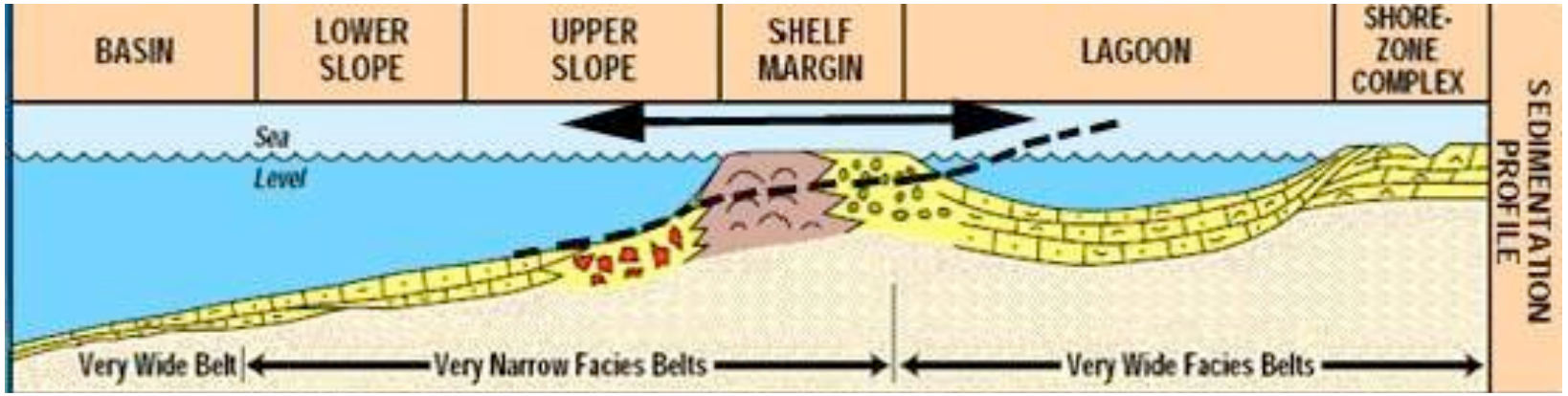
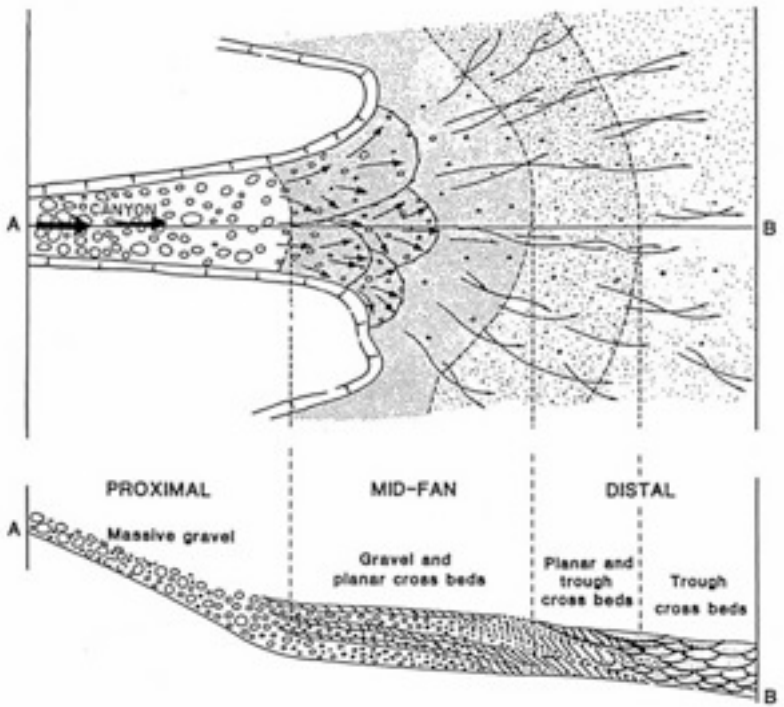
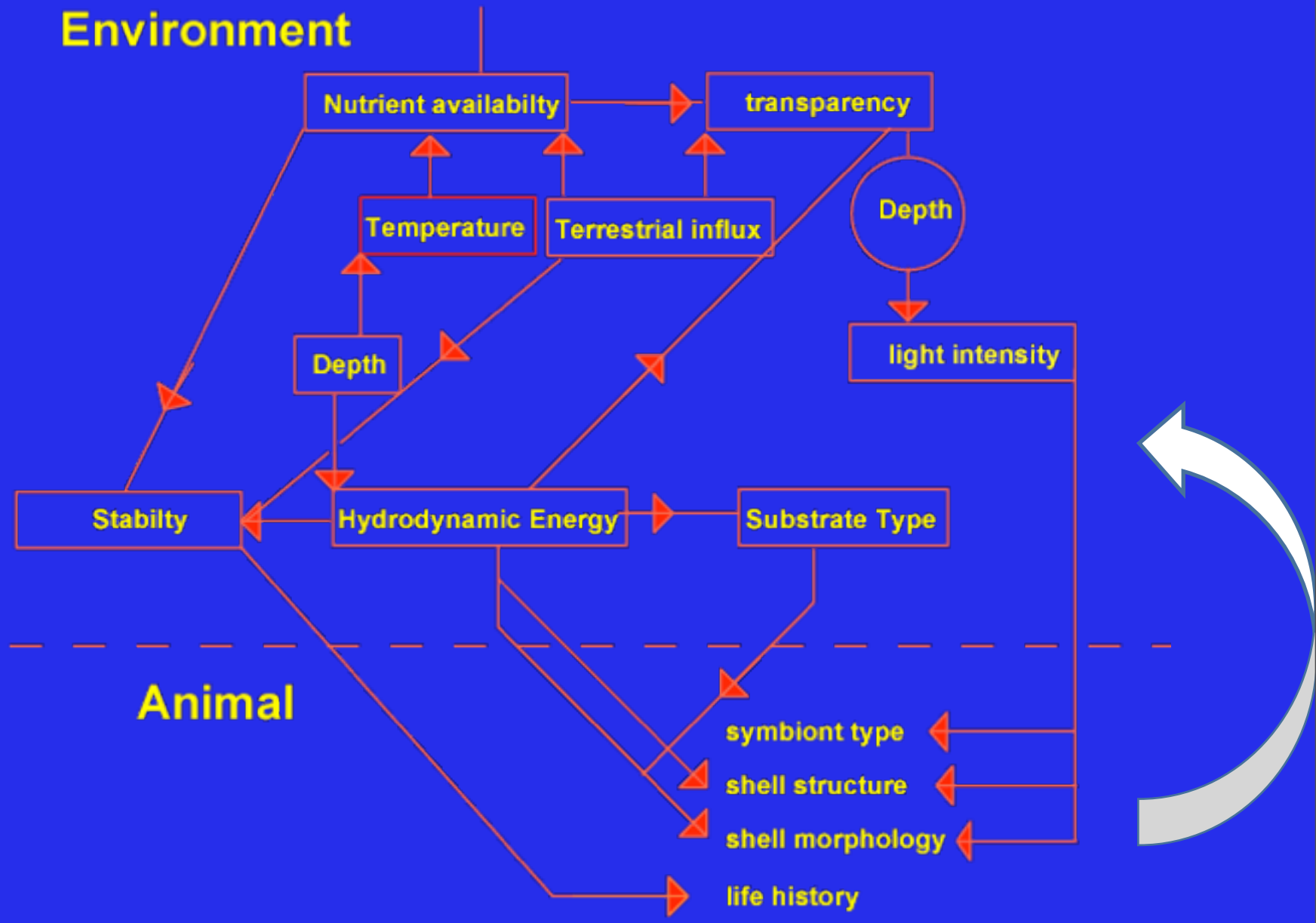
Mixed carbonate- silliciclastic shallow marine facies


BASIN
LOWER SLOPE
UPPER SLOPE
SHELF MARGIN
LAGOON
SHORE-ZONE COMPLEX
SEDIMENTATION PROFILE
Sea Level
Very Wide Belt
Very Narrow Facies Belts
Very Wide Facies Belts


A
CANYON
B
PROXIMAL
MID-FAN
DISTAL
A
Massive gravel
Gravel and planar cross beds
Planar and trough cross beds
Trough cross beds
B


Environment
Nutrient availabilty
transparency
Temperature
Terrestrial influx
Depth
Depth
light intensity
Stabilty
Hydrodynamic Energy
Substrate Type
Animal
symbiont type
shell structure
shell morphology
life history

Nationaal
Natuurhistorisch
Museum

Foraminifera (1)

What are foraminfera?

Nationaal
Natuurhistorisch
Museum

Foraminifera (1)

What are foraminfera? single celled organisms with tests

Foraminifera (1)

What are foraminfera? single celled organisms with tests

Technical definition: single celled organisms with pseudopodia showing bidirectional flow, which are used to attach, and to gather food

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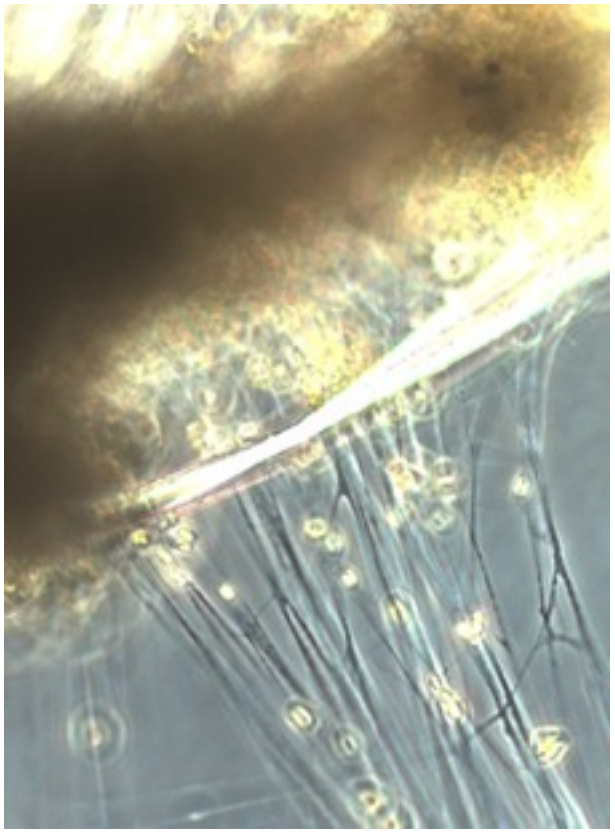

Foraminifera (1)

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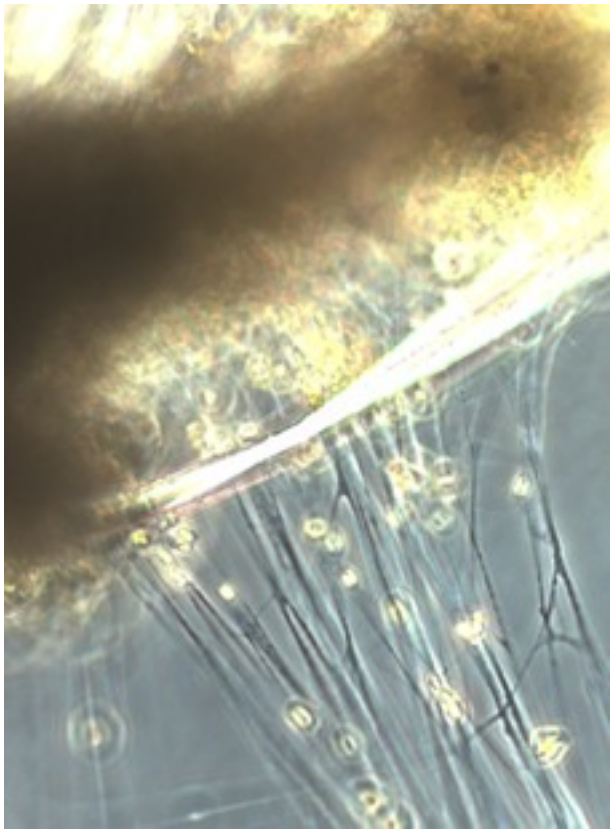
Technical definition: single celled organisms with pseudopodia showing bidirectional flow, which are used to attach, and to gather food



Nationaal
Natuurhistorisch
Museum

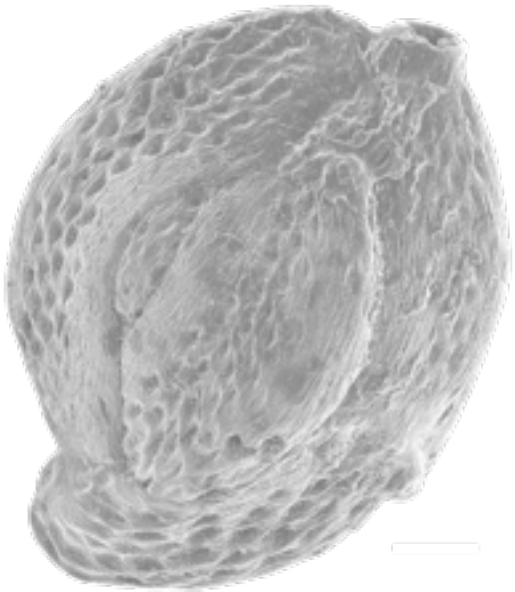
Foraminifera (4)

Nationaal
Natuurhistorisch
Museum

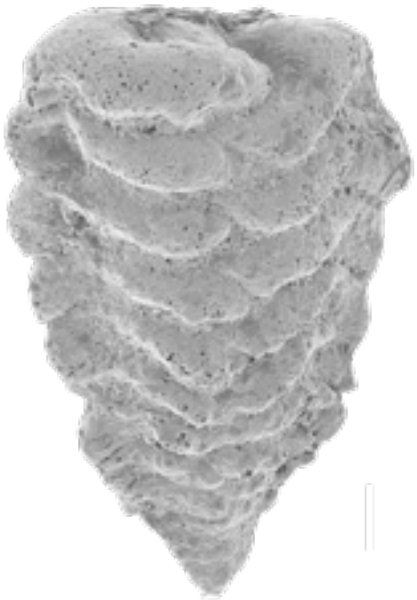
Foraminifera (4)

Perforate

Imperforate



Aglutinated

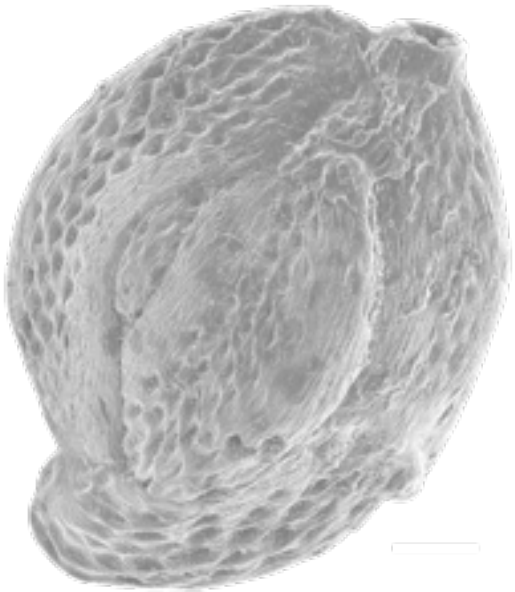


Nationaal
Natuurhistorisch
Museum

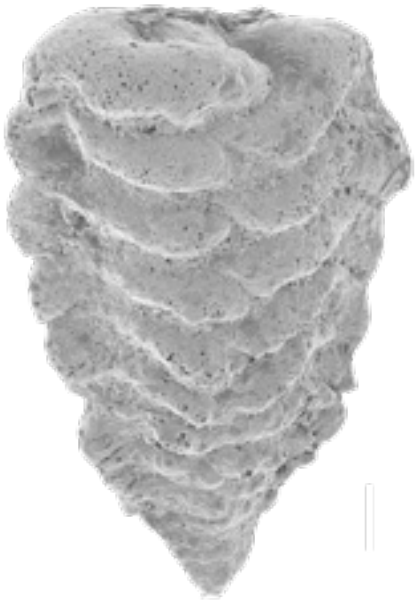
Foraminifera (4)

