The effects of solar irradiance on reef coral physiology and recruitment

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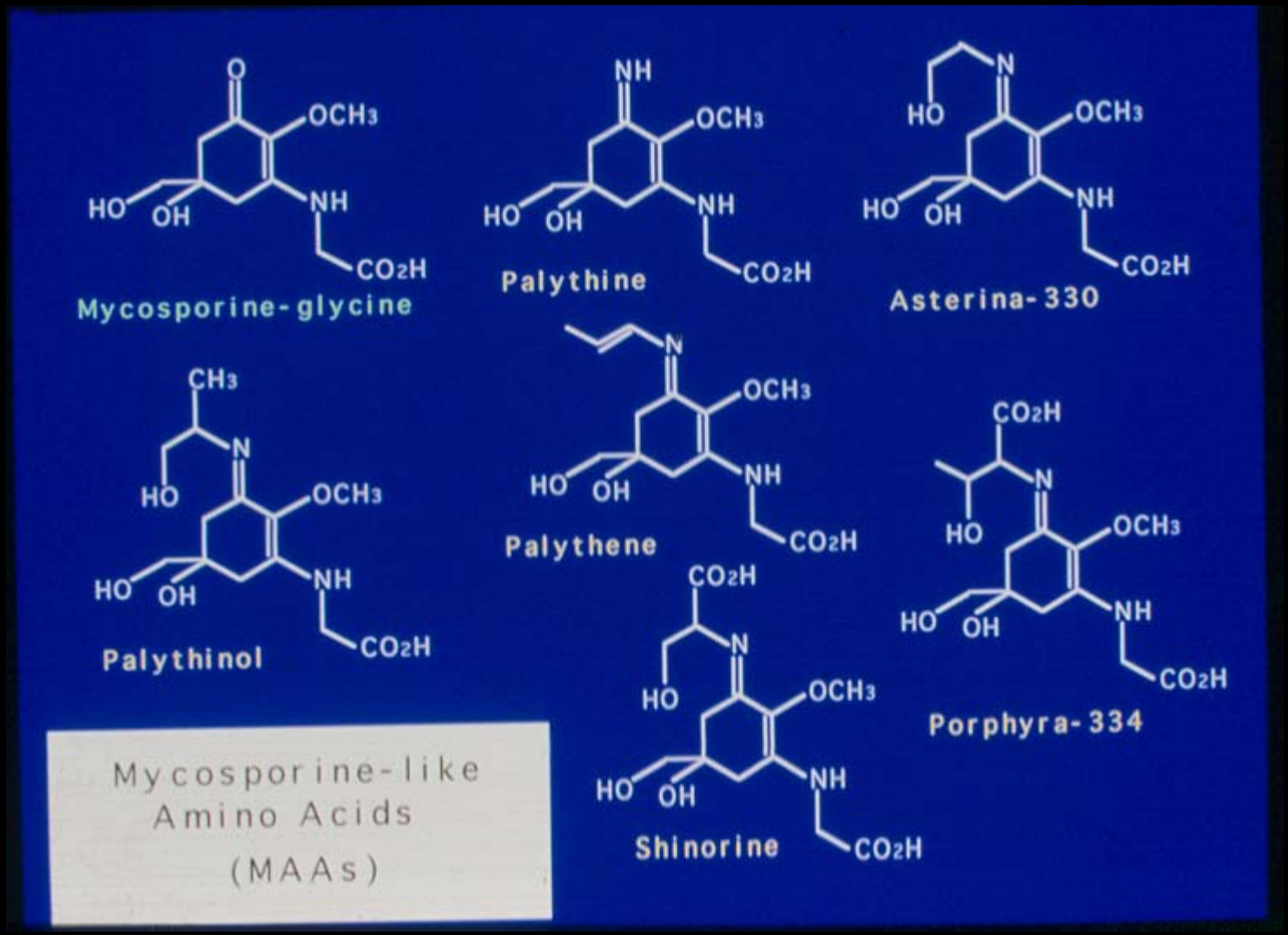
science for a changing world

