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Successions of Microbioeroding Communities over a Year Period with a Monthly Resolution : Impact on Biogenic Dissolution in Dead Corals (New Caledonia)



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Introduction

Coral reefs maintenance results from the balance between constructive and destructive forces, those being mainly due to the agents of bioerosion. Microborers -cyanobacteria, microalgae and fungi- are the main agents of biogenic dissolution in dead substrates such as coral skeletons. However, very little is known on the early stages of their community successions and associated biogenic dissolution rates.

In this study we present

- The early stages of community successions over a year period
- When *Ostreobium quekettii*, the main agent of carbonate dissolution settles down and becomes the dominant species
- The dynamics of the biogenic dissolution process with a monthly resolution and the correlation with the microborer communities

Material and Methods

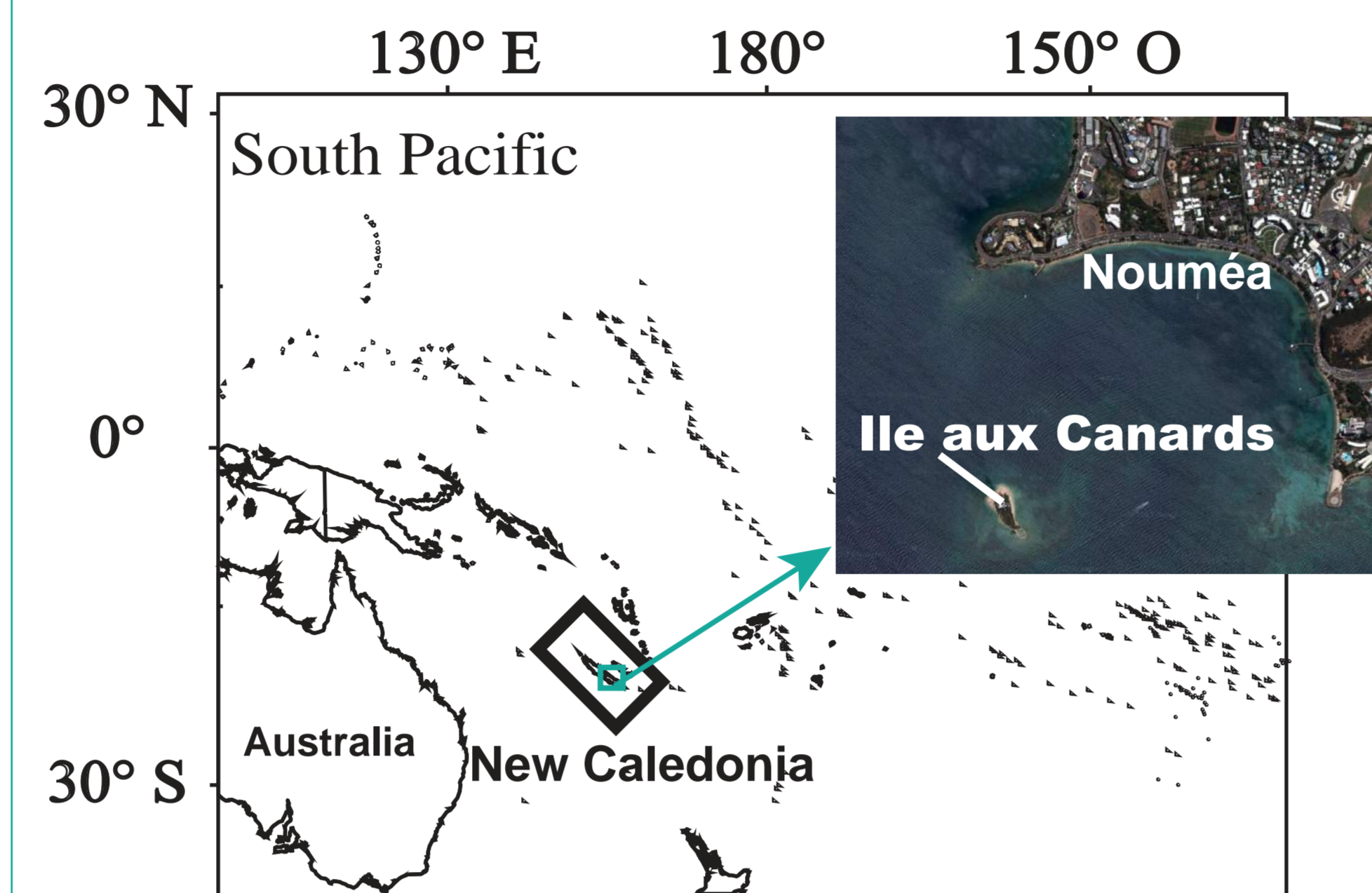


Figure 1: Map of the study site in New Caledonia.

An *in situ* high temporal resolution study is carried out in New Caledonia (Fig.1) since 2009. Experimental coral blocks (skeleton of *Porites* sp.) are regularly exposed to colonization by microborers.

60 Blocks were fixed on 2 grids at 3-m depth in December 2010 (summer season) for a year period (Fig.2). Each month, 5 blocks were sampled: 3 blocks for this study and 2 additional blocks for the study of the impact of microborers on the geochemical composition of coral skeletons (see Poster #2254 C.Brahmi et al.)