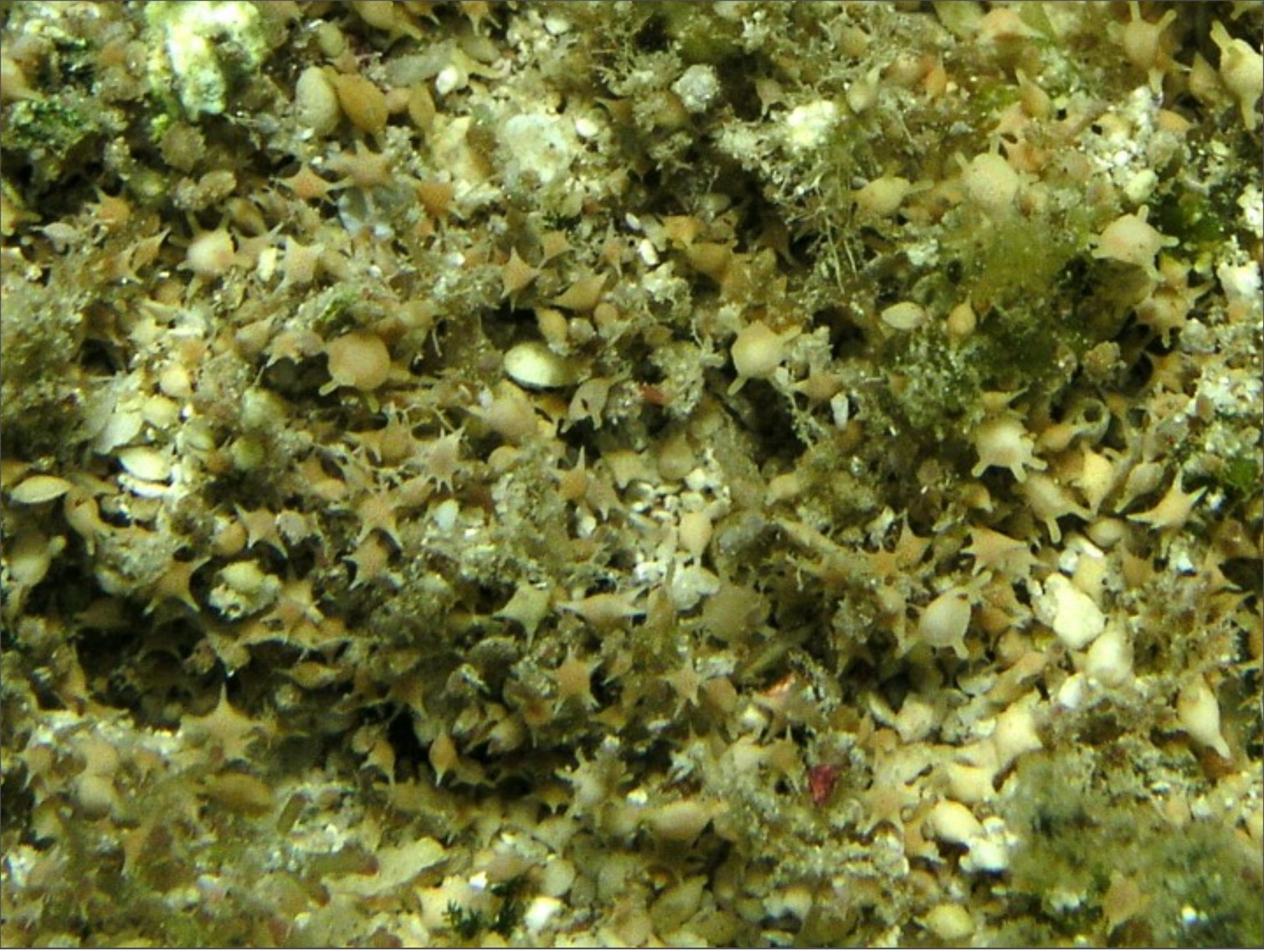
Perforate

Imperforate

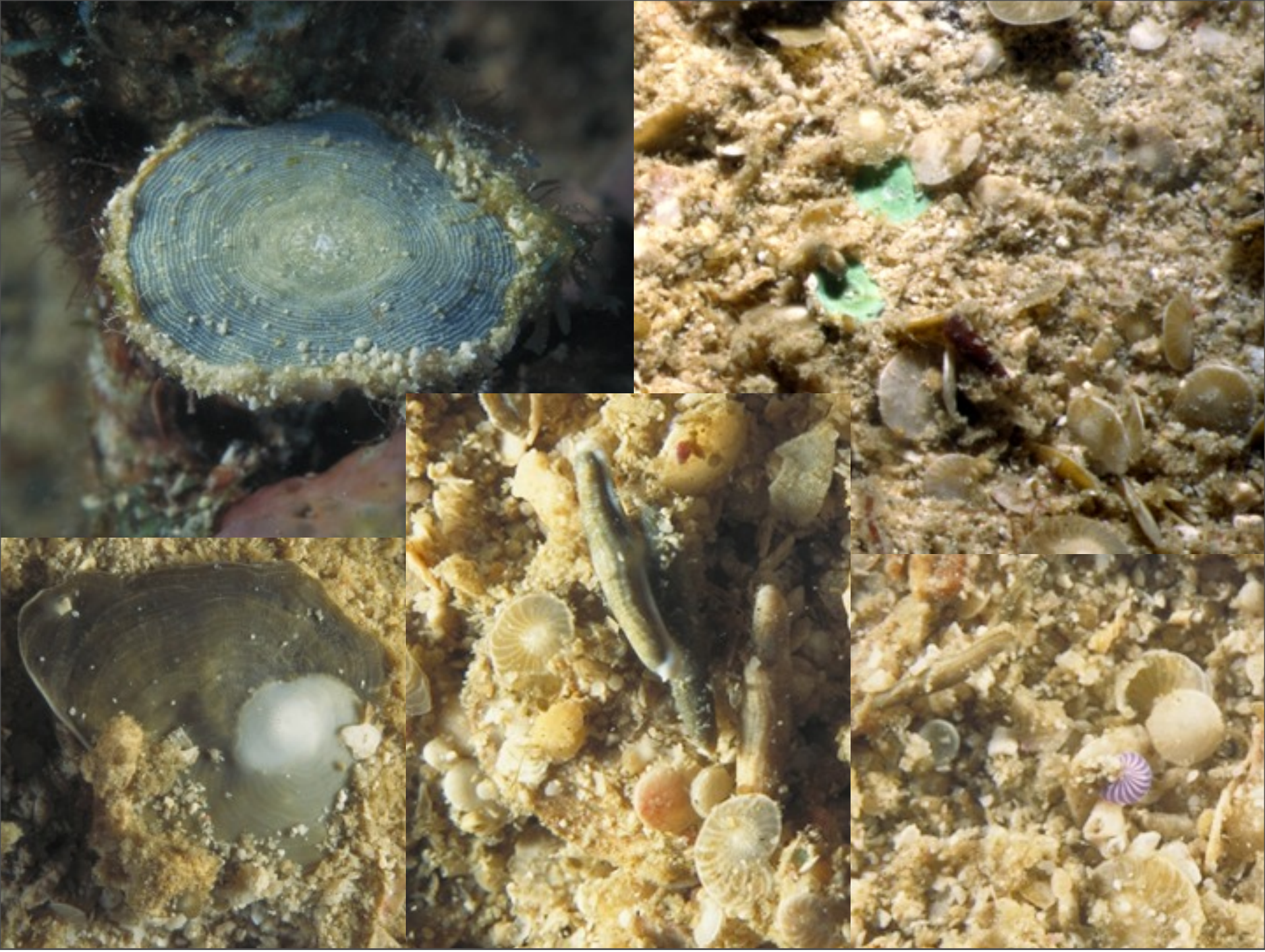


Aglutinated





Friday, 7 October 2011



Friday, 7 October 2011

What is different between open marine (no influence of terrestrial run-off) and coastal carbonate settings?

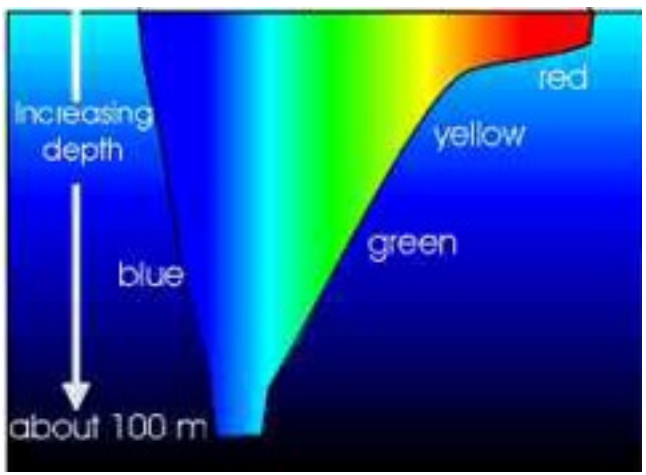
1) Light

2) Seasonality

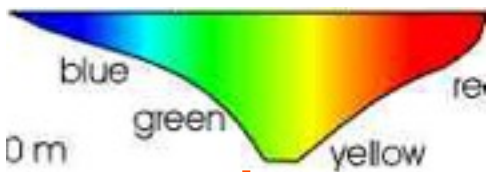
3) Nutrients

Irradiance and light spectrum

1. **Incident solar radiation**
2. **Optical properties of the water**
3. **Presence of dissolved organic matter**
4. **Macrophyte components and sediment type (coastal waters)**



clear water (e.g. open ocean)