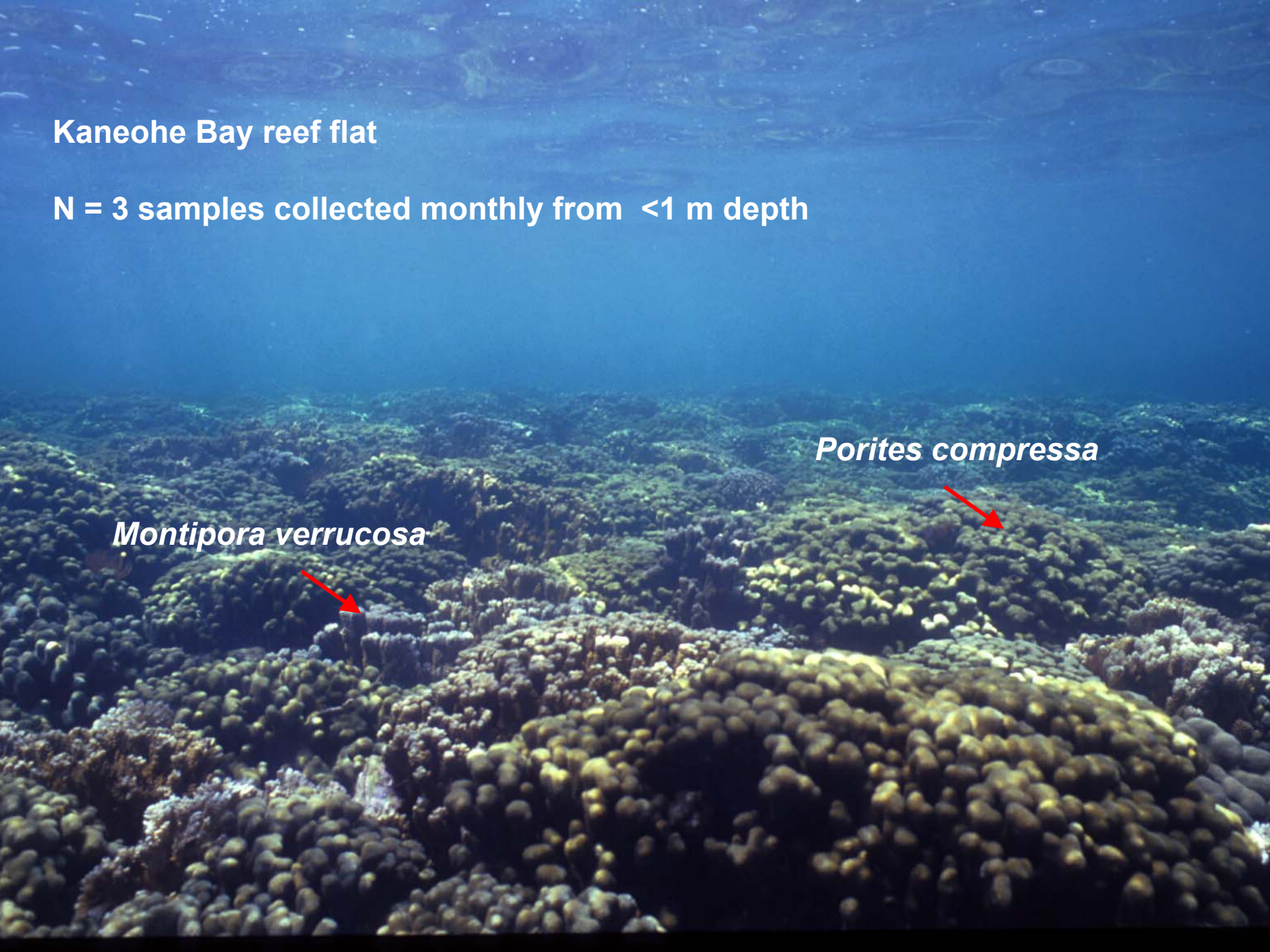
Center for Coastal & Watershed Studies

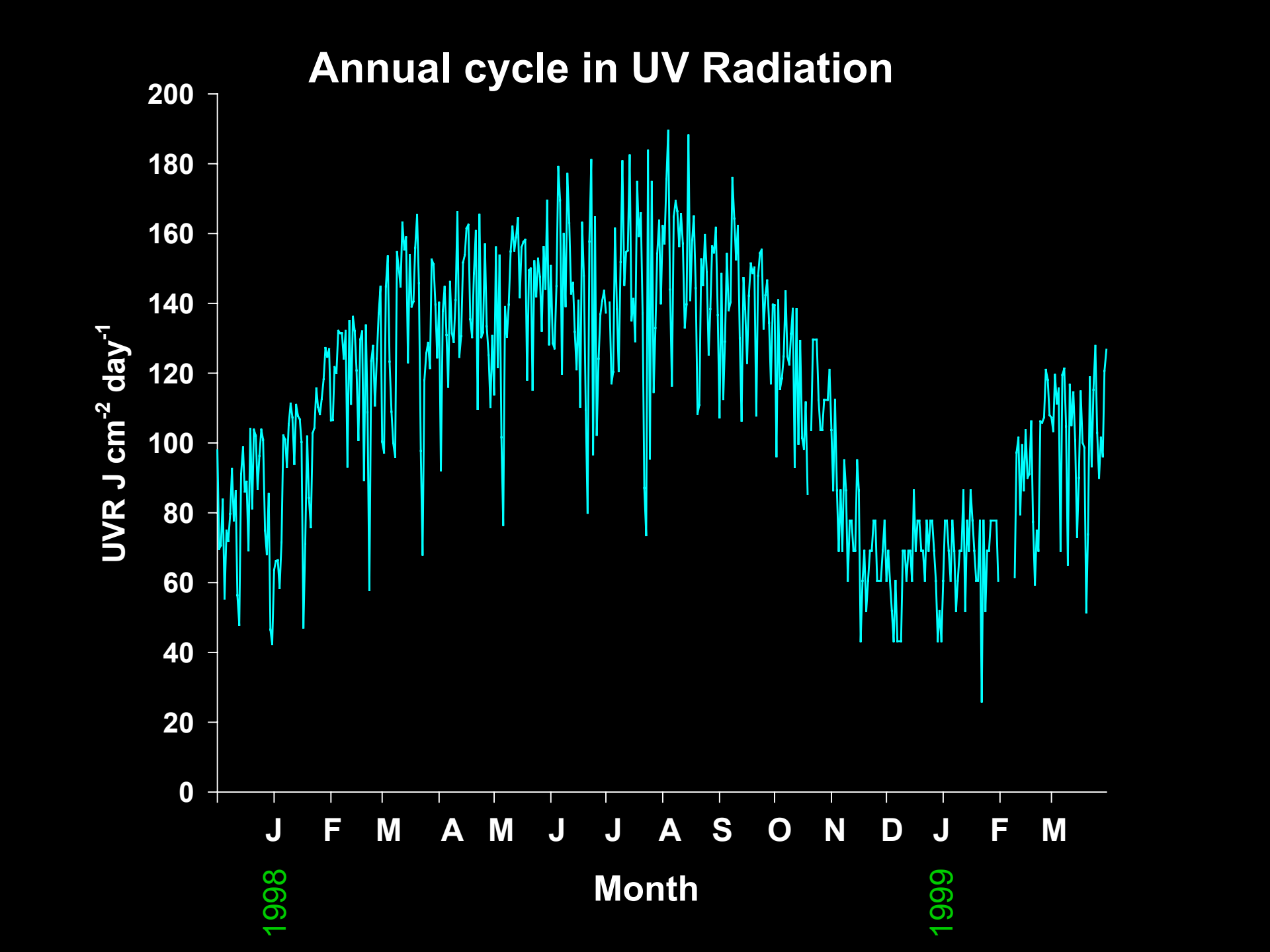
Data of interest regarding coral bleaching & coral recruitment

