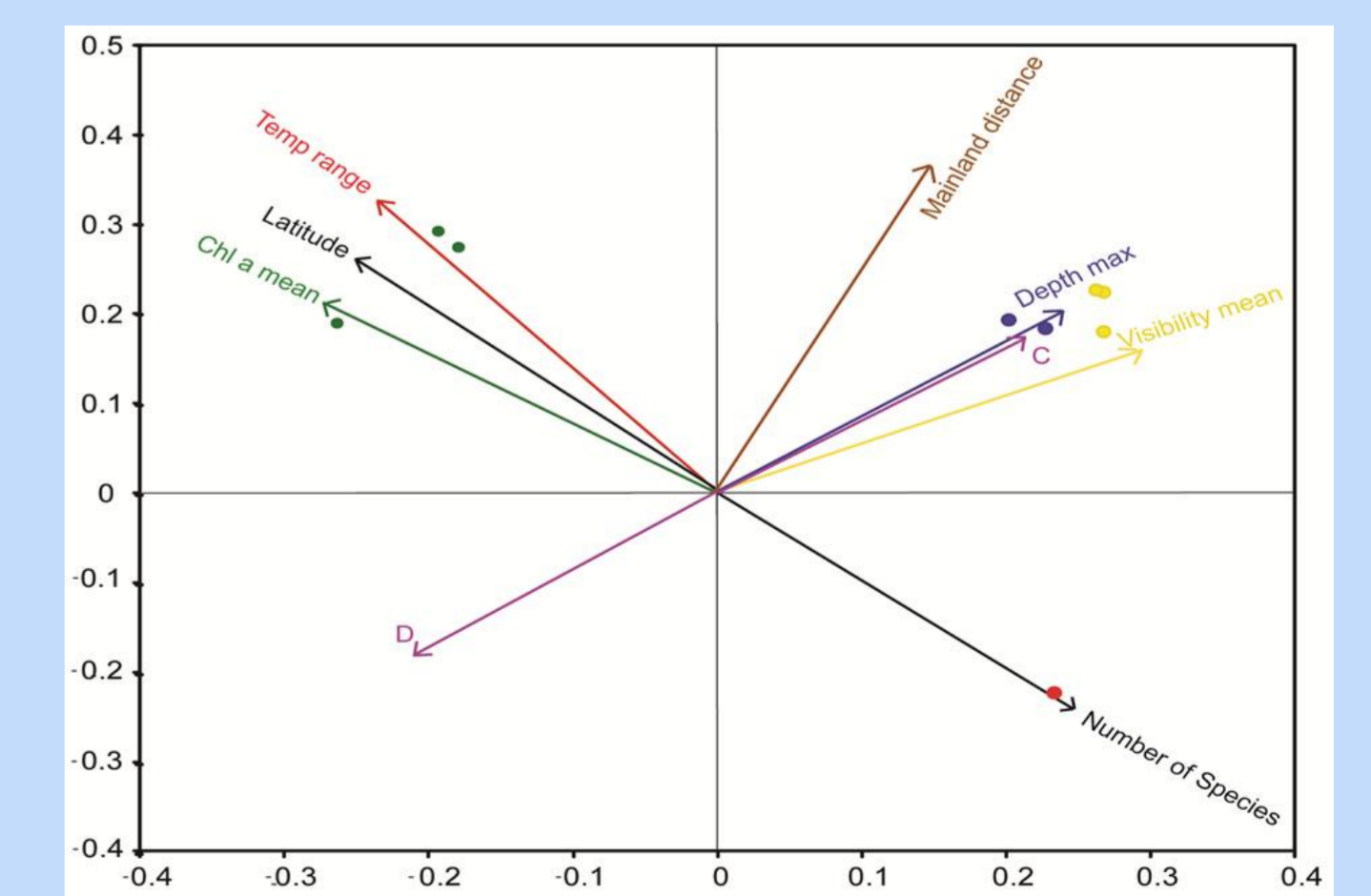

Fig. 3. Principal component analysis (PCA) of seven measured environmental variables and the two *Symbiodinium* main groups (C and D) (R^2 = 0.73).

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