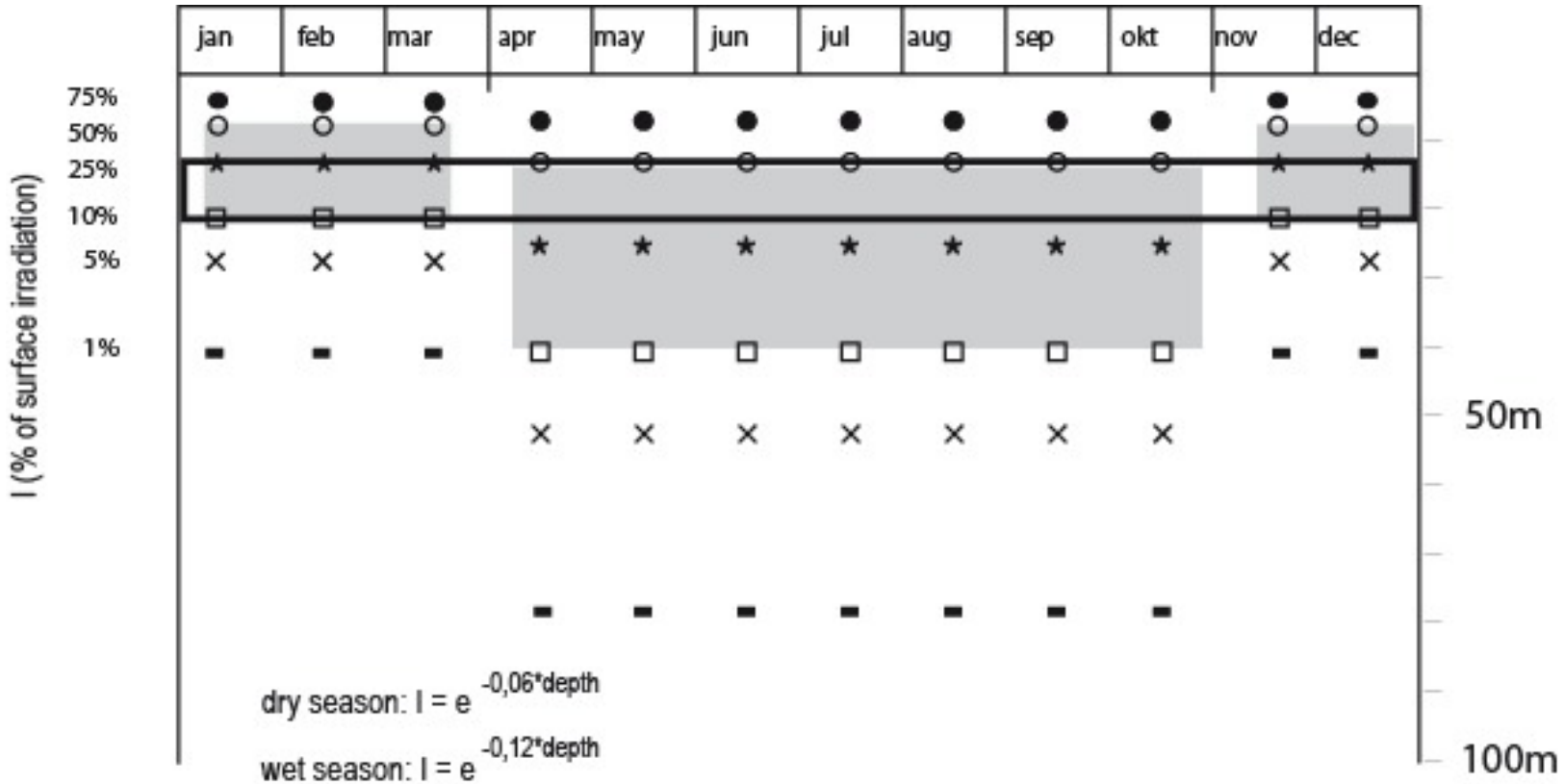
coastal marine

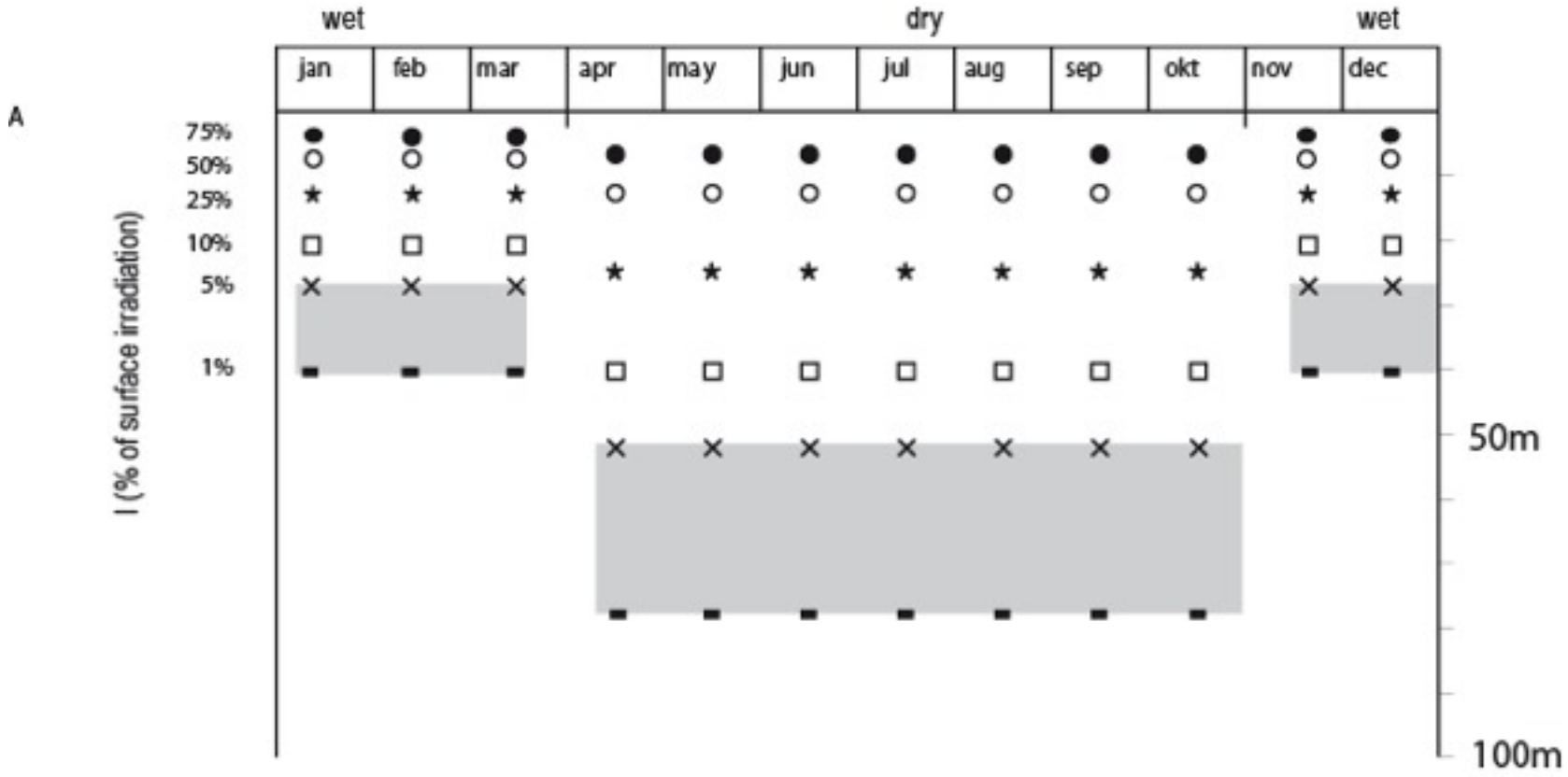
estuarine

Light spectrum used by rhodophytes

Kirk, 1994

Seasonality

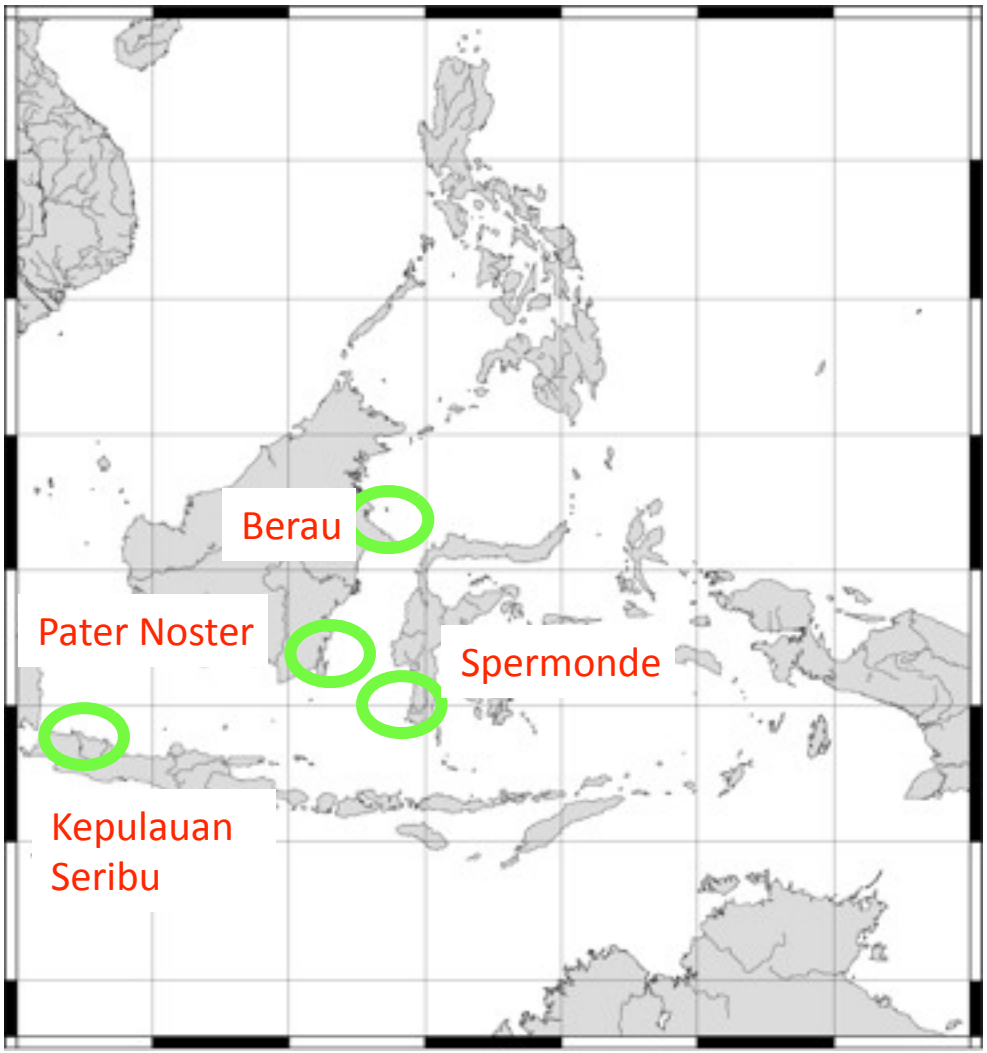




Obligate mixotrophic organisms cannot survive: increase of

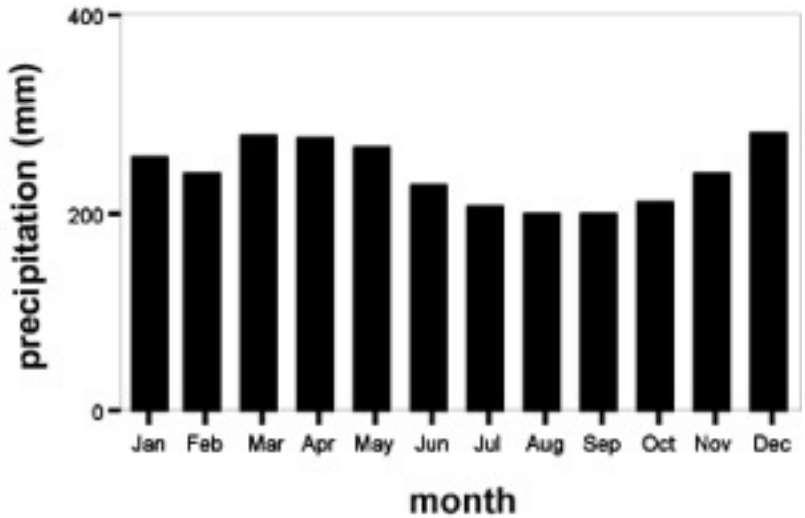
Nutrients

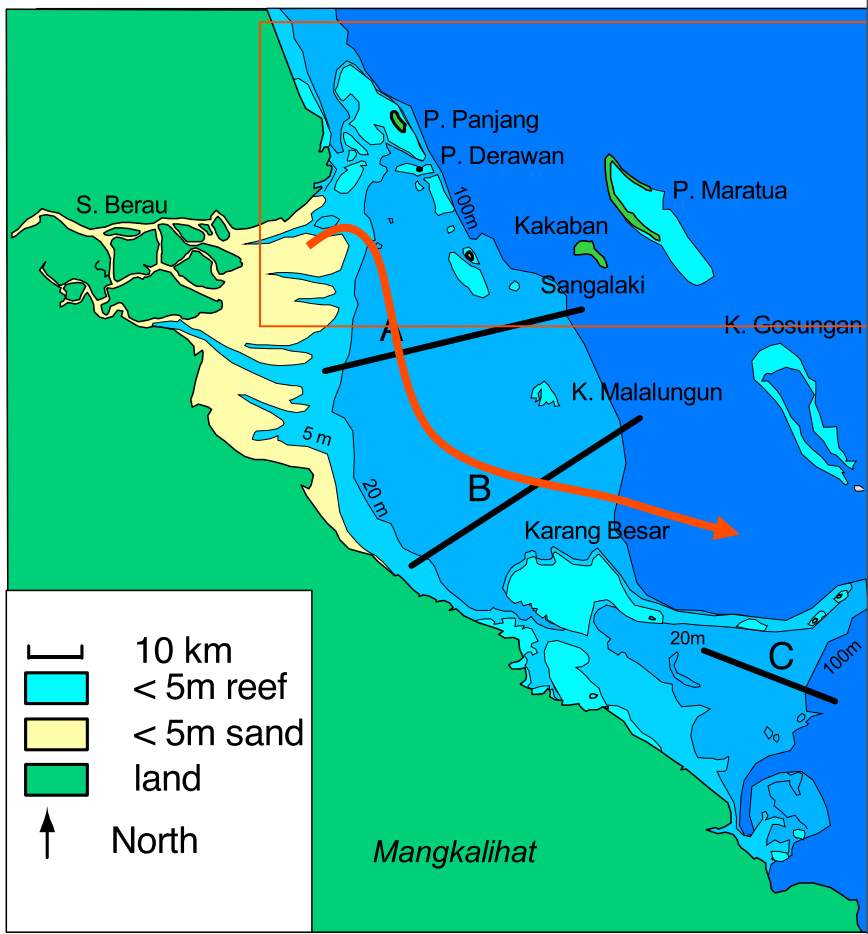
Case studies



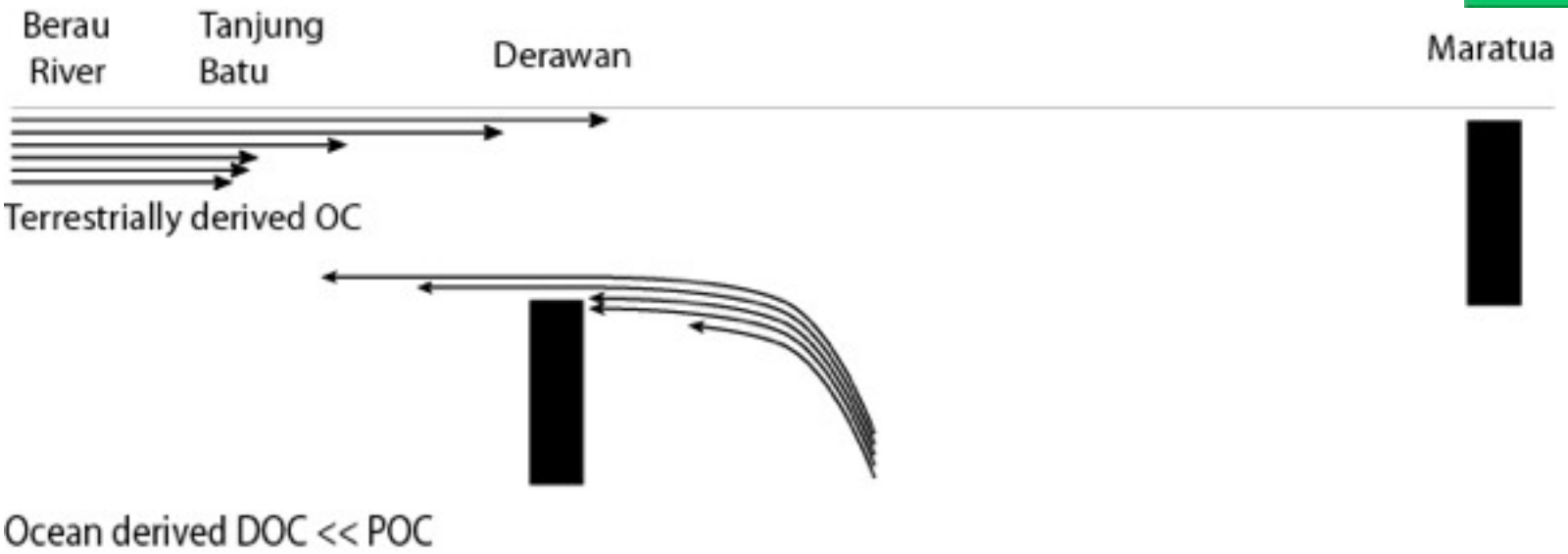
Berau

- Rimmed shelf, 50 km whide
- Barrier interrupted
- rimmed shelf, 50 km whide



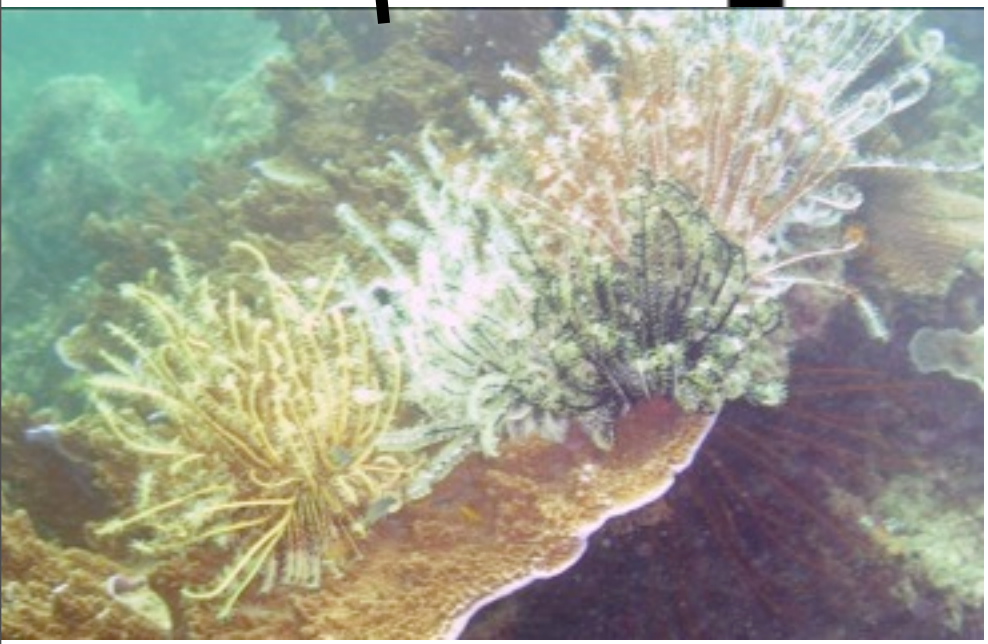


Nutrients

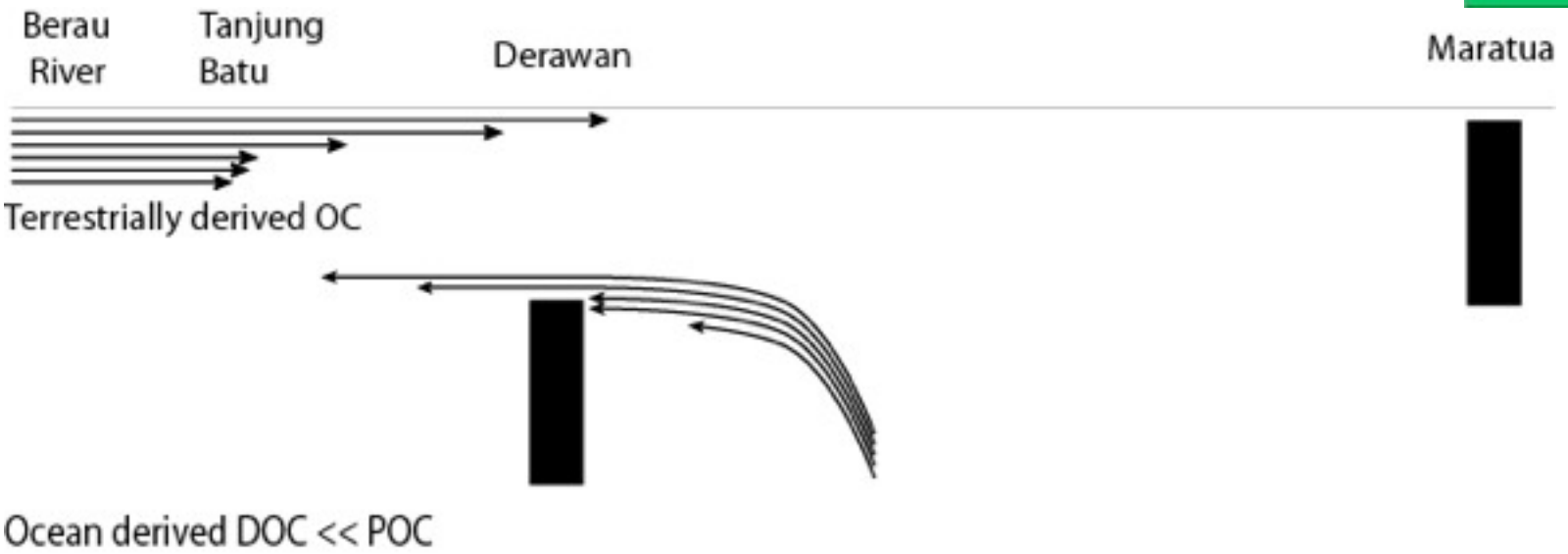

Berau River
Tanjung Batu
Derawan
Maratua
Terrestrially derived OC
Ocean derived DOC << POC

Nutrients

Berau
River
Tanjung
Batu
Derawan
Maratua
Terrestrially derived OC



Nutrients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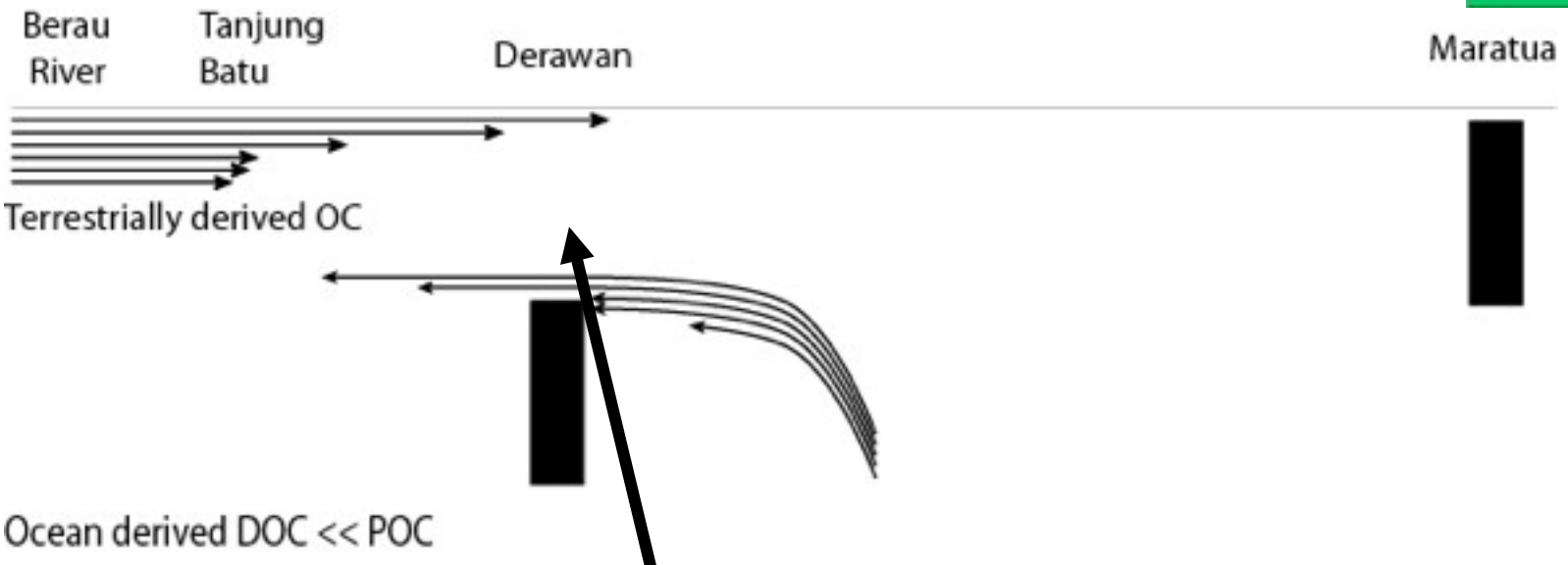
Nutrients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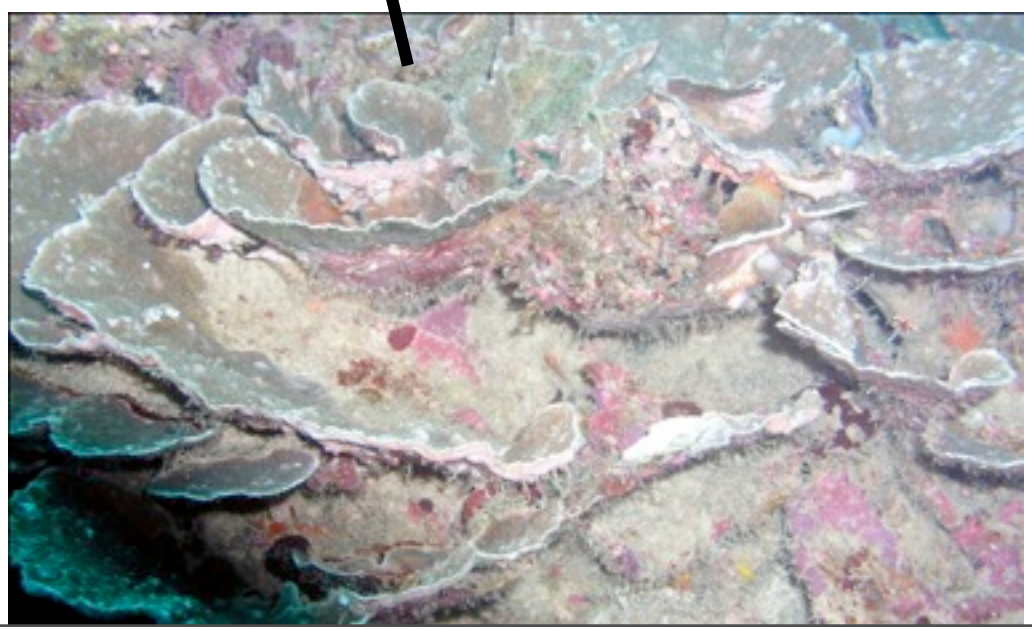
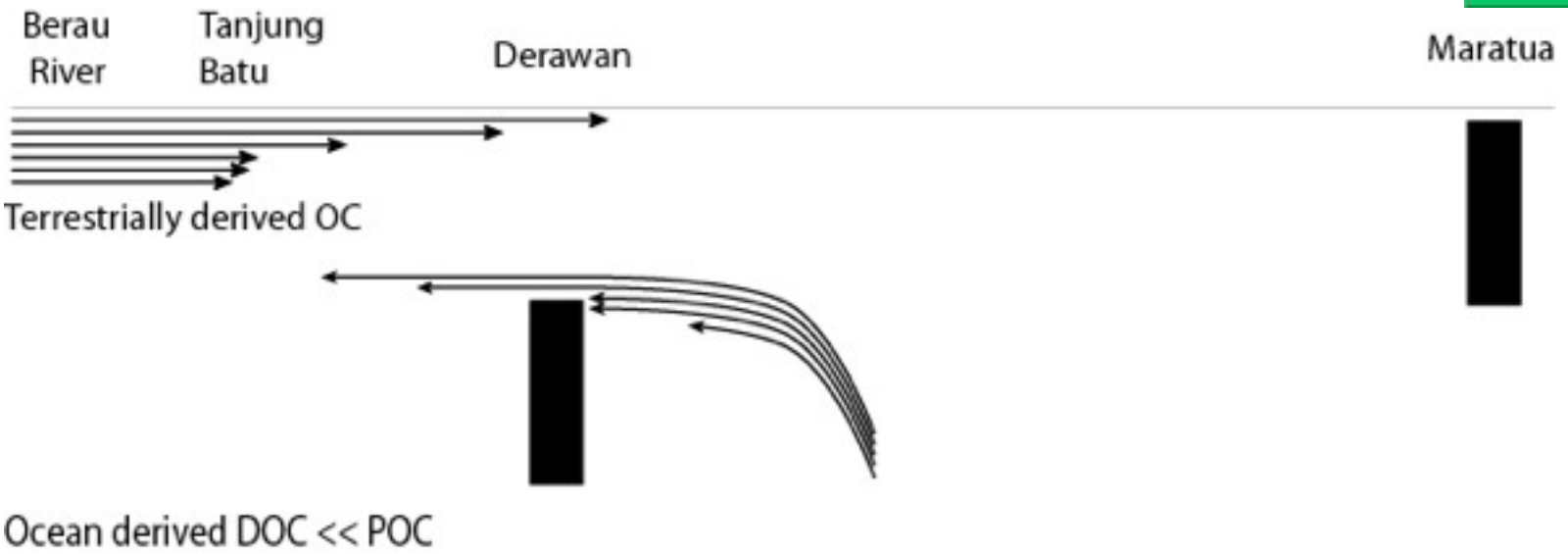