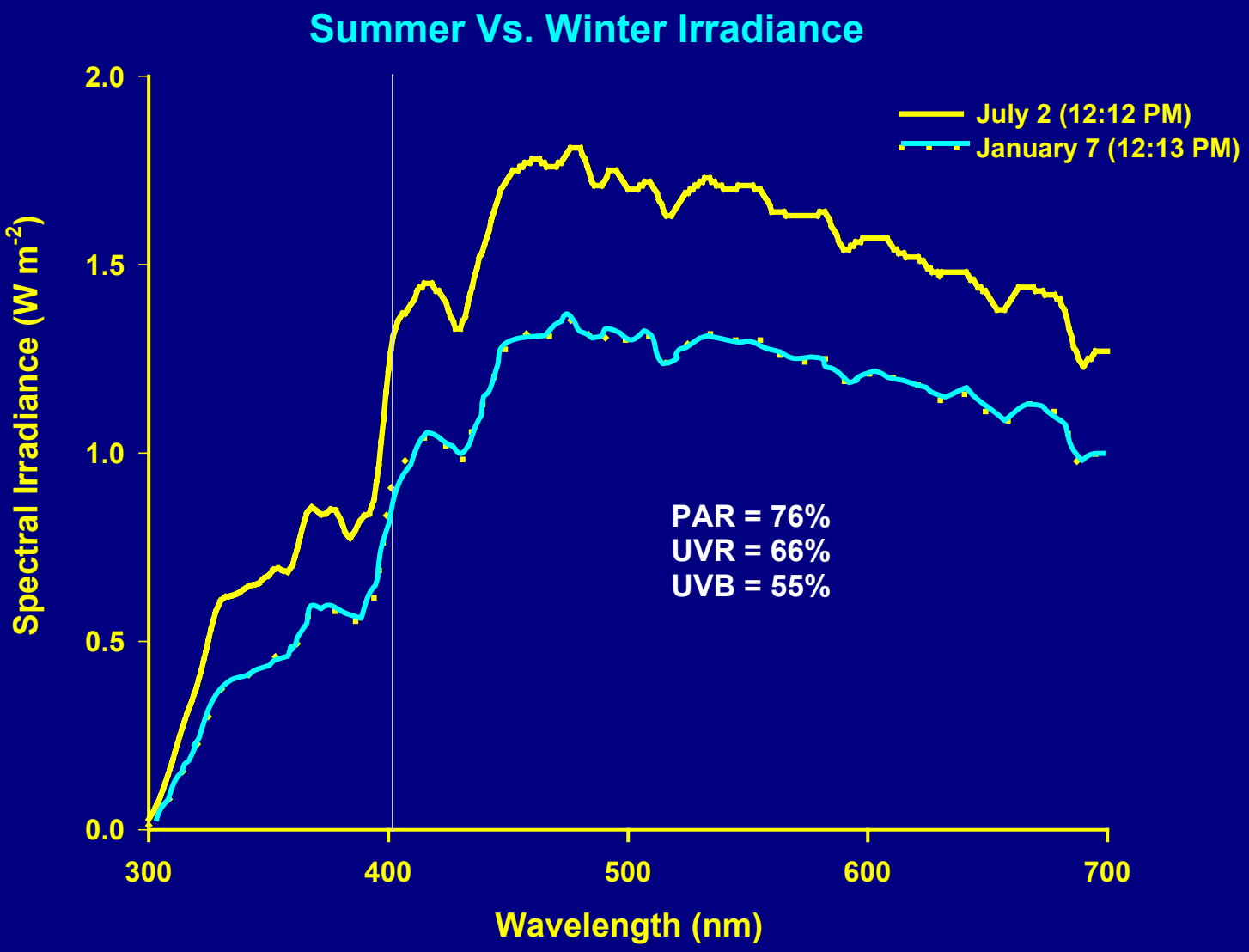
- An annual cycle in MAAs and pigments
- Colony-specific patterns in MAAs and UVR response
- Effects of UVR on coral recruitment
- Thoughts on future experiments using CREWS data

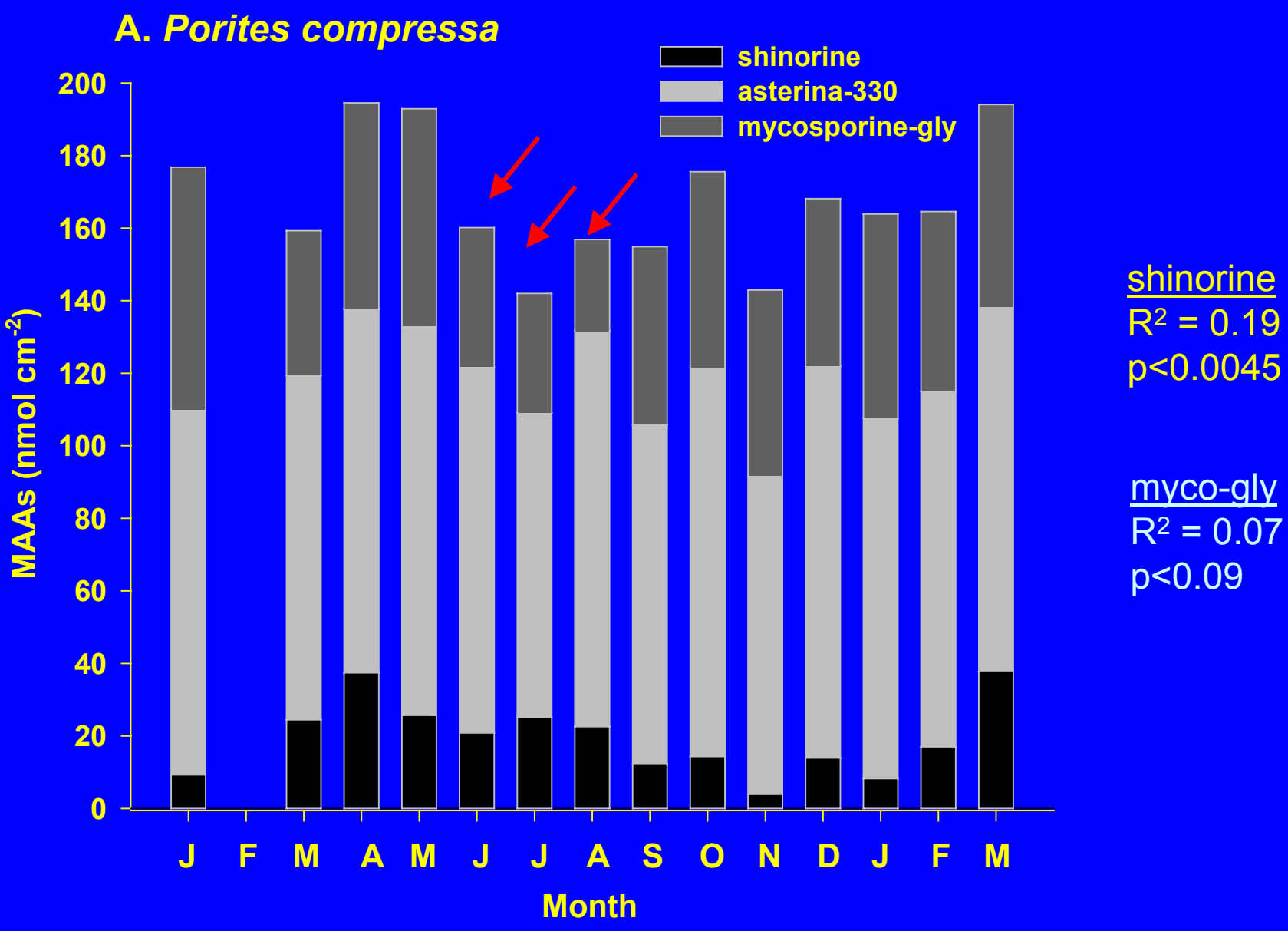
I. Is there a seasonal cycle in MAA concentration or photosynthetic pigments?