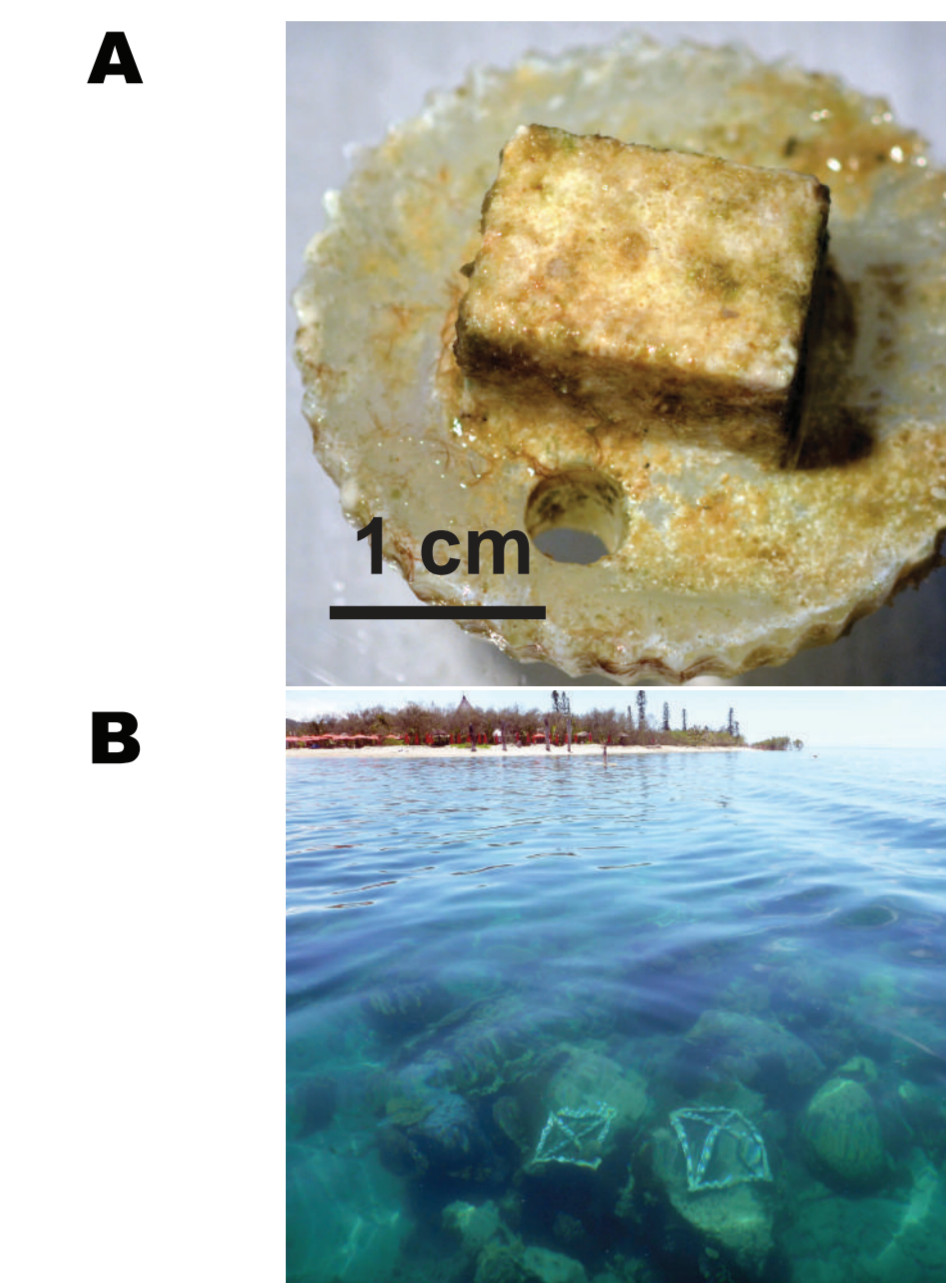


Figure 2: A-Coral block after 6 months of microbioersion; B-The 2 grids at 3-m depth

To characterize the biogenic dissolution per month due to microborers, 4 parameters were determined on blocks:

- (1) Species composition of microborering communities,
- (2) Succession of microborers,
- (3) Filament depth of penetration in blocks
- (4) the bioeroded surface area at the surface of blocks.

Here, biogenic dissolution is expressed in kg of CaCO₃ dissolved per square meter of coral reef and per unit of time.

All data were analysed using R software.

Community Composition

Observed microborers comprised (Fig.3):

-3 species of **chlorophytes** (*Eugomontia* sp., *Phaeophila* sp., *Ostreobium quekettii* and unidentified species),

-3 species of **cyanobacteria** (*Hyella* sp., *Mastigocoleus testarum*, *Plectonema terebrans*),