Nutrients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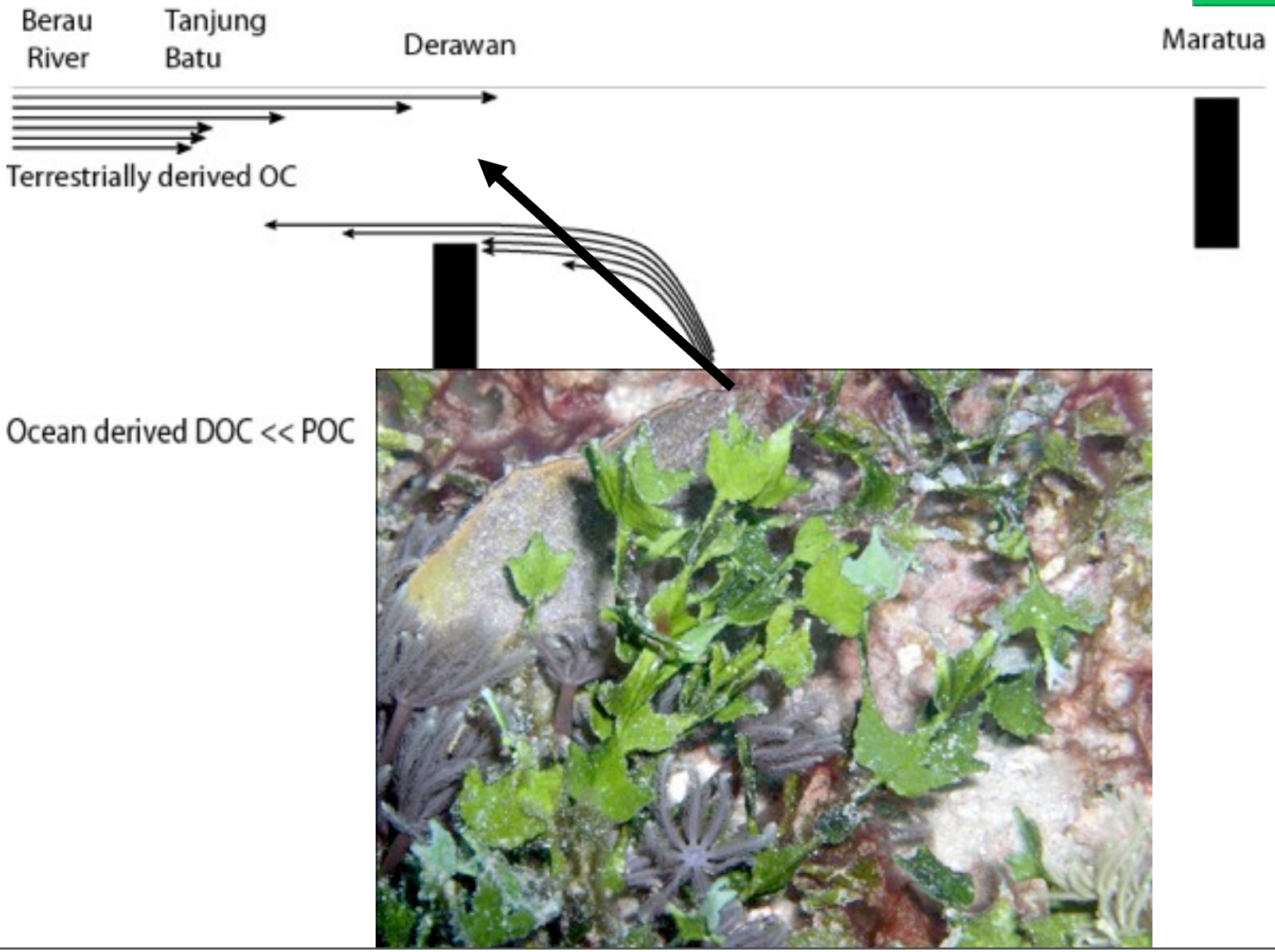
Nutrients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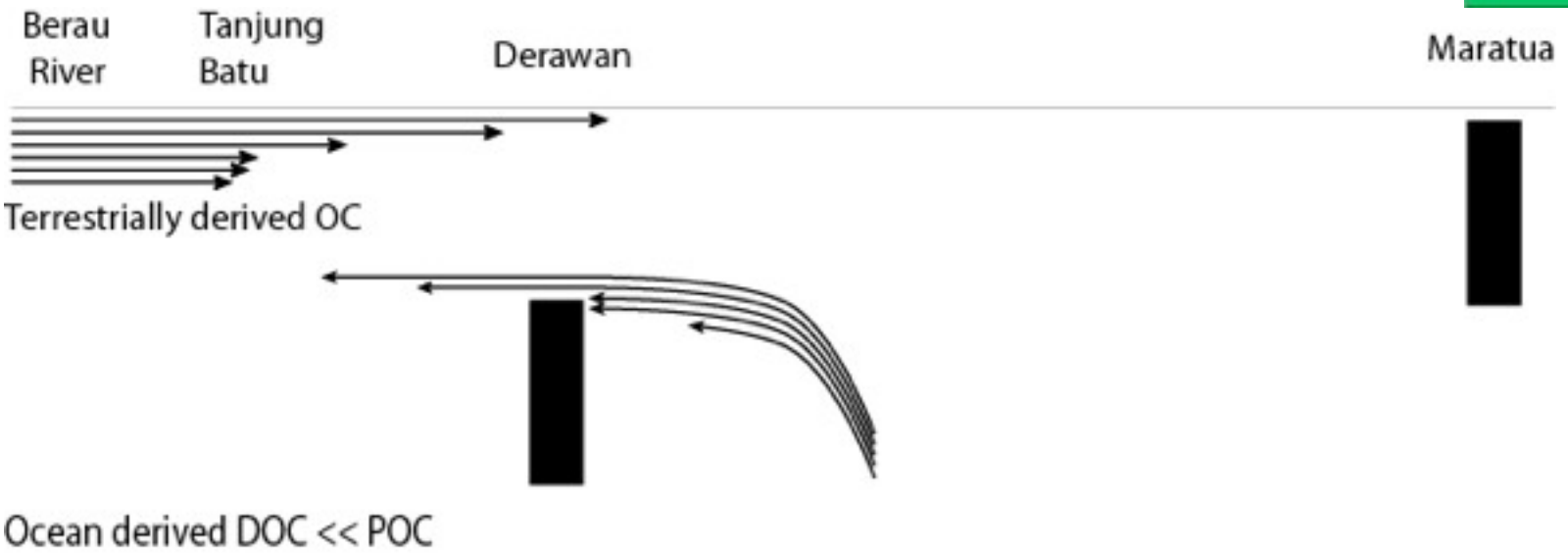
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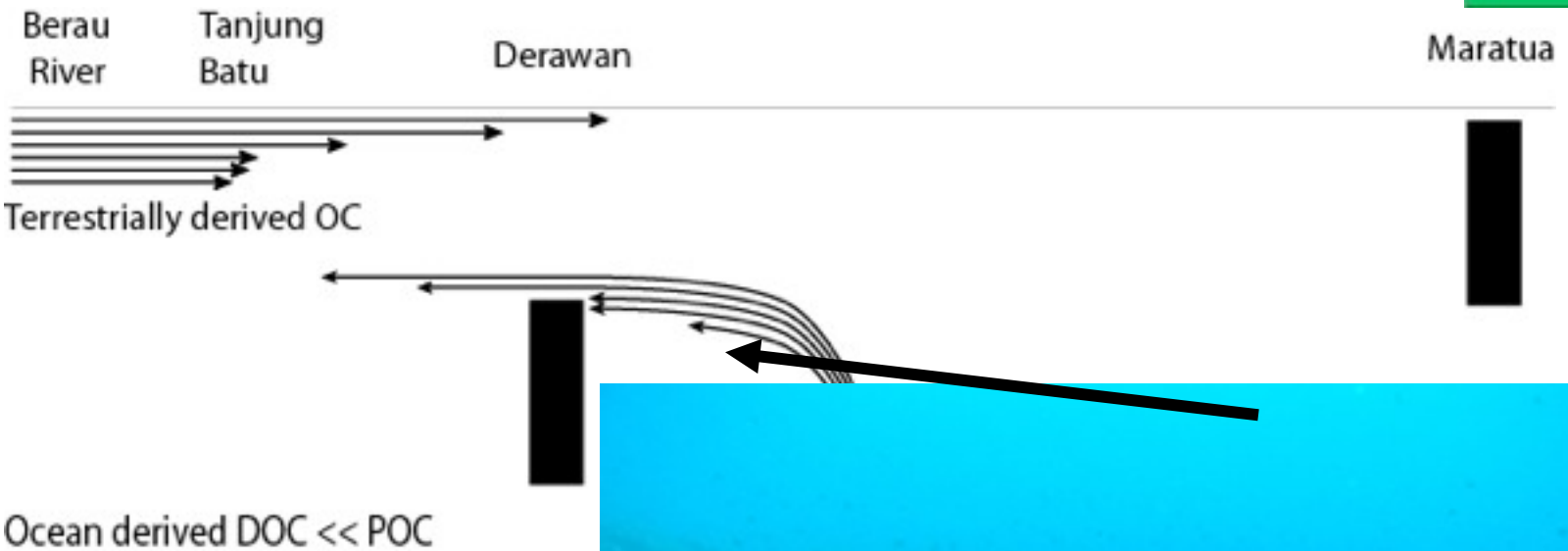
Nutrients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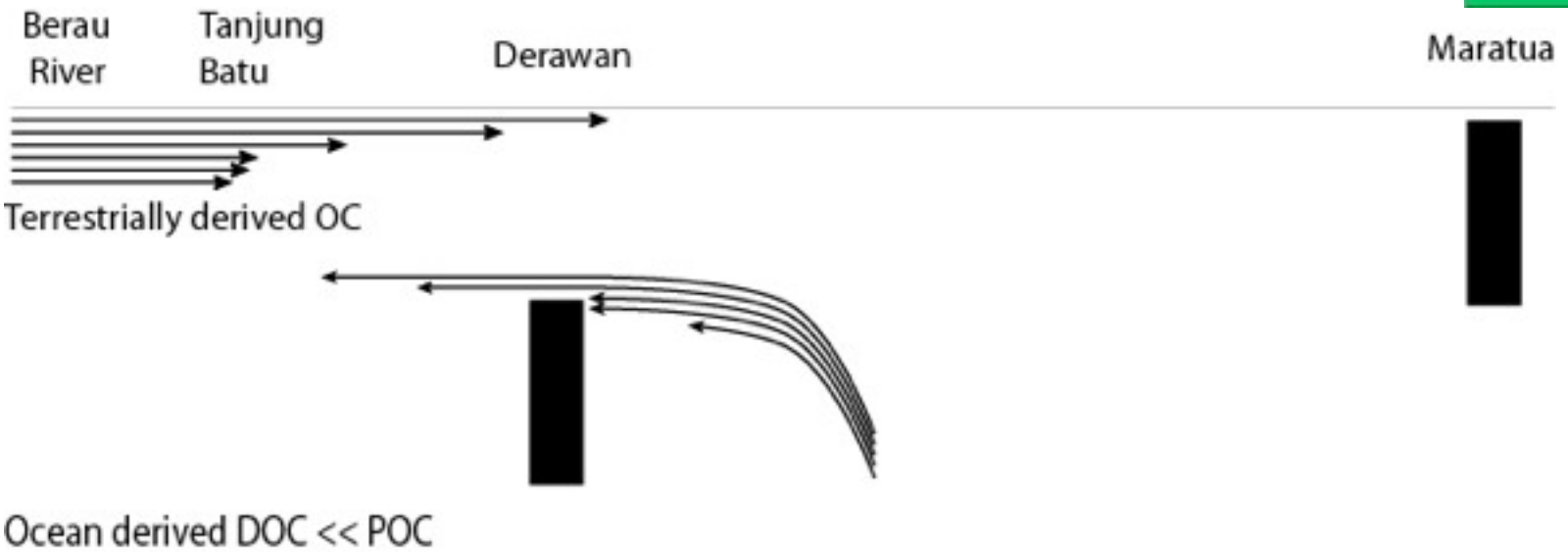
Nutrients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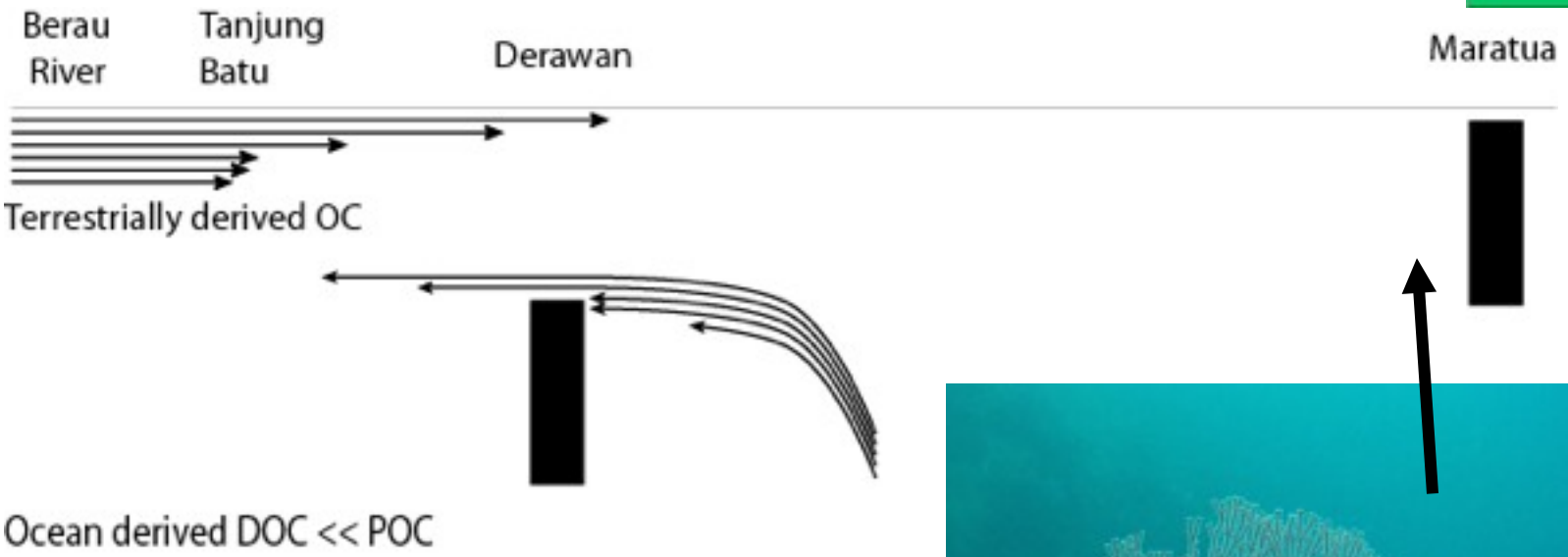
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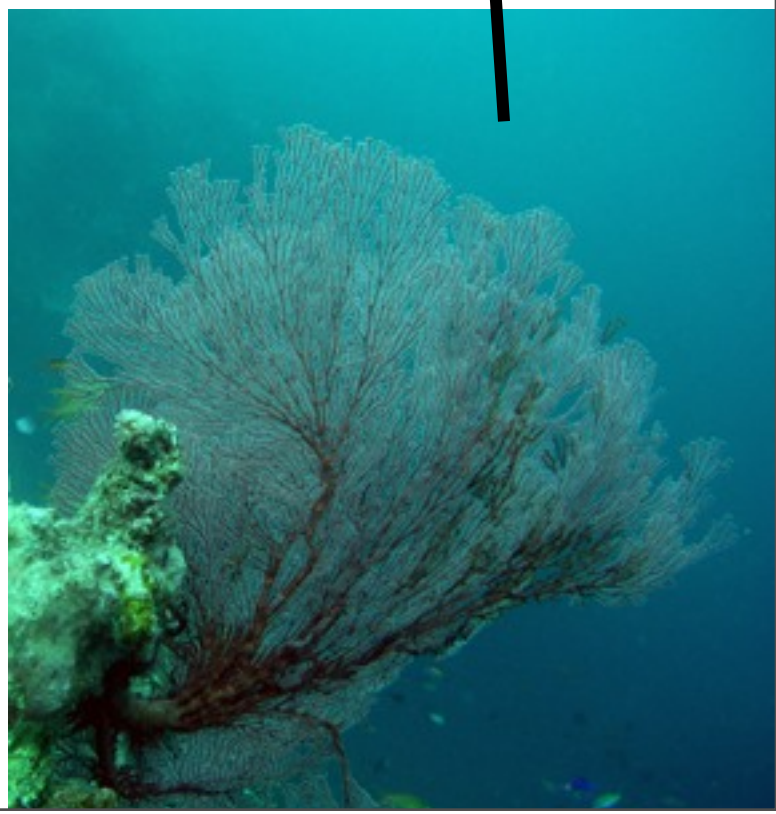
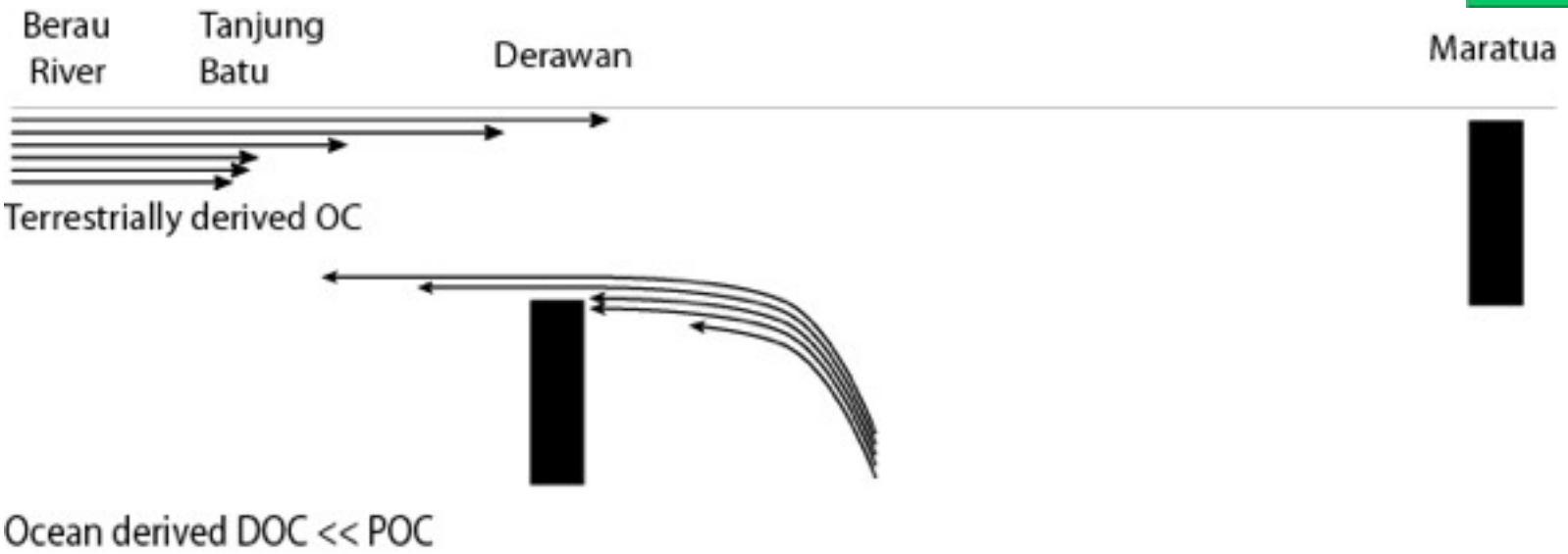