Kaneohe Bay reef flat
N = 3 samples collected monthly from <1 m depth
Porites compressa
Montipora verrucosa

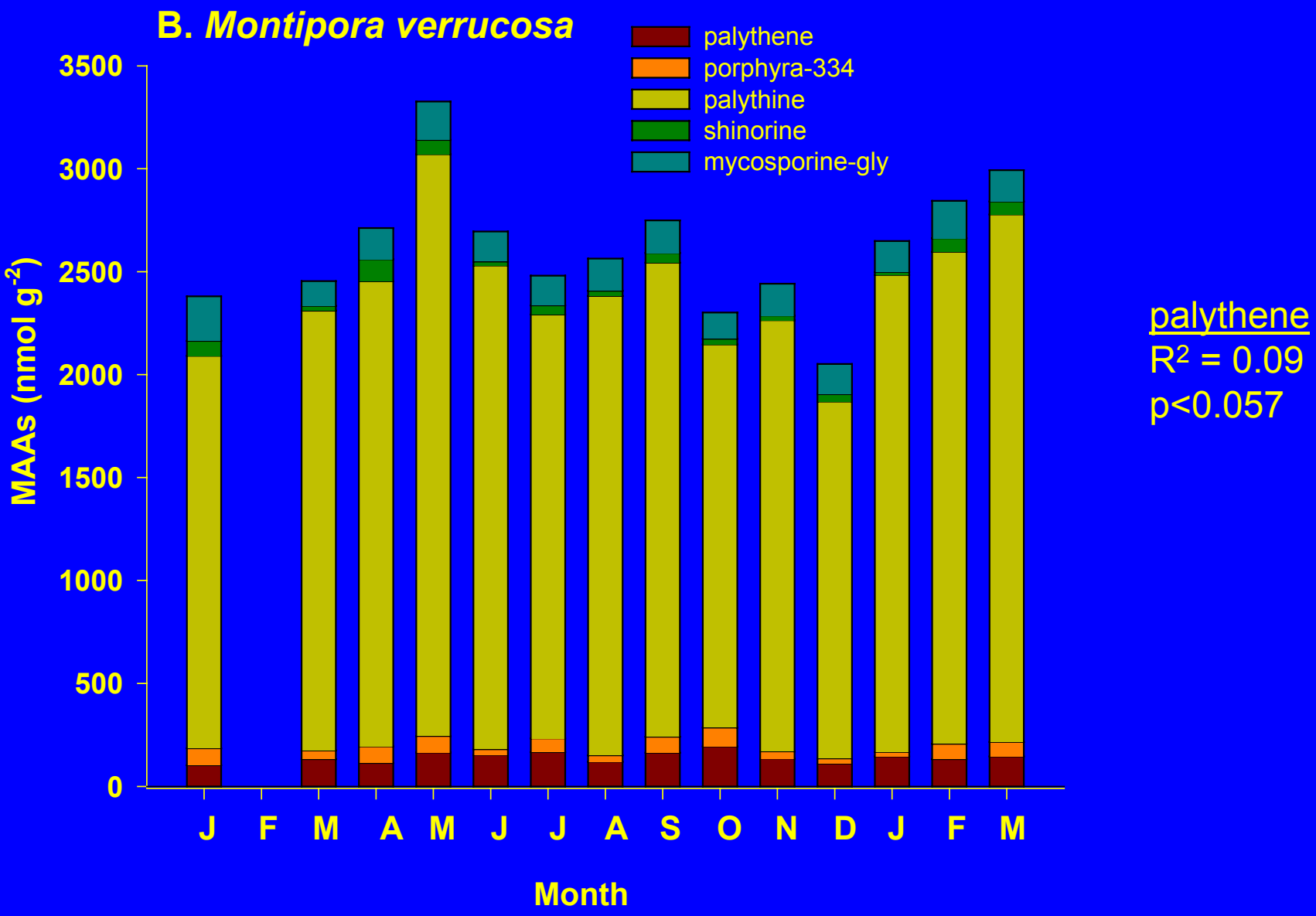

Annual cycle in UV Radiation
UVR J cm-2 day-1
200
180
160
140
120
100
80
60
40
20
0
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
1998
Month
1999


Summer Vs. Winter Irradiance
July 2 (12:12 PM)
January 7 (12:13 PM)
PAR = 76%
UVR = 66%
UVB = 55%
Spectral Irradiance (W m-2)
2.0
1.5
1.0
0.5
0.0
300
400
500
600
700
Wavelength (nm)