-fungal filaments

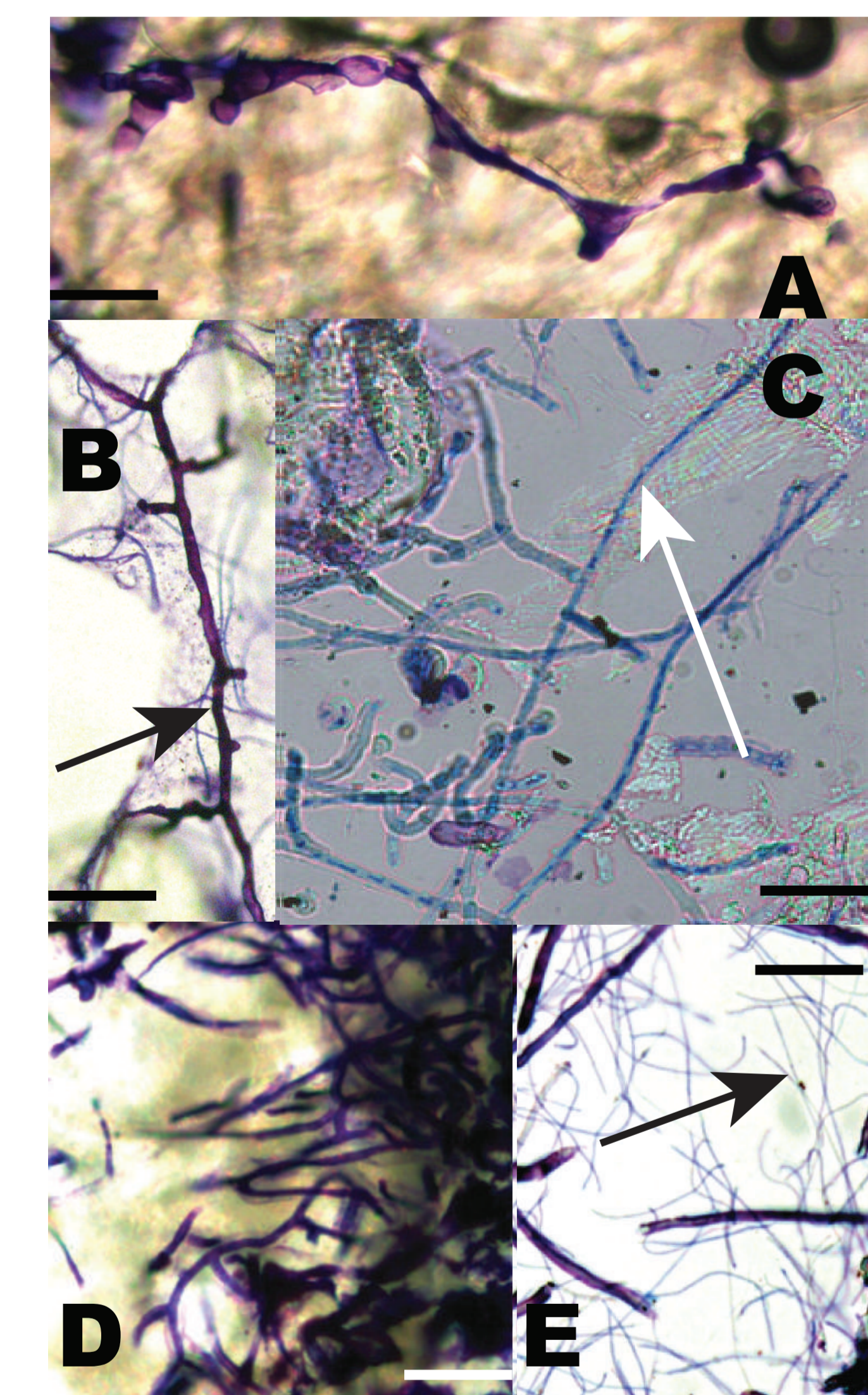


Figure 3: A- *Phaeophila* sp.; B- *Ostreobium quekettii*; C- *Hyella* sp.; D- *Mastigocoleus testarum*; E- Fungi or *Plectonema terebrans*. Scale bar = 40µm