Nutrients



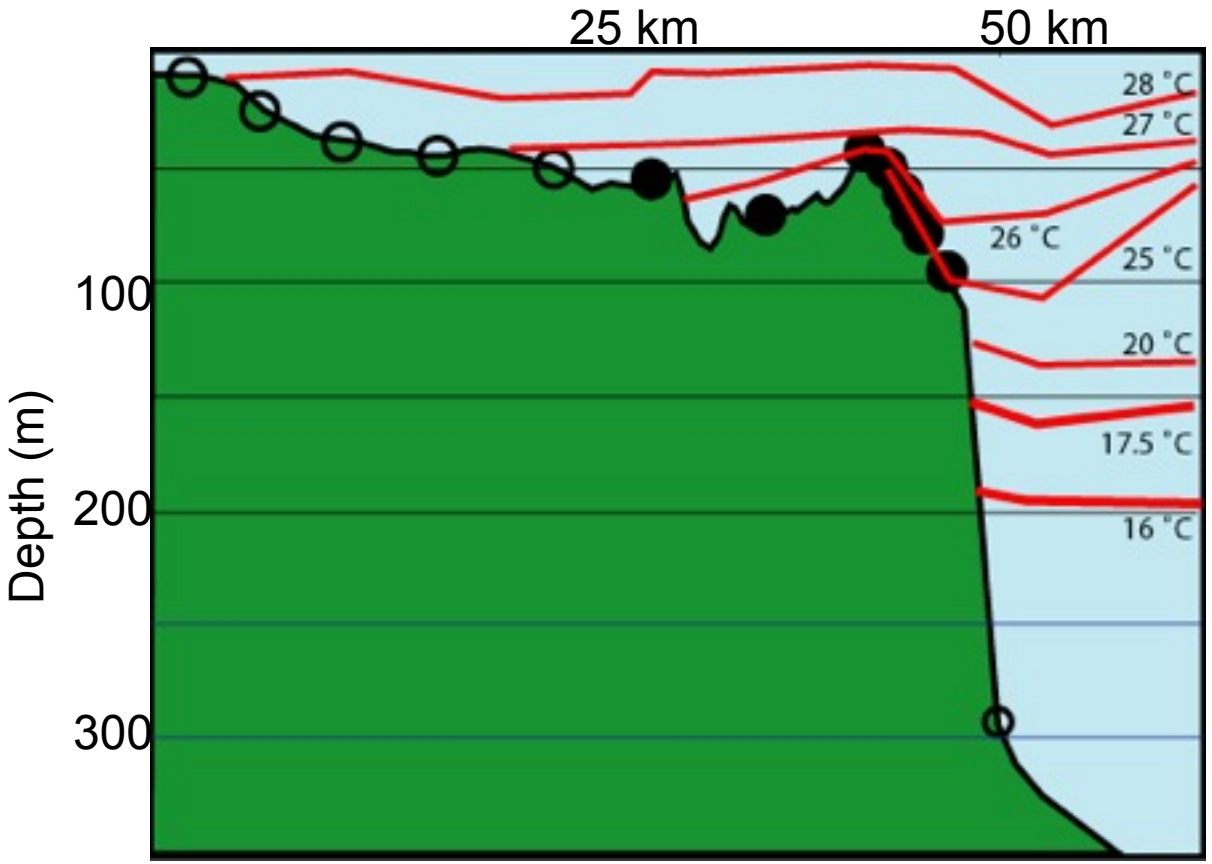
In surface water: high POC

Consumption in benthic boundary layer
About 50%

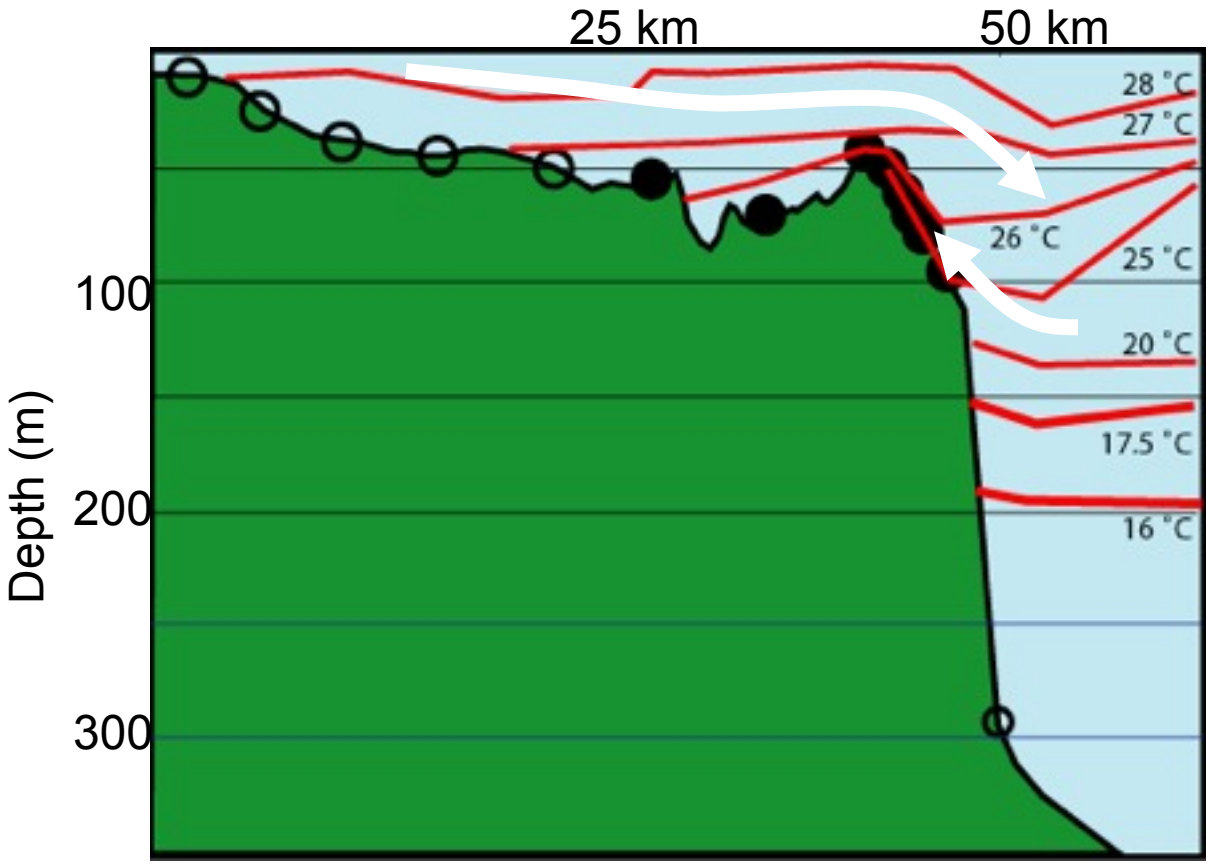
In surface water:
1/3 of neaarshore POC

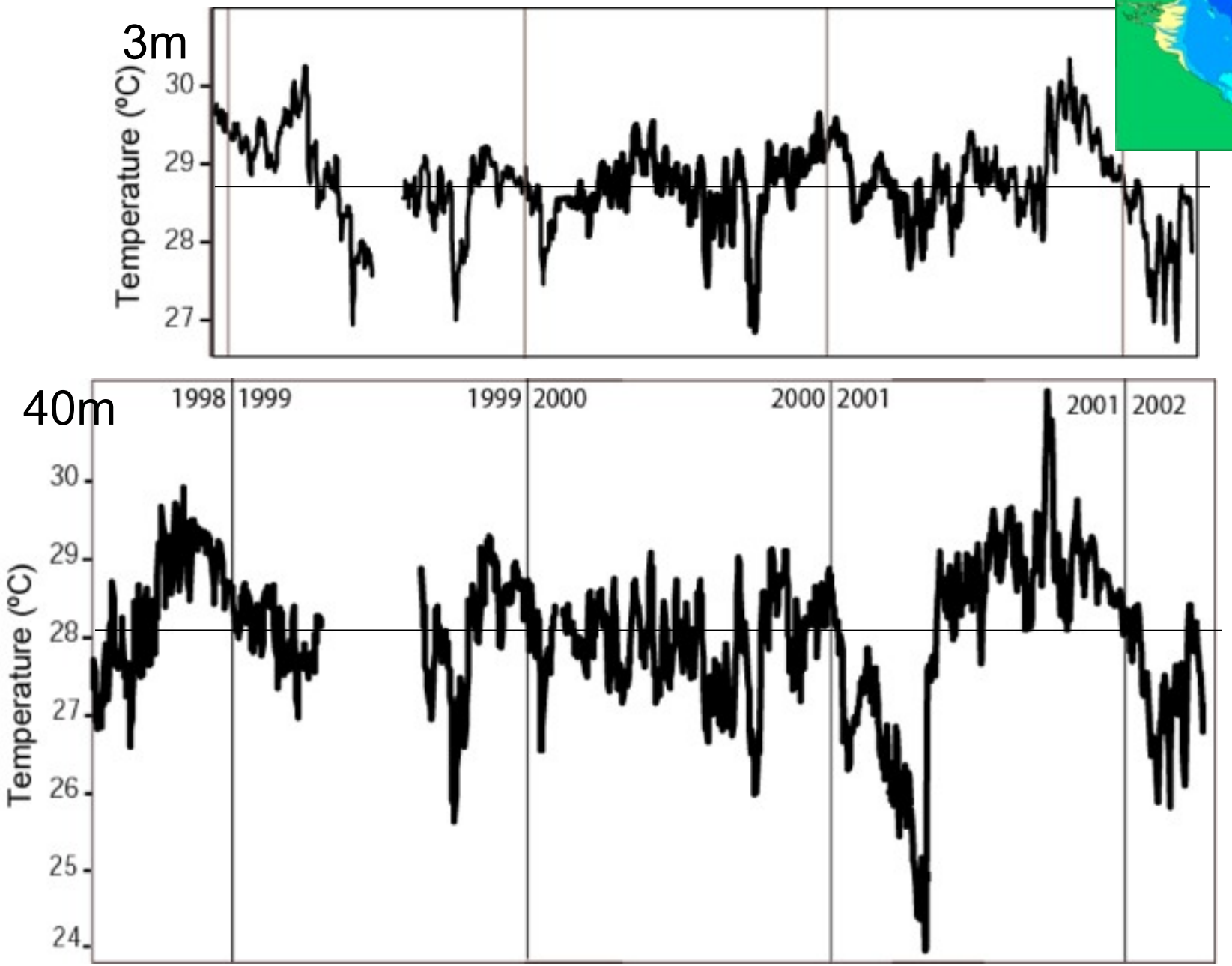
Consumption in benthic boundary la
About 80-90%

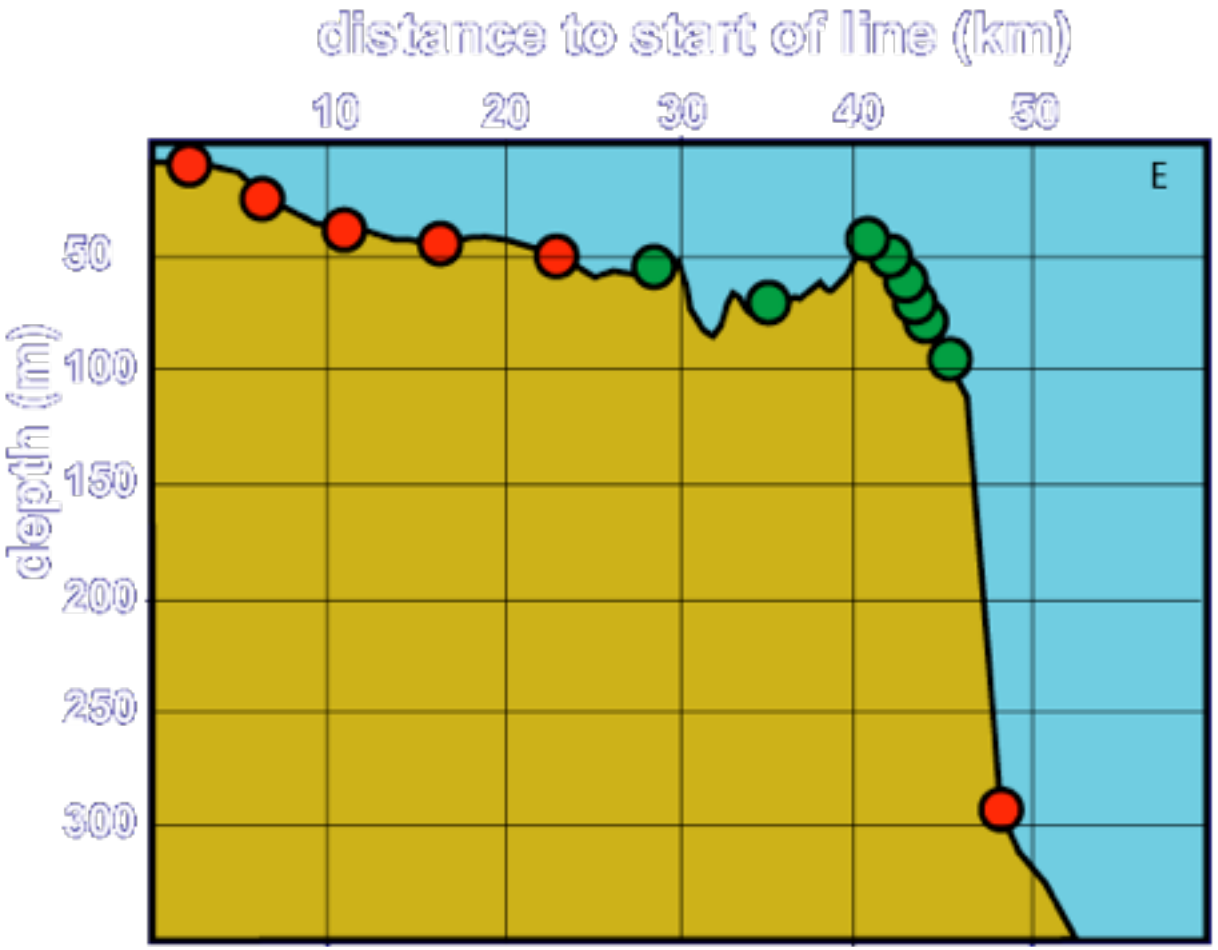
Temperature

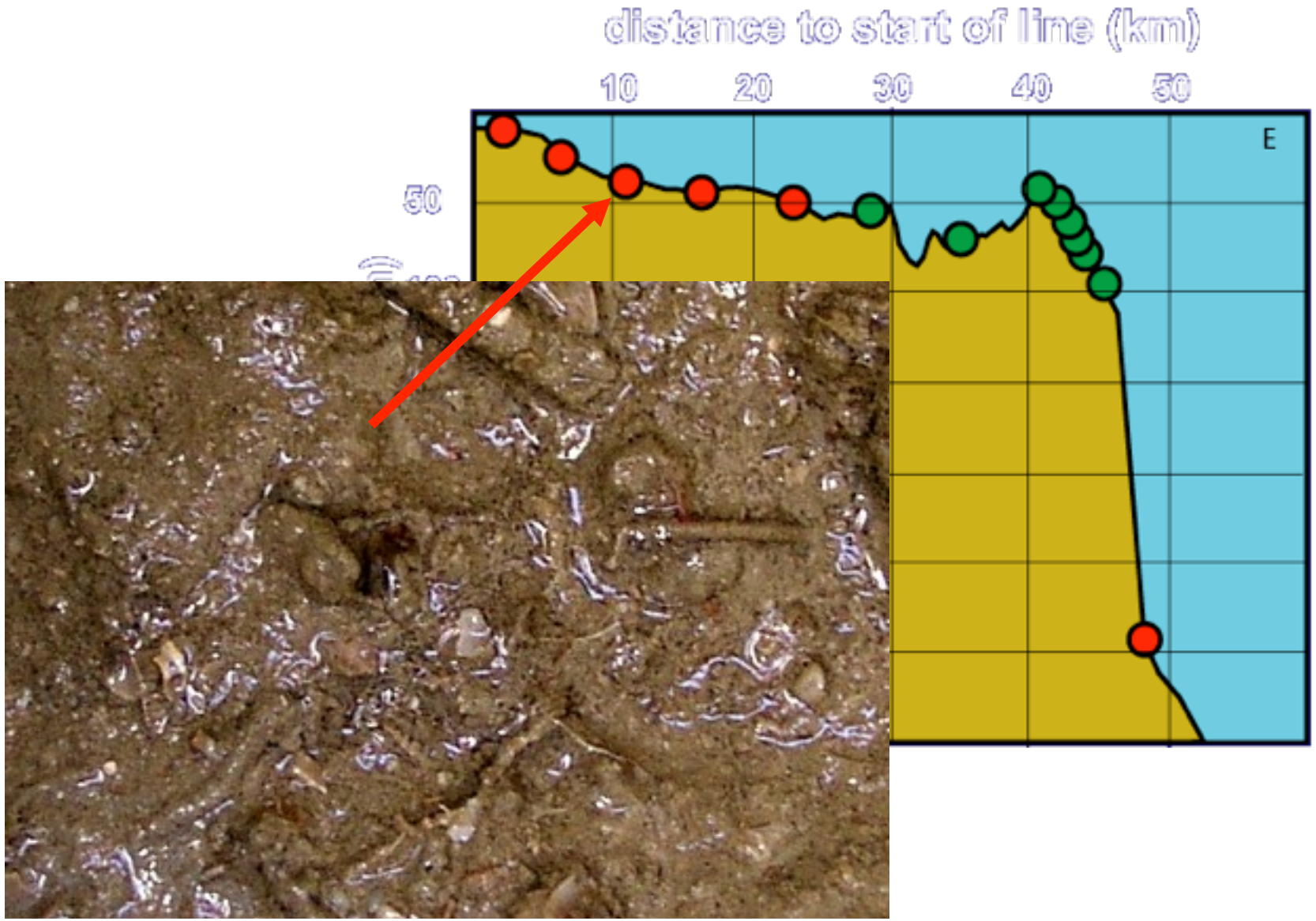


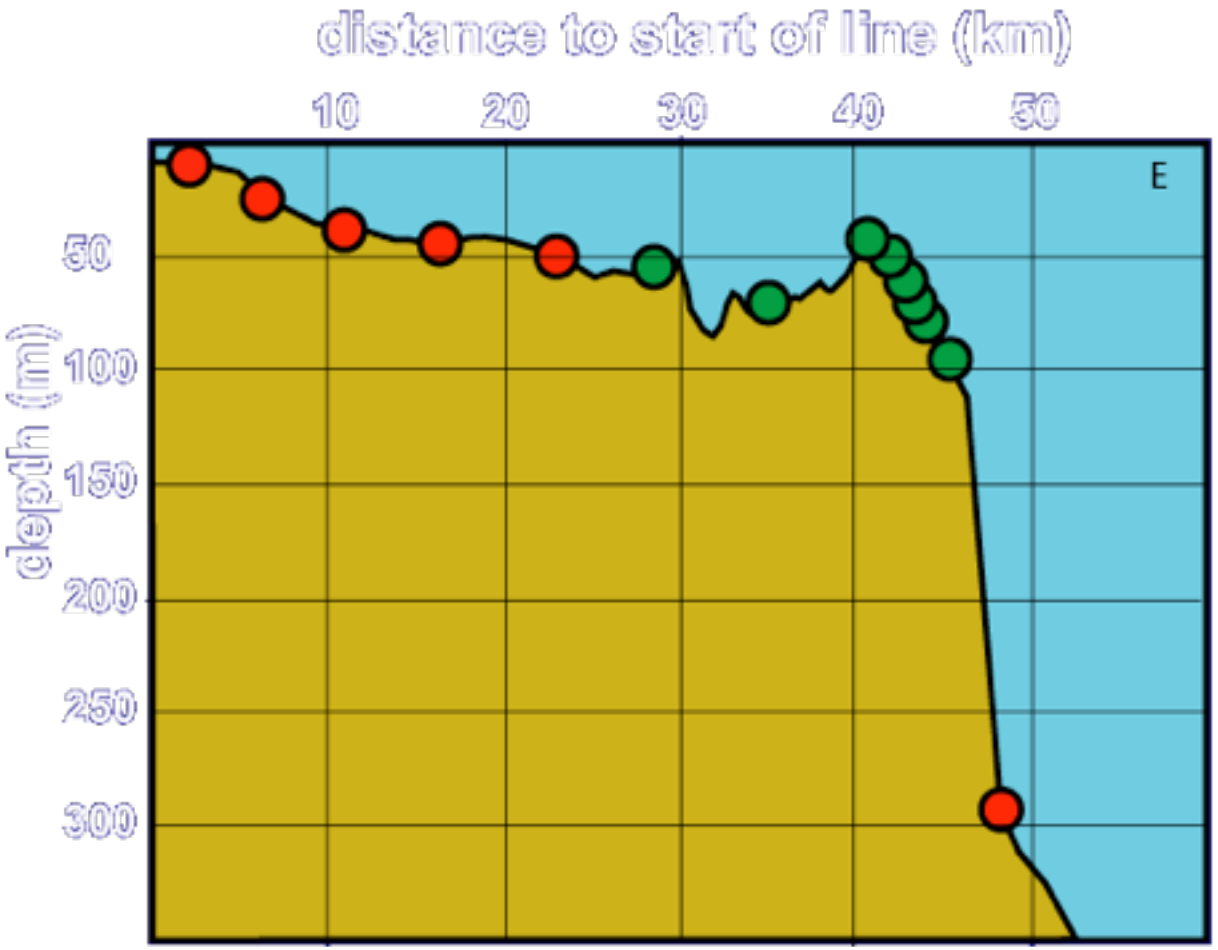
Temperature




3m
Temperature (°C)
30
29
28
27
40m
1998
1999
1999
2000
2000
2001
2001
2002
Temperature (°C)
30
29
28
27
26
25
24