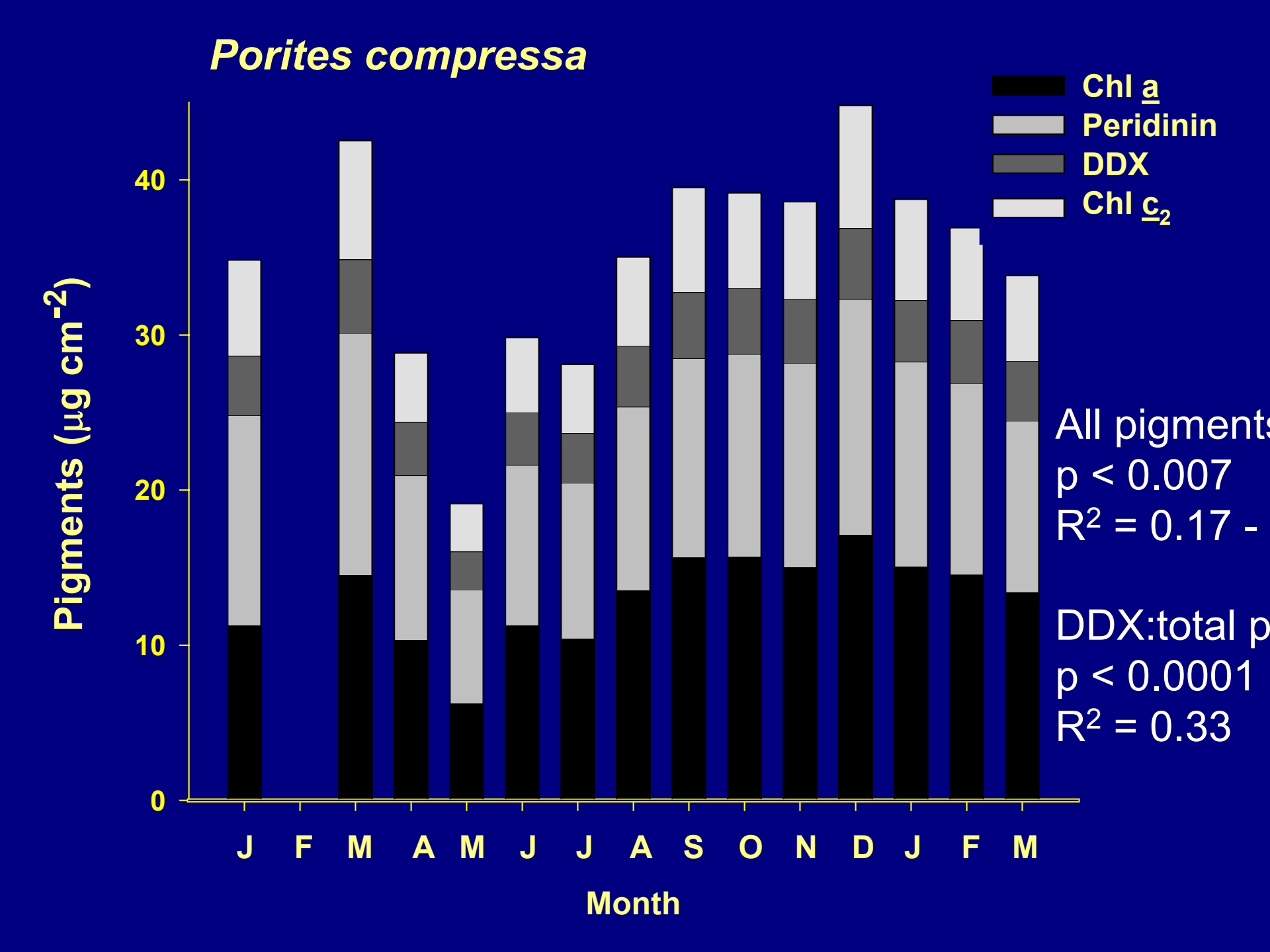


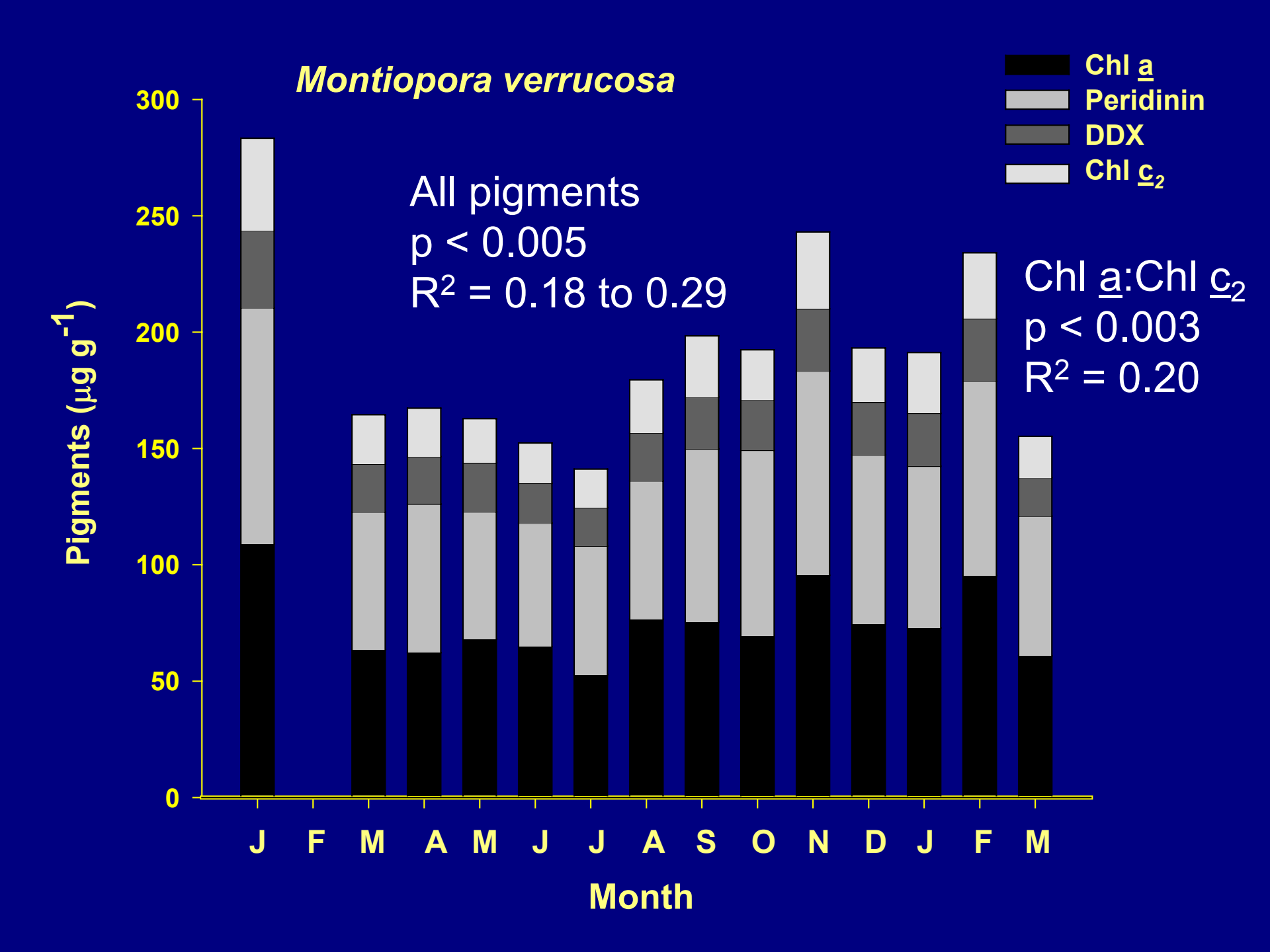
shinorine
$R^2 = 0.19$
$p<0.0045$

myco-gly
$R^2 = 0.07$
$p<0.09$



palythene
$R^2 = 0.09$
$p<0.057$


Porites compressa
Chl a
Peridinin
DDX
Chl c2
Pigments (µg cm-2)
0
10
20
30
40
J
F
M
A
M
J
J
A
S
O
N
D
J
F
M
Month
All pigments
p < 0.007
R2 = 0.17 -
DDX:total p
p < 0.0001
R2 = 0.33


Montiopora verrucosa
Chl a
Peridinin
DDX
Chl c2
All pigments
p < 0.005
R2 = 0.18 to 0.29
Chl a:Chl c2
p < 0.003
R2 = 0.20
Pigments (µg g-1)
300
250
200
150
100
50
0
J F M A M J J A S O N D J F M
Month