Microborer Successions and Distribution

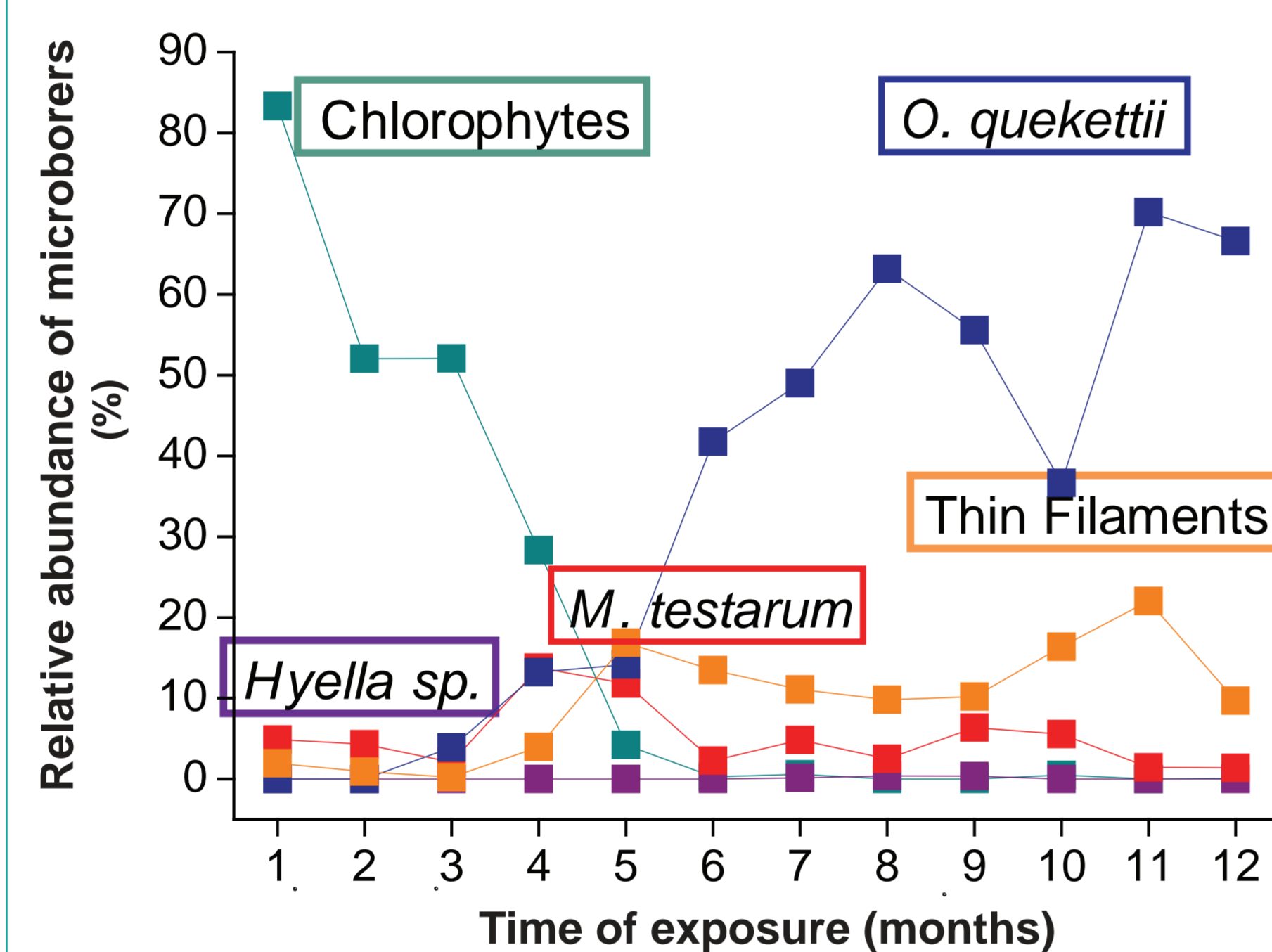


Figure 4: Relative abundance of microborers in percent according to the time of exposure in months.