distance to start of line (km)
10
20
30
40
50
E
depth (m)
50
100
150
200
250
300


distance to start of line (km)
10
20
30
40
50
50
E


distance to start of line (km)
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20
30
40
50
E
depth (m)
50
100
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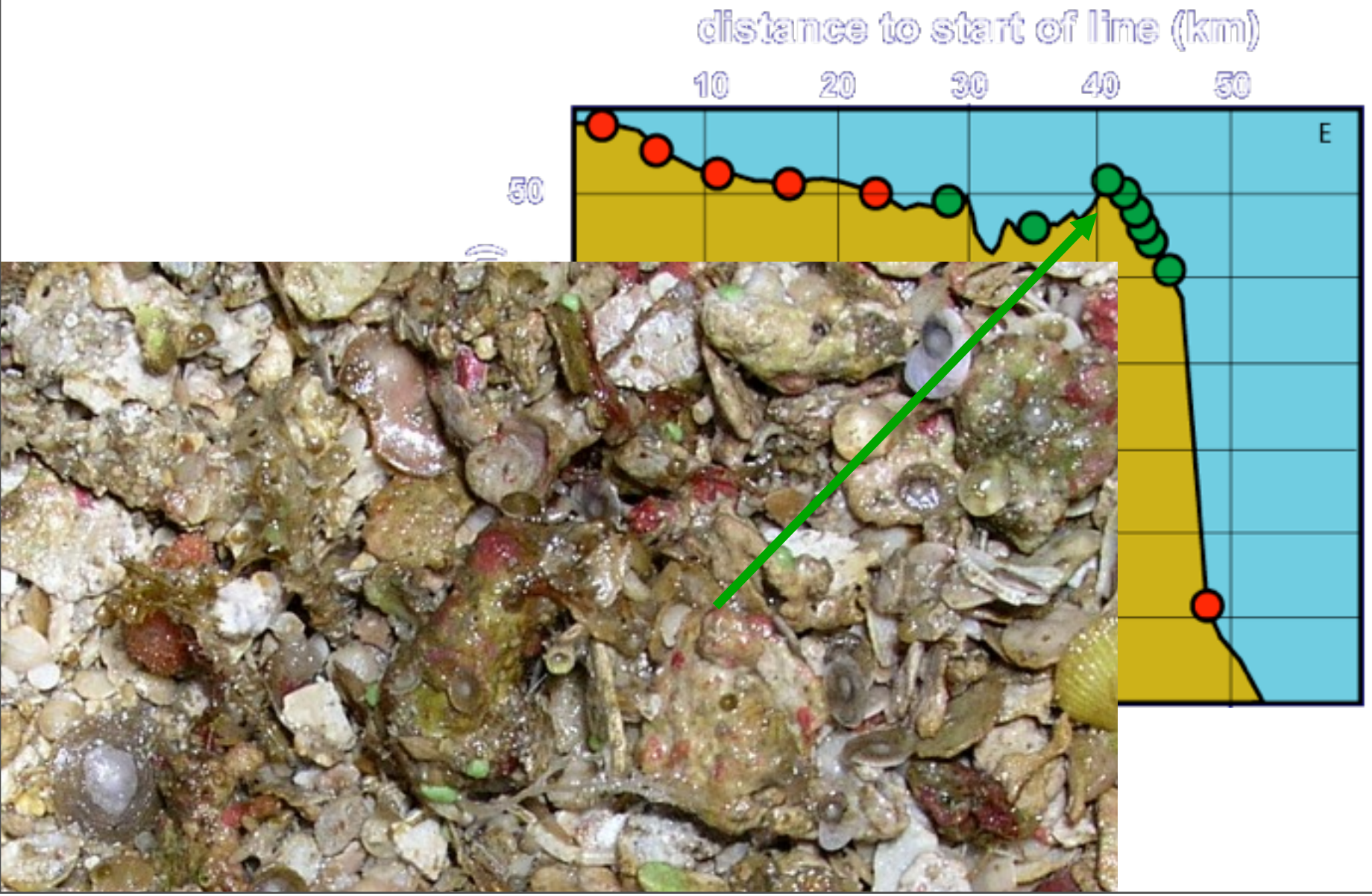
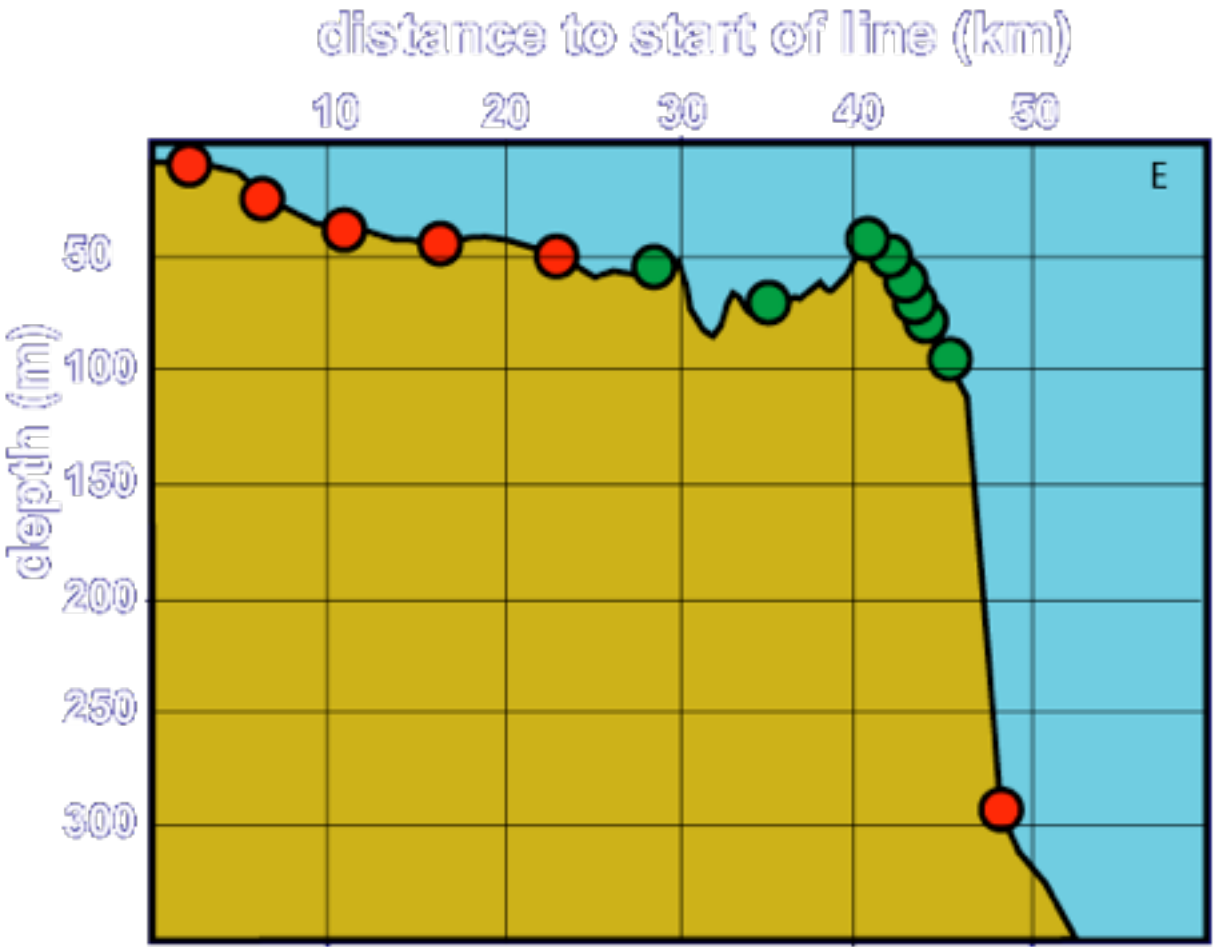
200
250
300

Nationaal
Natuurhistorisch
Museum




distance to start of line (km)
10
20
30
40
50
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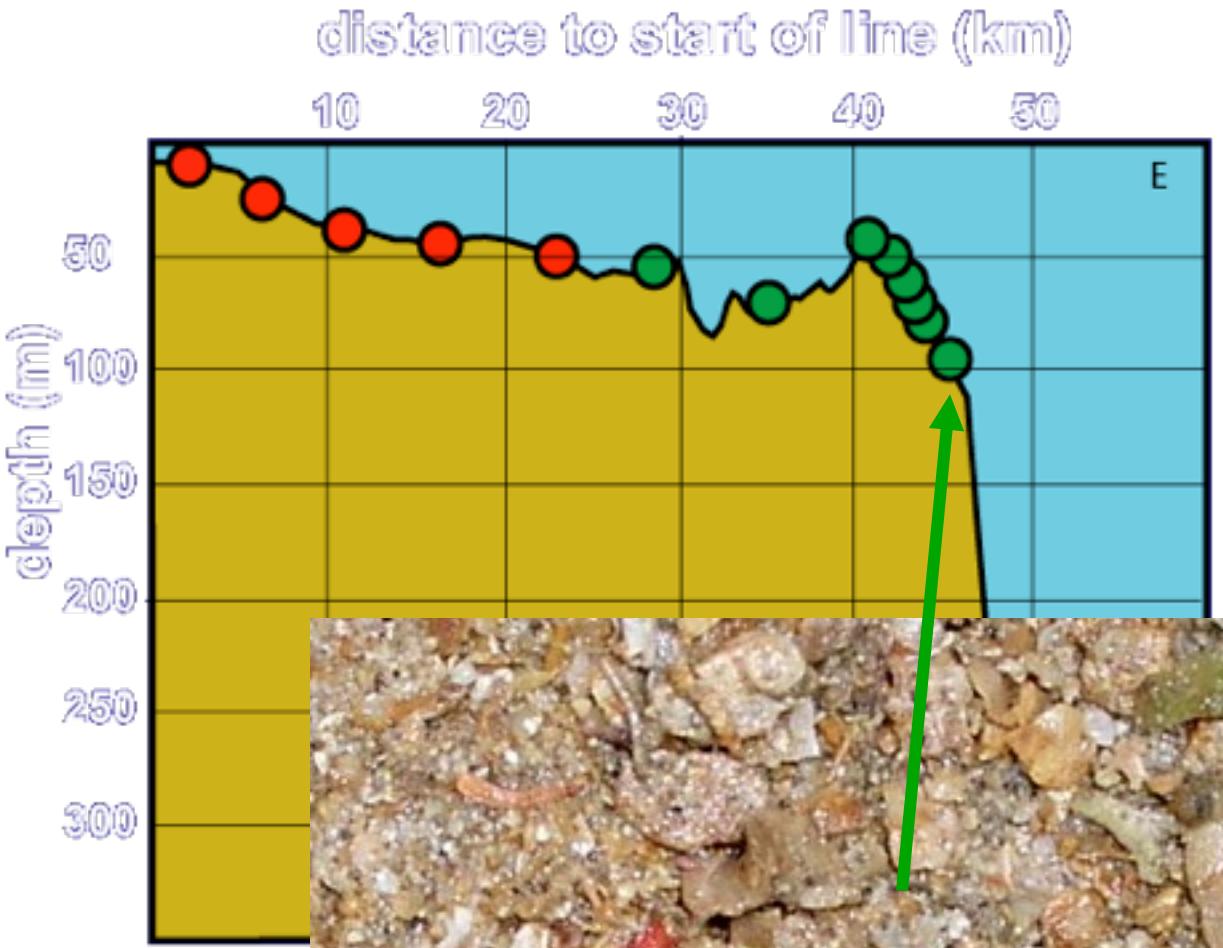
depth (m)
50
100
150
200
250
300


distance to start of line (km)
10
20
30
40
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E
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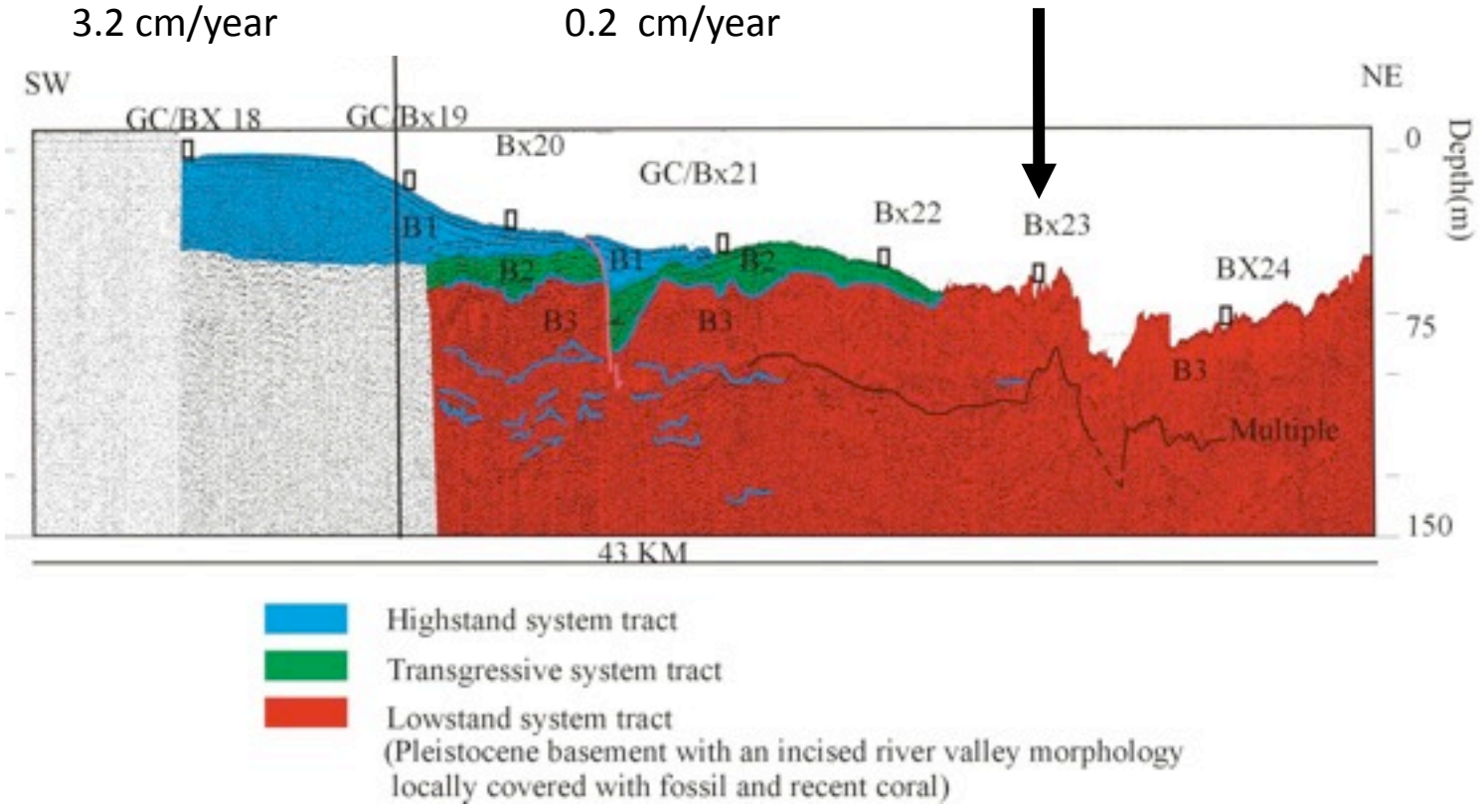
50
100
150
200
250
300

sedimentation rate

3.2 cm/year

0.2 cm/year



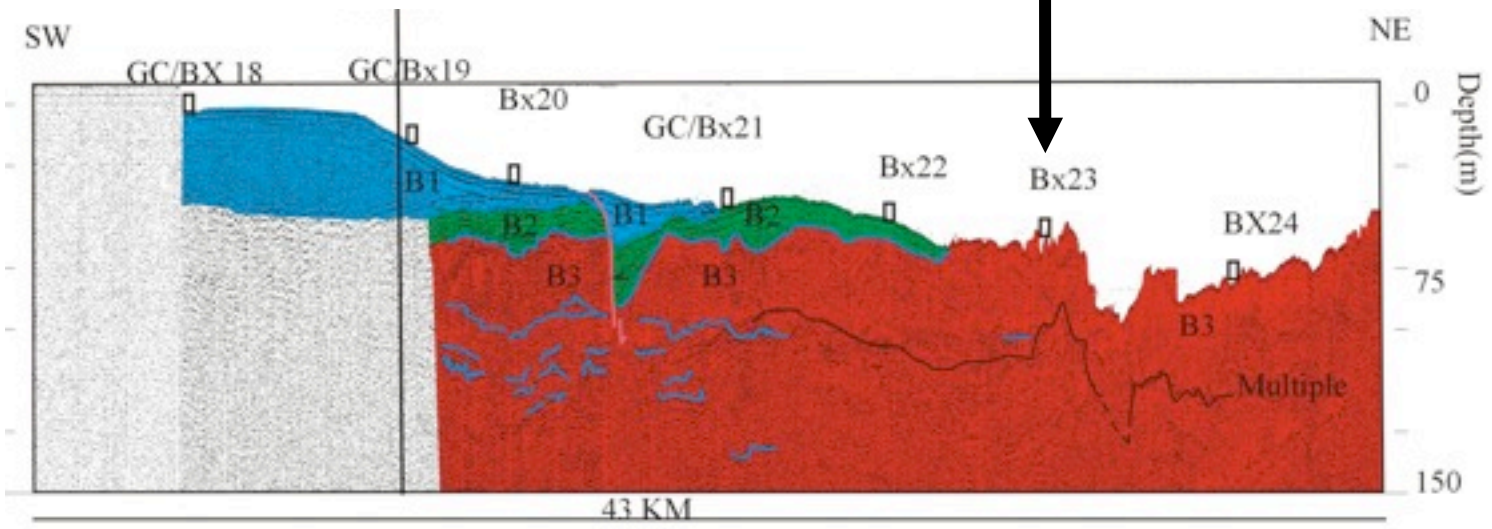
High org C, N

low org C, low N

sedimentation rate

3.2 cm/year

0.2 cm/year



Highstand system tract

Transgressive system tract

Lowstand system tract
(Pleistocene basement with an incised river valley morphology locally covered with fossil and recent coral)