Conclusions I

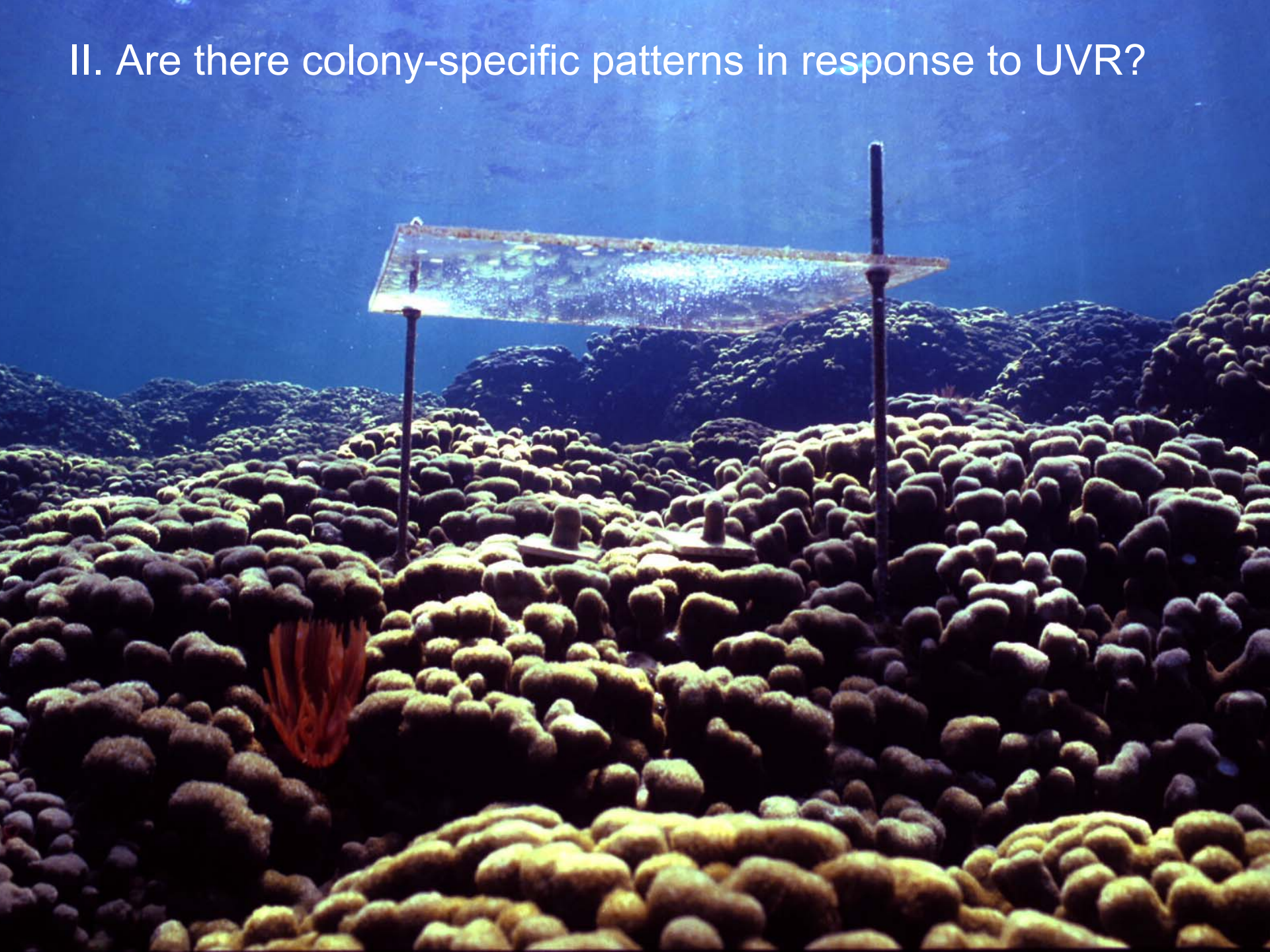
- Two MAAs exhibited a positive relationship with UVR exposure.
  - shinorine in *P. compressa* – Nov. value was 10% of March value
  - palythene in *M. Verrucosa* – Dec. value was 61% of May value

- [mycosporine-gly] decreased during summer months in *P. compressa* (antioxidant role?)