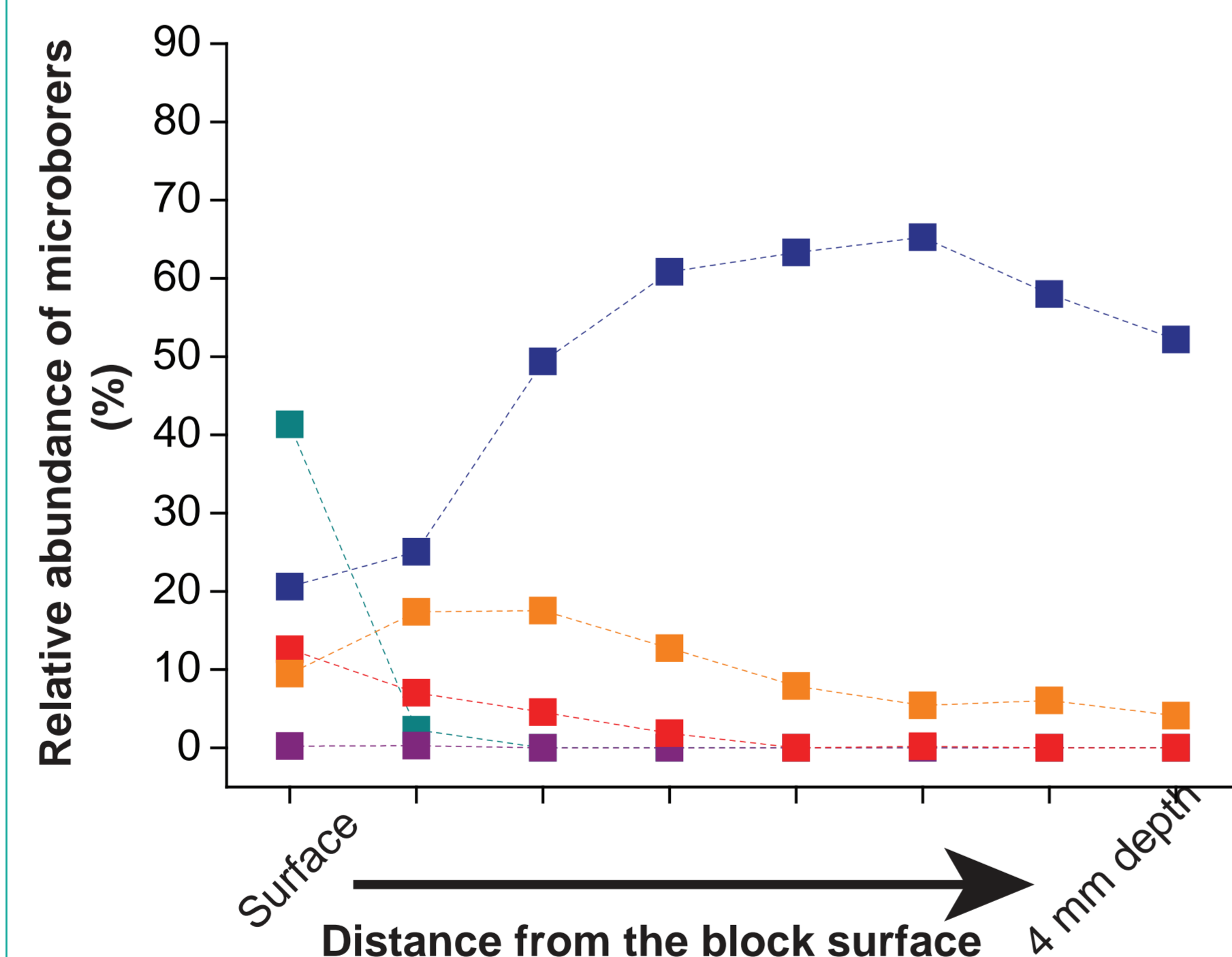


Figure 5: Relative abundance of microborers in percent according to the distance from the block surface. See legend in the Fig.4

-Chlorophytes other than *O. quekettii* are dominant during the first 4 months (Fig.4), characterizing immature communities.

-*M. testarum* and thin filaments (fungi and *P. terebrans*) are present through the duration of the experiment but are not abundants (<20%, Fig.4).

-*O. quekettii* start settling on substrates after 3 months of exposure and dominates after 6 months (Fig.4), characterizing mature communities.

-Chlorophytes other than *O. quekettii* and cyanobacteria penetrate no more than 2 mm into substrates (Fig.5). Those organisms are known to request light (photophile species).

-*O. quekettii* and thin filaments (mainly fungi) penetrate up to 4mm into substrates (Fig.5). *O. quekettii* is a sciaphile species, adapted to low light intensities.