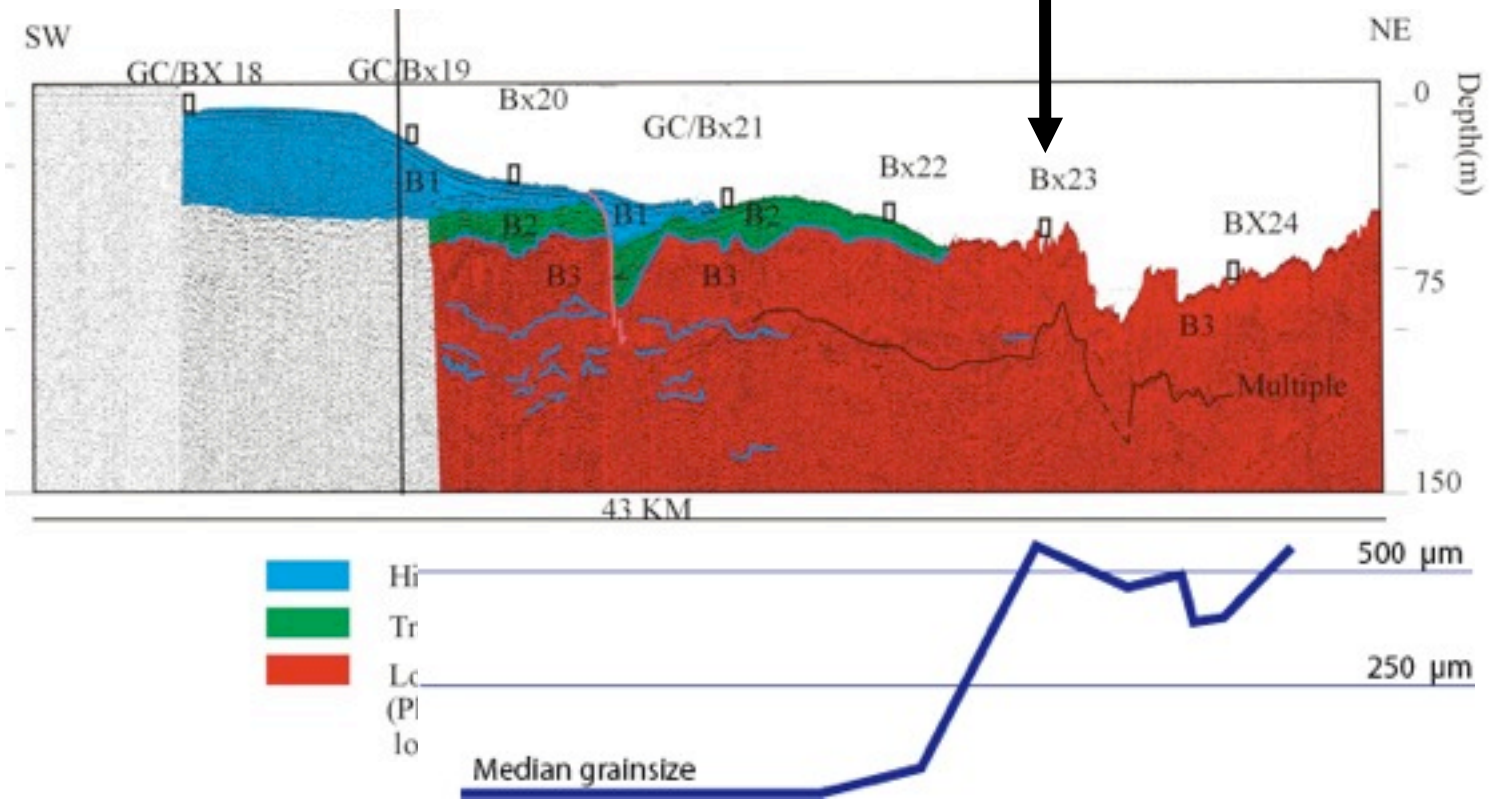
High org C, N

low org C, low N

sedimentation rate

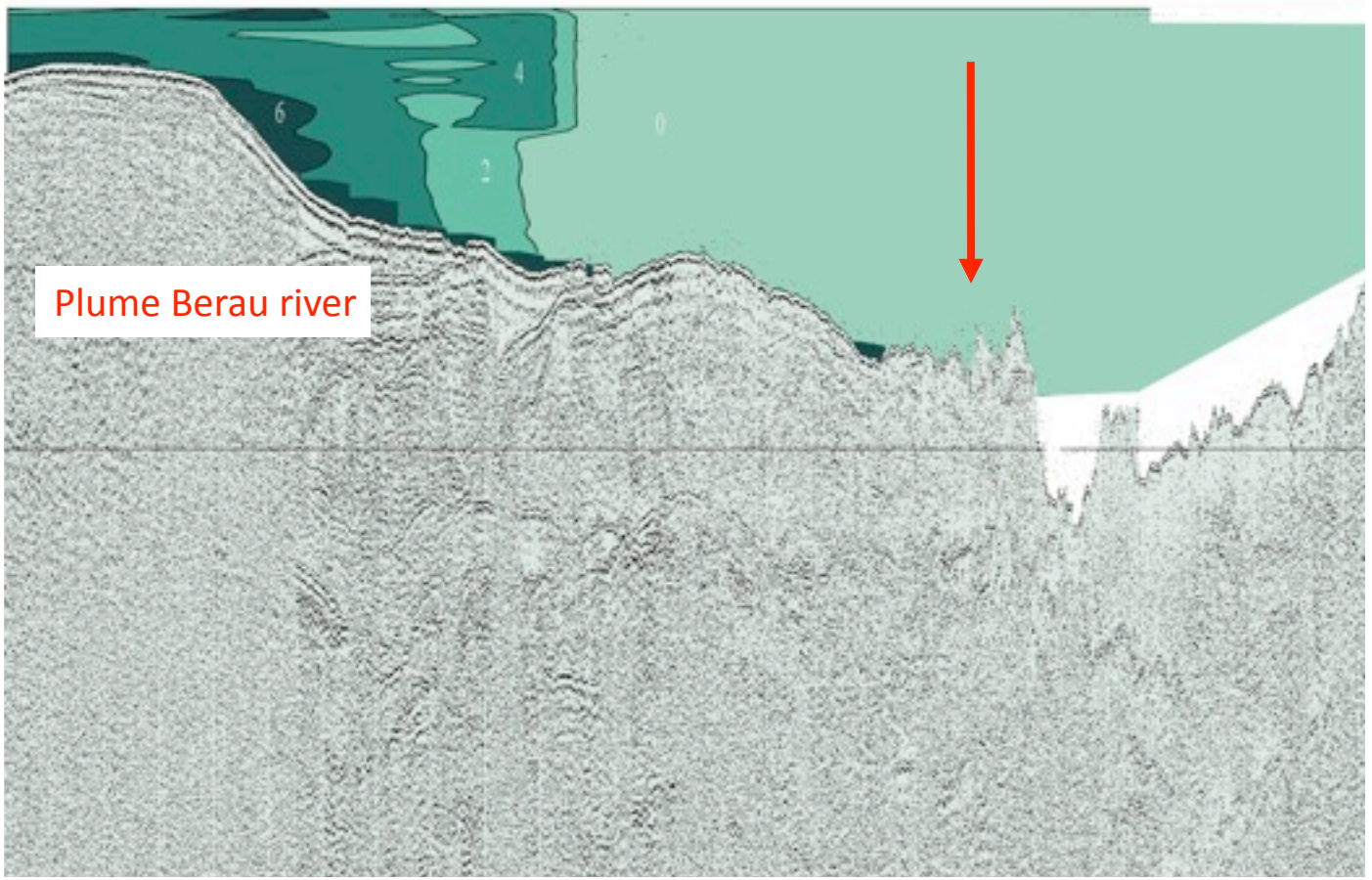
3.2 cm/year

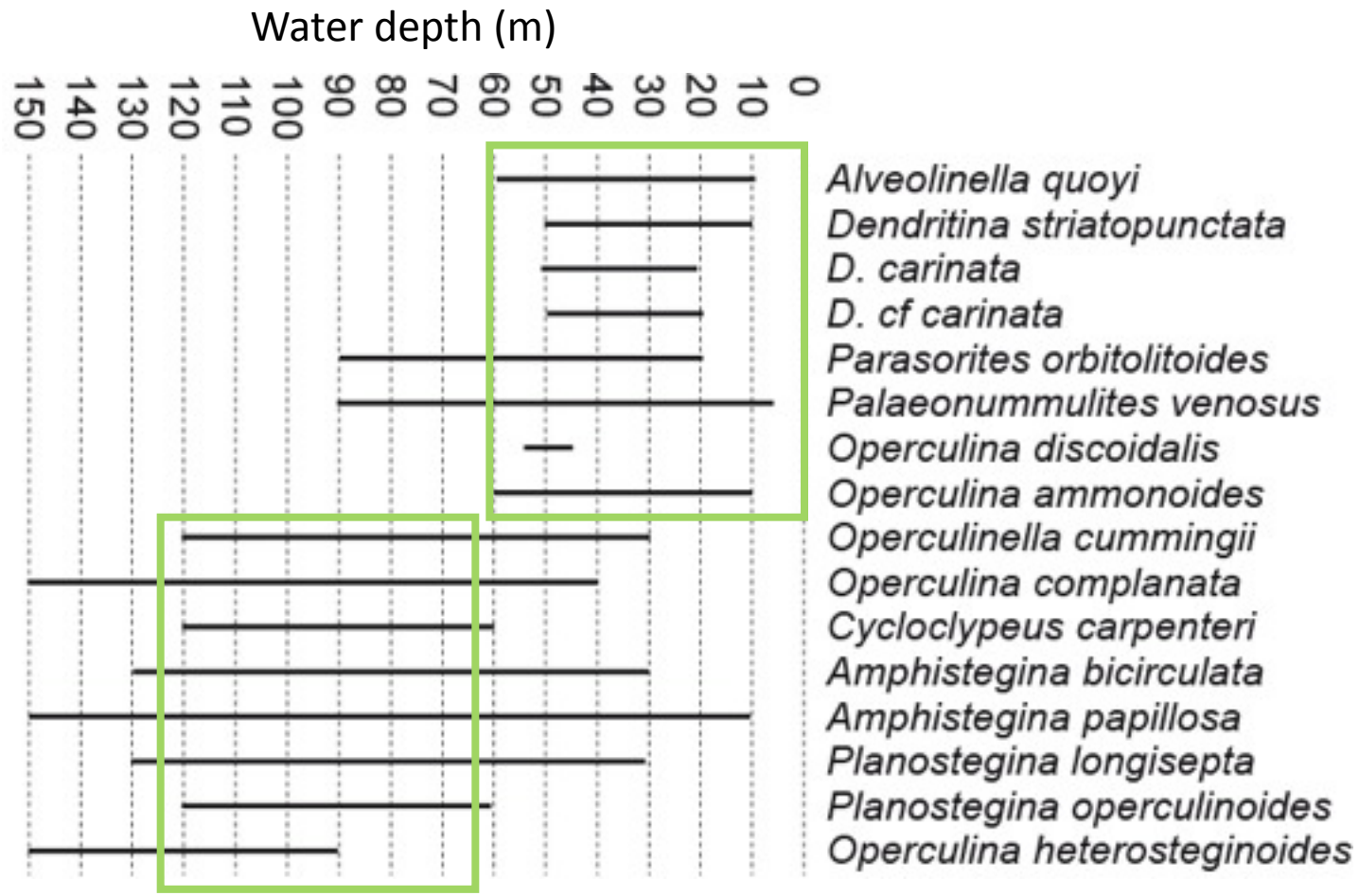
0.2 cm/year



Transparency

B-Bx 23

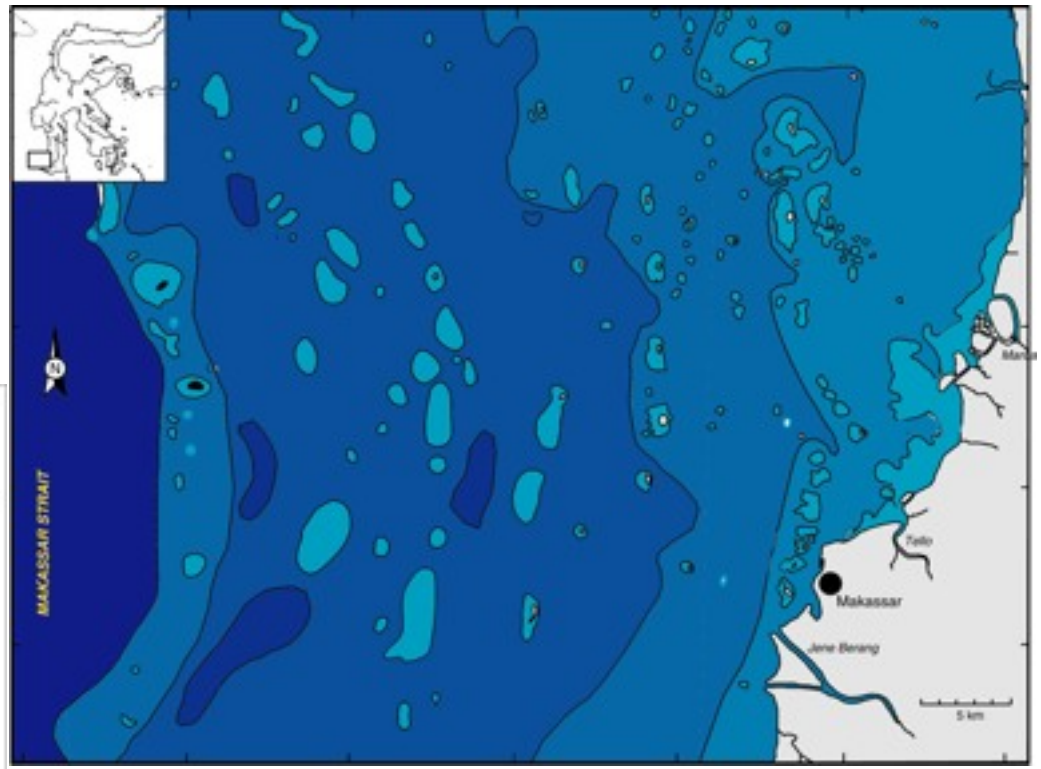


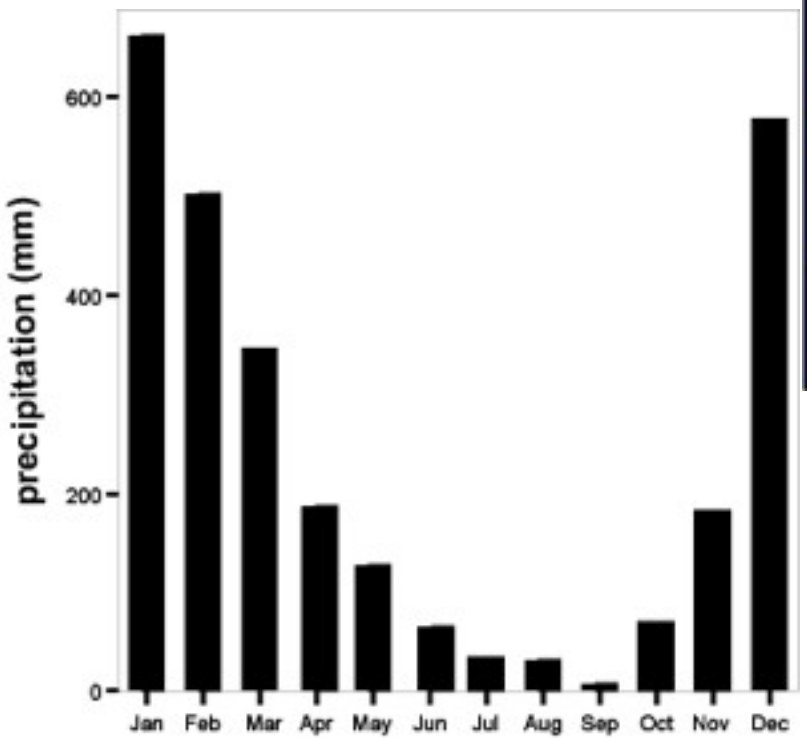

Water depth (m)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Alveolinella quoyi
Dendritina striatopunctata
D. carinata
D. cf carinata
Parasorites orbitolitoides
Palaeonummulites venosus
Operculina discoidalis
Operculina ammonoides
Operculinella cummingii
Operculina complanata
Cycloclypeus carpenteri
Amphistegina bicirculata
Amphistegina papillosa
Planostegina longisepta
Planostegina operculinoides
Operculina heterosteginoides