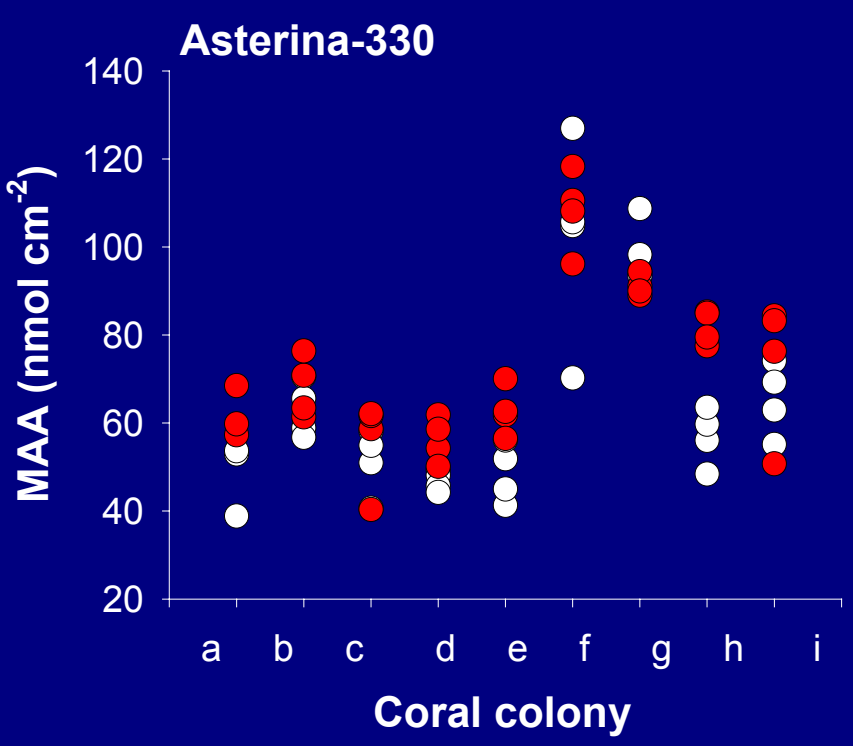
Conclusions I

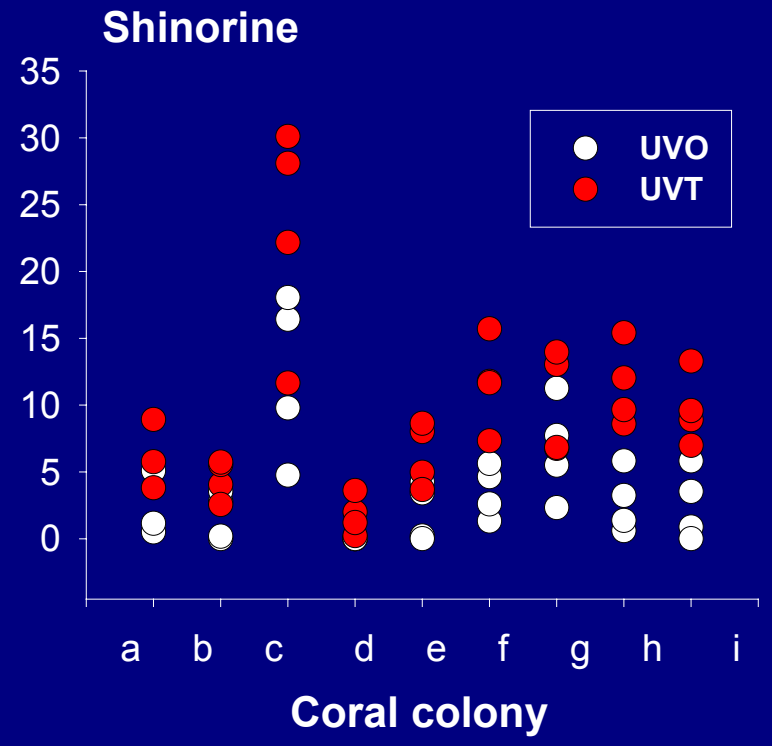
- Photosynthetic pigments increased in winter months (roughly doubled).
- Proportion of diadinoxanthin increased in the summer for *P. compressa* (up-regulation of xanthophyll cycle?)
- Chl a:Chl c_2 ratio decreased in winter months for *M. verrucosa*.

II. Are there colony-specific patterns in response to UVR?



Colony-specific patterns in MAA composition



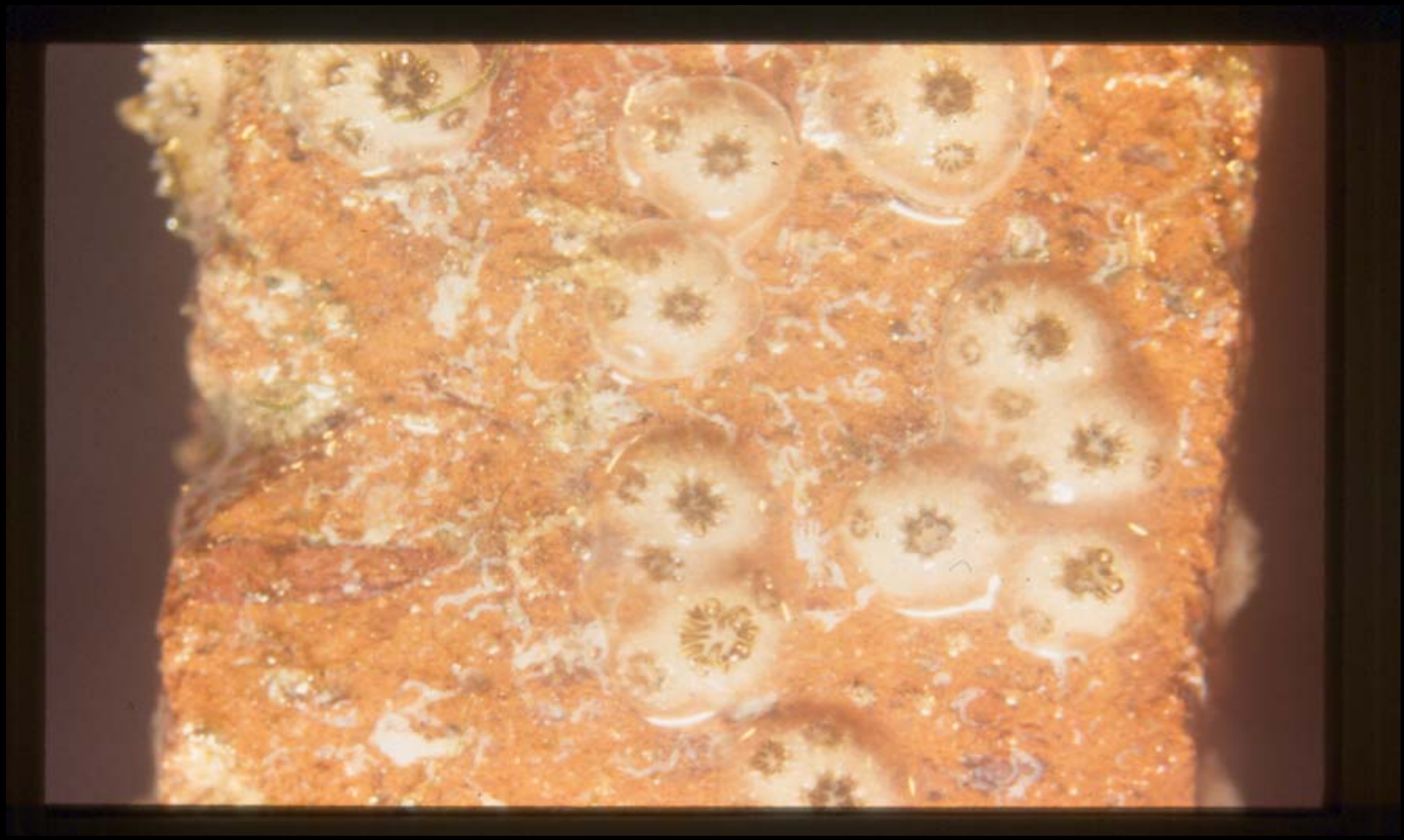


Conclusions II

- [MAA] was positively affected by UVR, however…

- There were marked colony-specific patterns in MAA composition and response to UVR