Biogenic Dissolution by Microborers

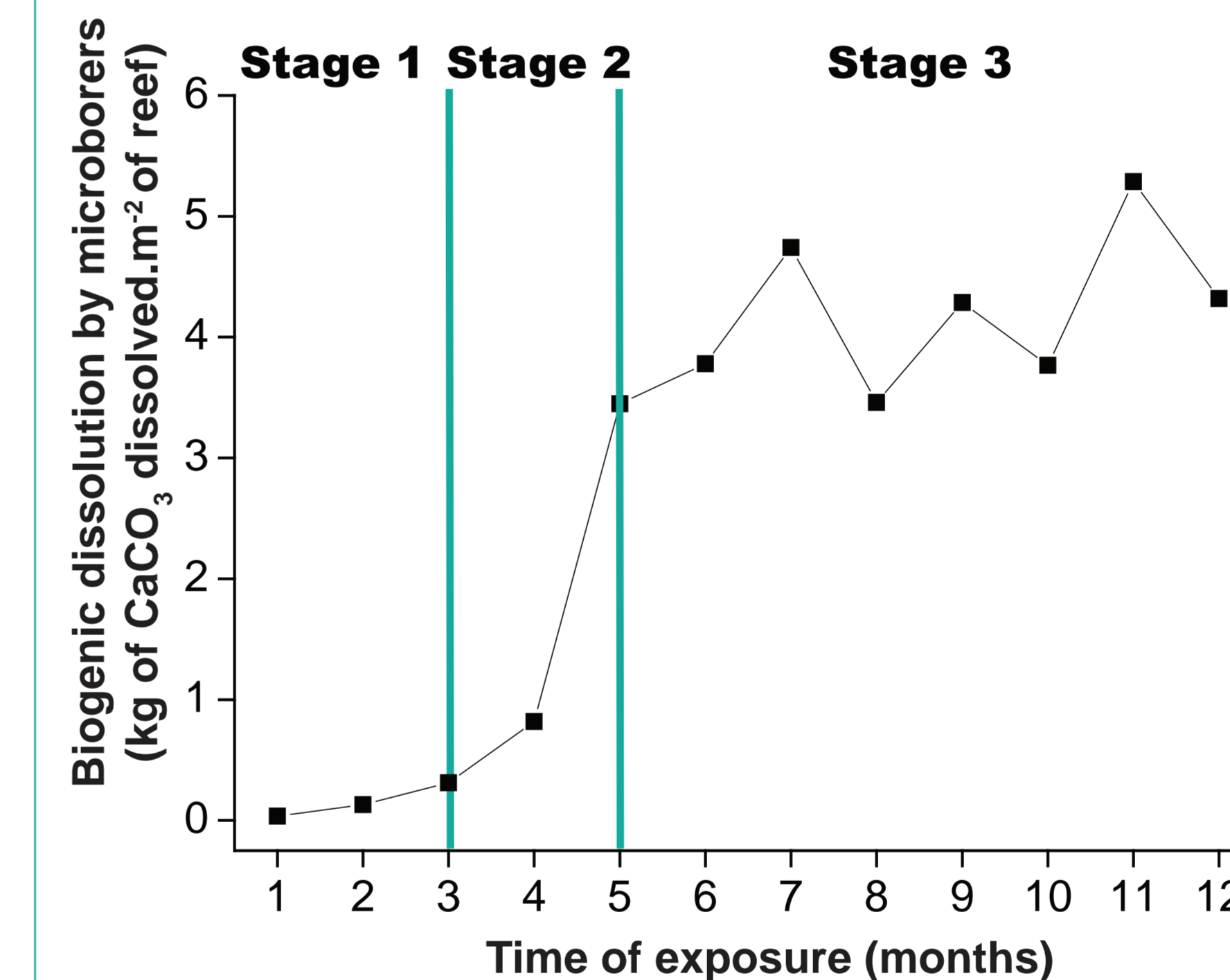


Figure 6: Biogenic dissolution by microborers expressed in kg of CaCO₃ dissolved per square meter of reef according to the time of exposure in months.

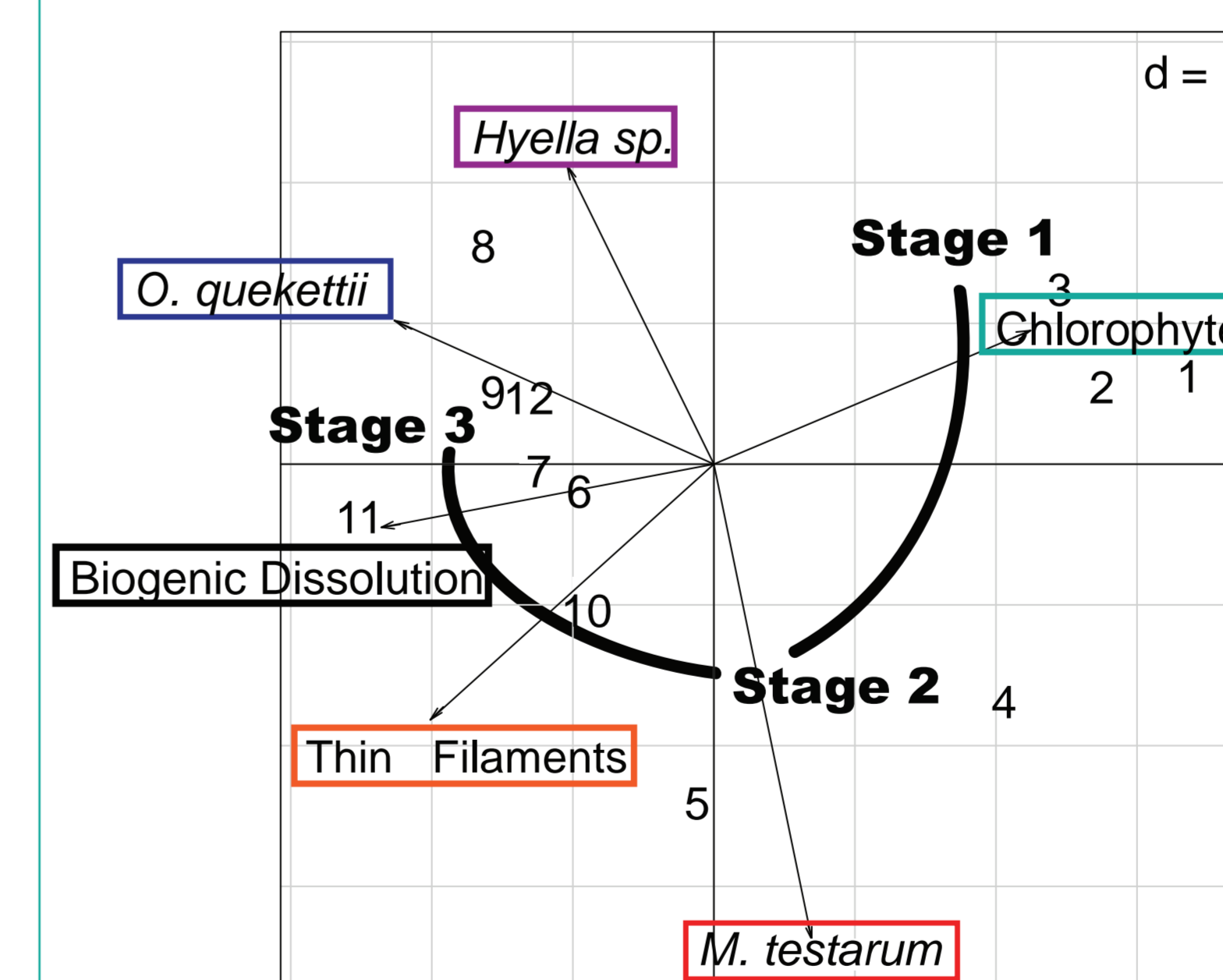


Figure 7: Principal Component Analysis

-After 12 months of colonization, 4.3 kg of CaCO₃ are dissolved per square meter of reef (gross dissolution rates, Fig.6).

-The dynamic of biogenic dissolution is non-linear (Fig.6) and seems to be strongly correlated with the successions of microborer communities (Fig.4, 6 and 7)

-The dynamic of biogenic dissolution comprised 3 stages (Fig.6 and 7):

Stage 1: Low dissolution rates
Settlement and dominance of Chlorophytes other than *O. quekettii* that remains at the surface (Fig.4 and 5).

Stage 2: High dissolution rates
Settlement of *O. quekettii* (Fig.4) that penetrates down to 4 mm (Fig.5). Increase of *M. testarum* abundance (Fig.4).

Stage 3: Stabilization of dissolution rates
O. quekettii dominates microborer communities (Fig.4) and drives the biogenic dissolution process (Fig.7).

Conclusions

This is the first study on the successions of microborer communities and the associated biogenic dissolution with a monthly resolution (Grange et al. *in prep.*).

Community successions

- The first 4 months, Chlorophytes other than *O. quekettii* are dominants but are beneath substrate surface. After 6 months, *O. quekettii* is the most abundant species and penetrates deeply into substrates (>4 mm). These results confirm those of Gektidis (1999, *Bull. Geol. Soc.*) and Chazottes et al. (1995, *Palaeos3*).
- The new finding here is that after 3 months (still in summer), *O. quekettii* is already settled and is deep inside substrates (~1 mm).

The pattern of early biogenic dissolution of carbonates by microborers

- This process evolves non-linearly nor proportionally over 12 months confirming the hypothesis of Tribollet & Golubic (2005, *Coral Reefs*). it's thus not recommended to extrapolate biogenic dissolution obtained after a few days or months to a year.
- 3 stages in this process are noticed over the 12 months period : (1) A slow increase between 0-3 months, (2) an exponential increase between 4 and 7 months, and then (3) a «plateau» after 7 months.
- Parameters such as grazing and environmental conditions (T°C, S...) could explain the variability after 7months.