III. How does UVR affect coral recruitment?



Pocillopora damicornis Larvae

Experiment I

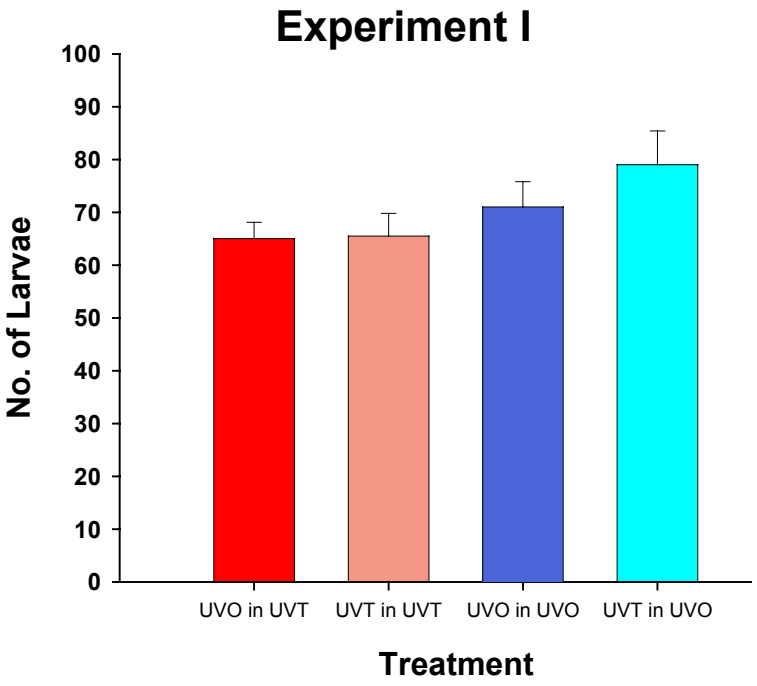
Treatment

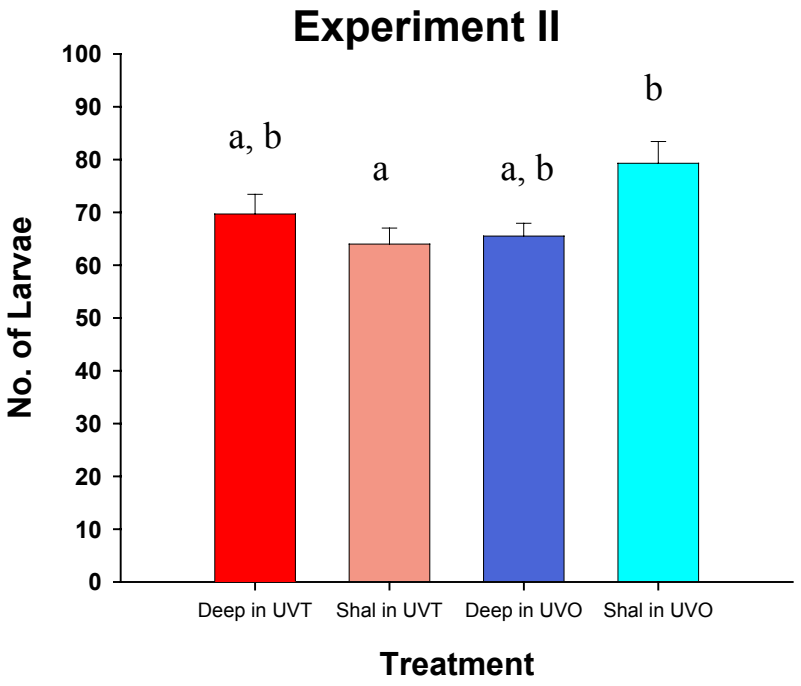
Origin	UVT	UVO
UVT	N = 4	N = 4
UVO	N = 4	N = 4

Experiments II & III

	UVT	UVO
Shallow	N = 4	N = 4
Deep	N = 4	N = 4

Survival of *P. damicornis* larvae

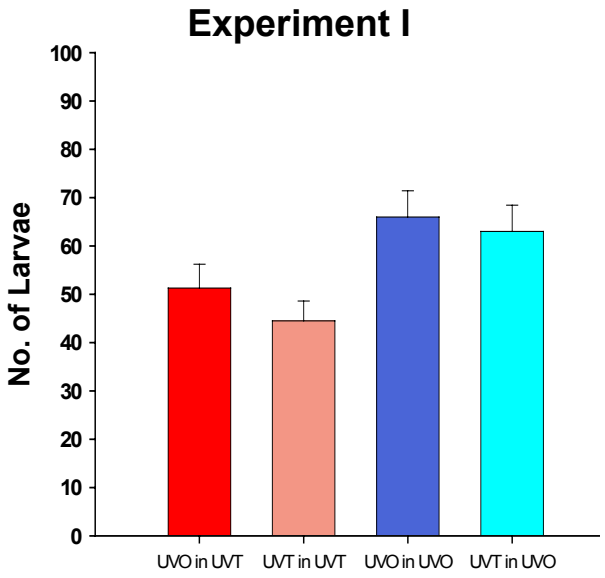


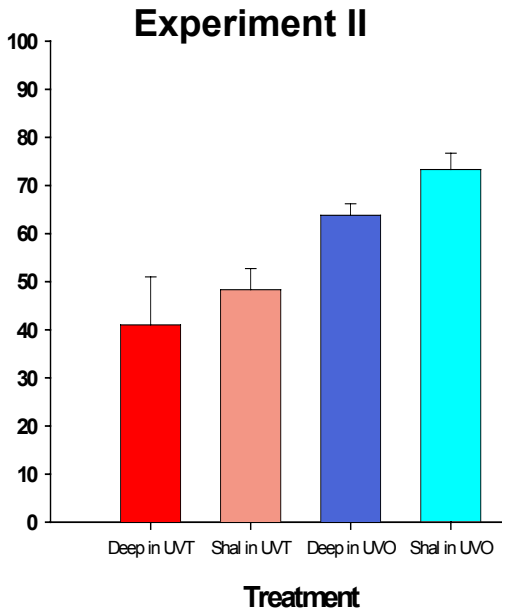


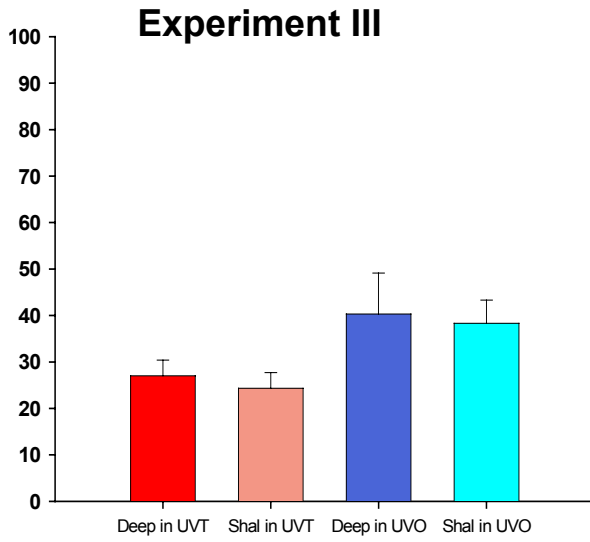
UVR	**p < 0.07**
Origin	**p < 0.39**
UVR x Origin	**p < 0.45**

UVR	**p < 0.12**
Origin	**p < 0.24**
UVR x Origin	**p < 0.014**

Recruitment of *P. damicornis* larvae







UVR	**p < 0.0059**	**p < 0.0012**	**p < 0.032**
Origin	**p < 0.35**	**p < 0.15**	**p < 0.68**
UVR x Origin	**p < 0.71**	**p < 0.83**	**p < 0.95**

Conclusions III

- The presence of UVR had a negative effect on recruitment of *Pocillopora damicornis* larvae regardless of where the larvae came from

- Larval MAA concentrations within the range tested here did not have an effect on recruitment

IV. Thoughts on future experiments using CREWS data

- the UVR data are critical
- the down-welling irradiance data are critical

I. *In situ* shading experiment during natural bleaching event in proximity to CREWS station