Nationaal
Natuurhistorisch
Museum

Spermonde Archipelago

- Rimmed shelf, 30 km whide
- Completely sheltered by barrier
- Sand cay reefs





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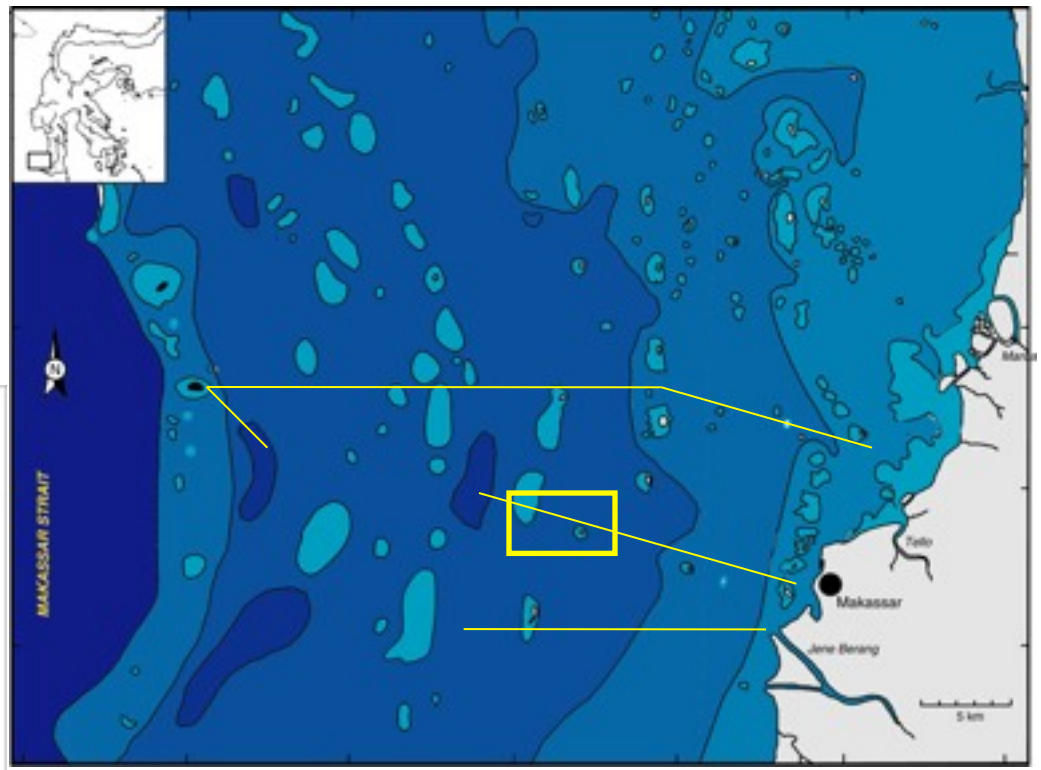
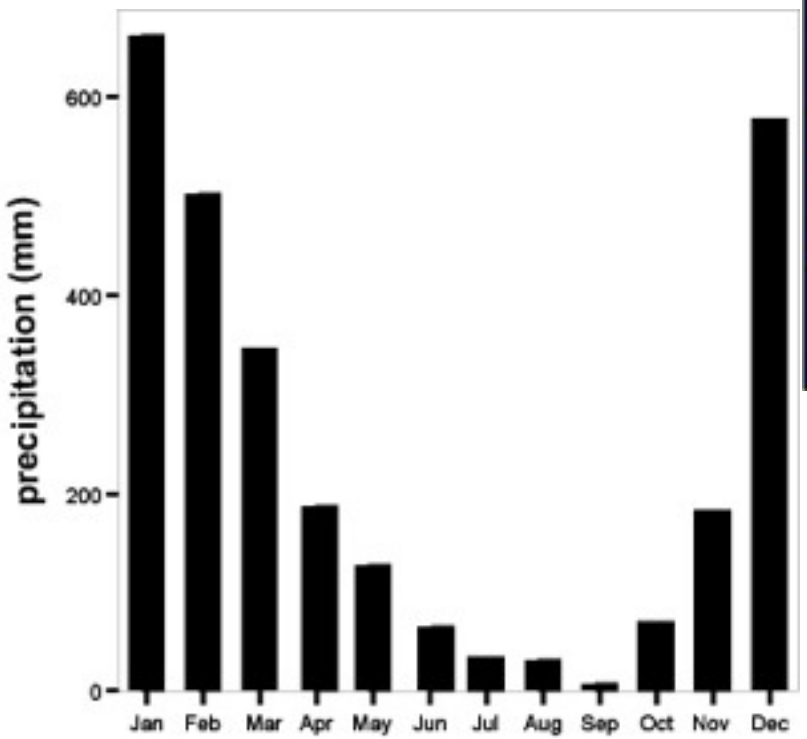
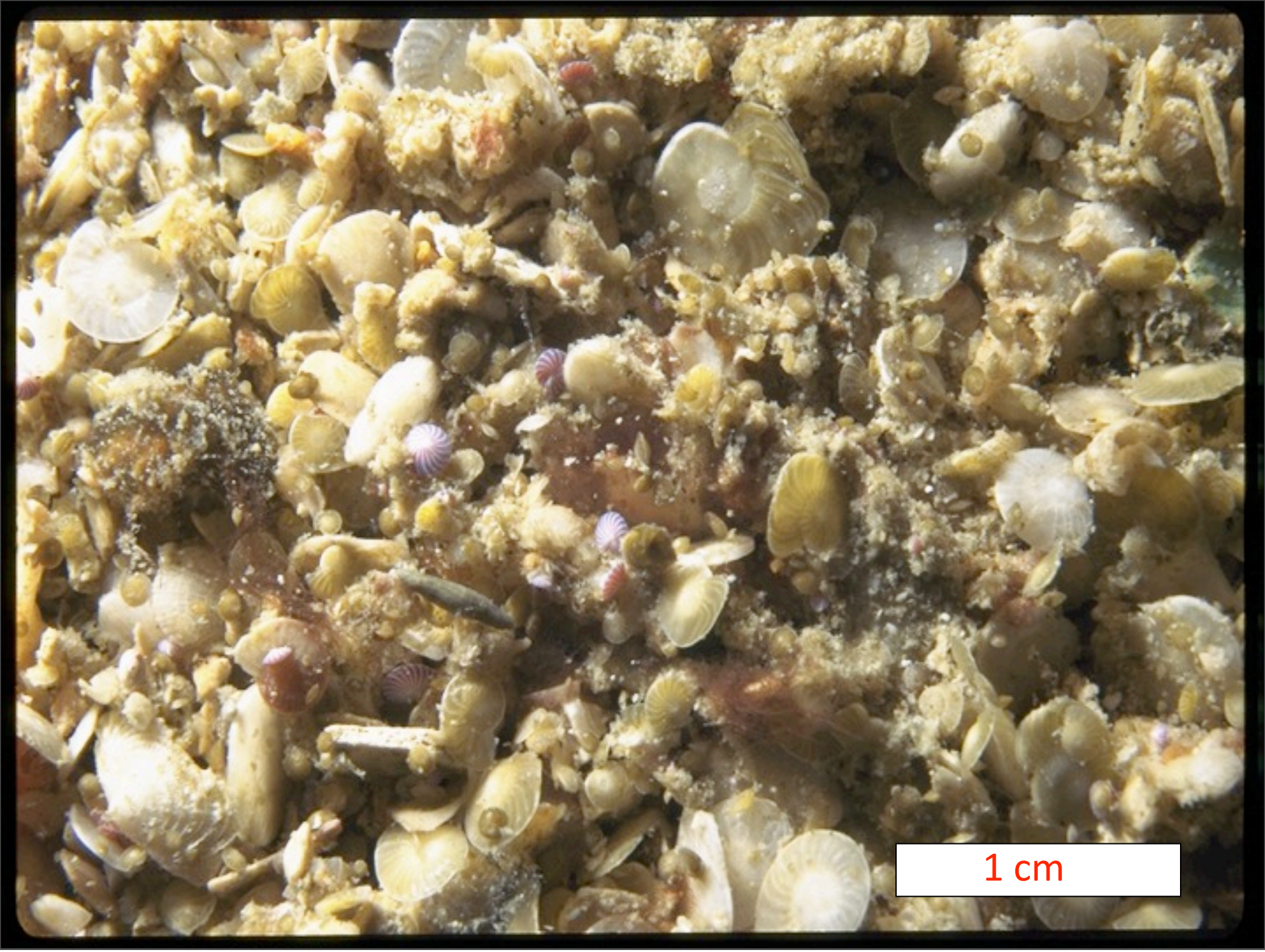
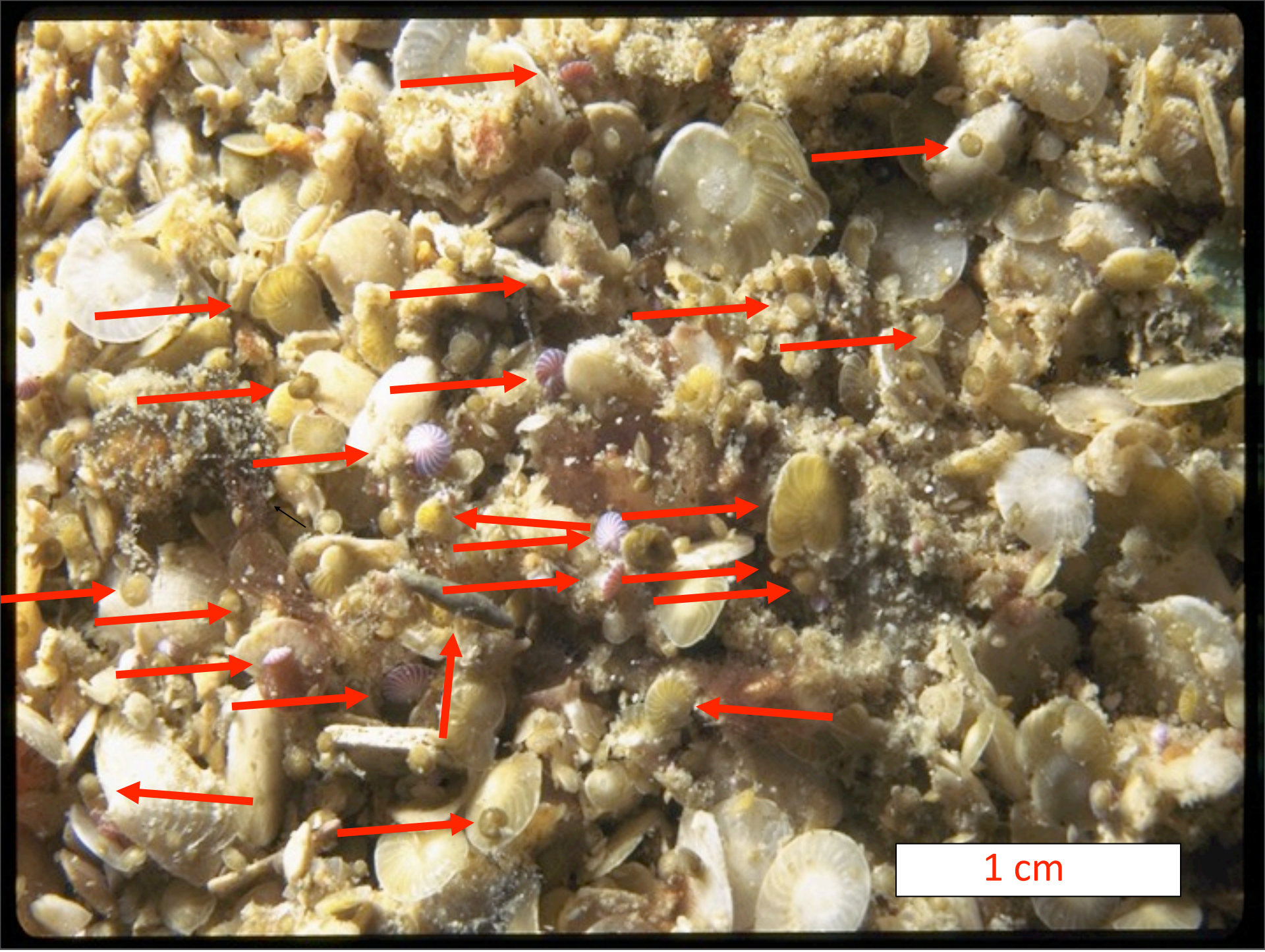
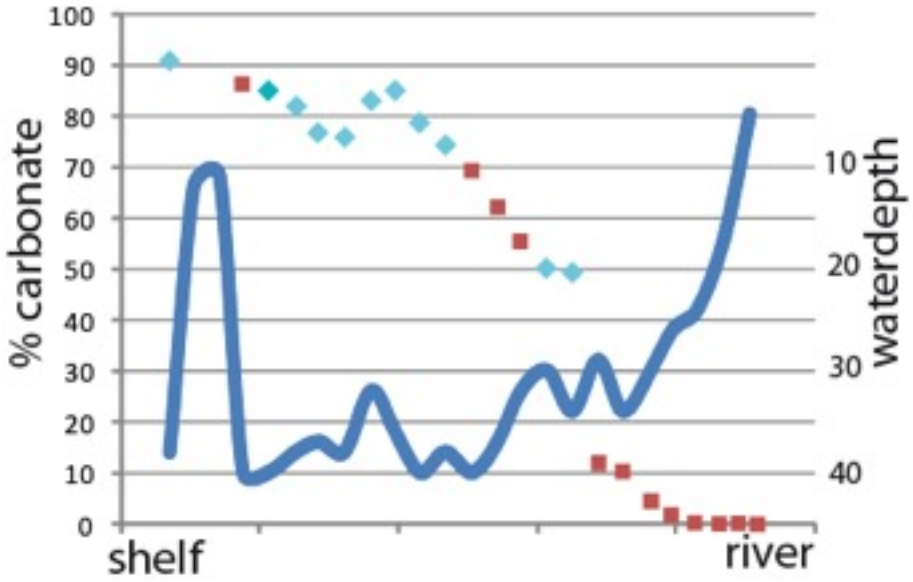
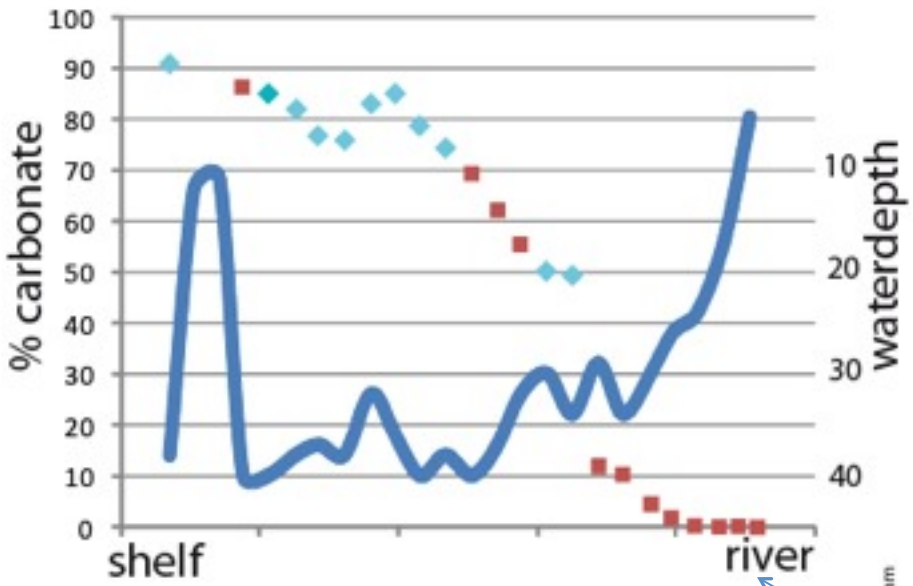





1 cm


1 cm


100
90
80
70
60
50
40
30
20
10
0
% carbonate
10
20
30
40
waterdepth
shelf
river


100
90
80
70
60
50
40
30
20
10
0
% carbonate
10
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30
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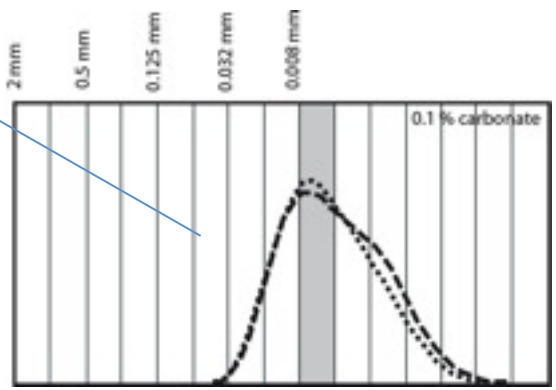
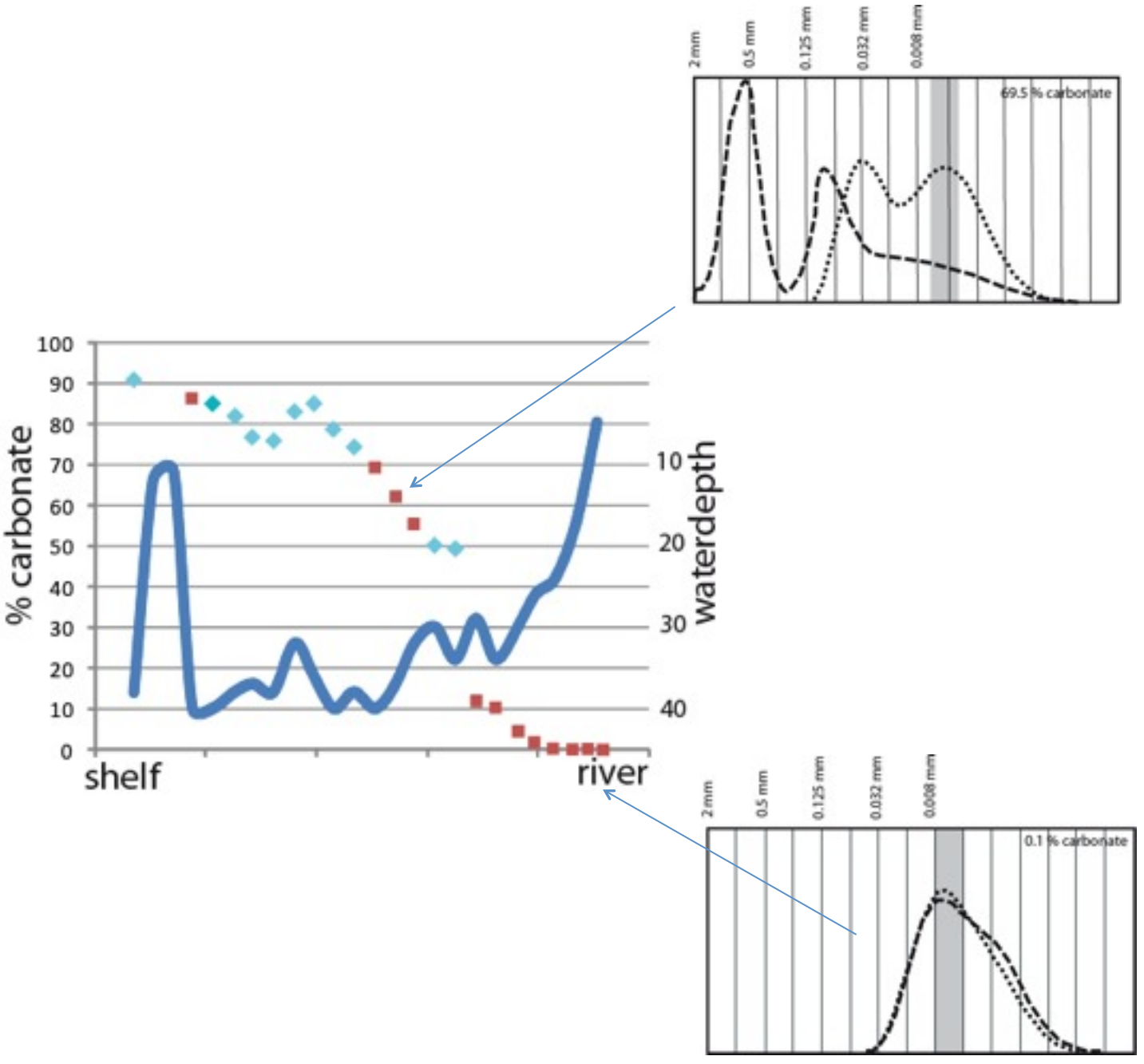
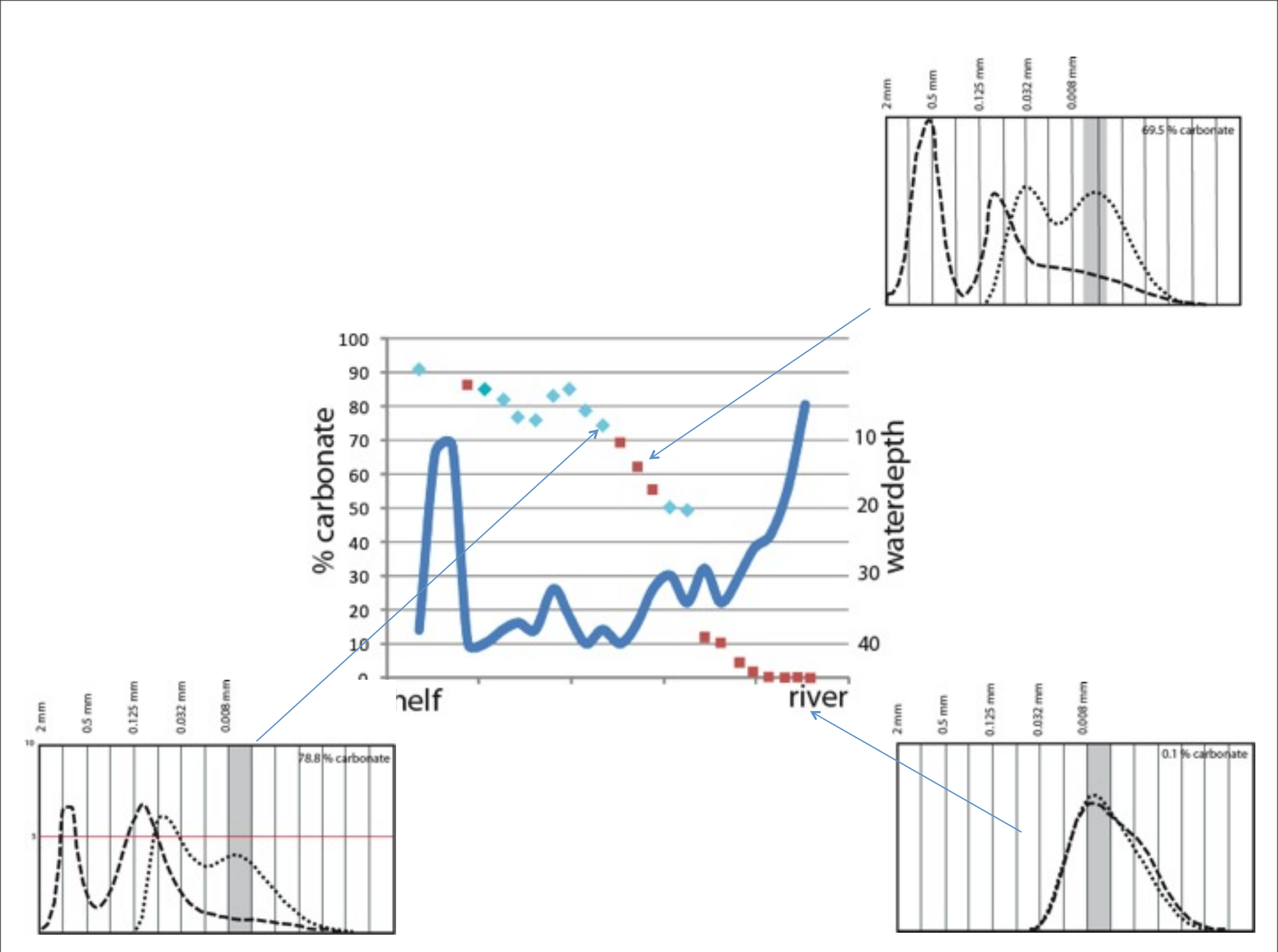
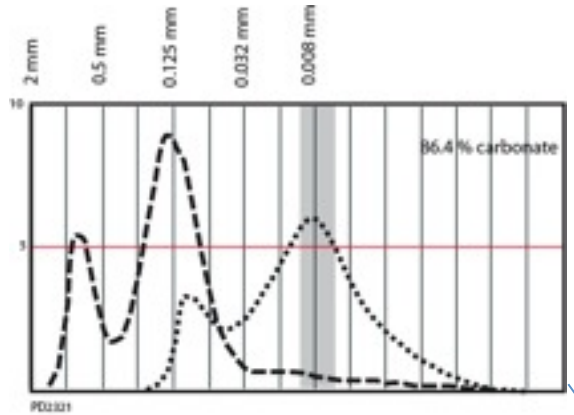
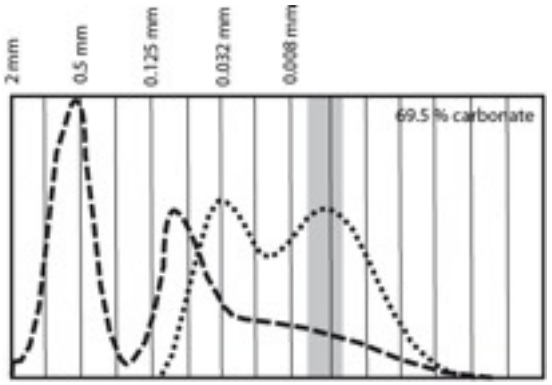
waterdepth
shelf
river

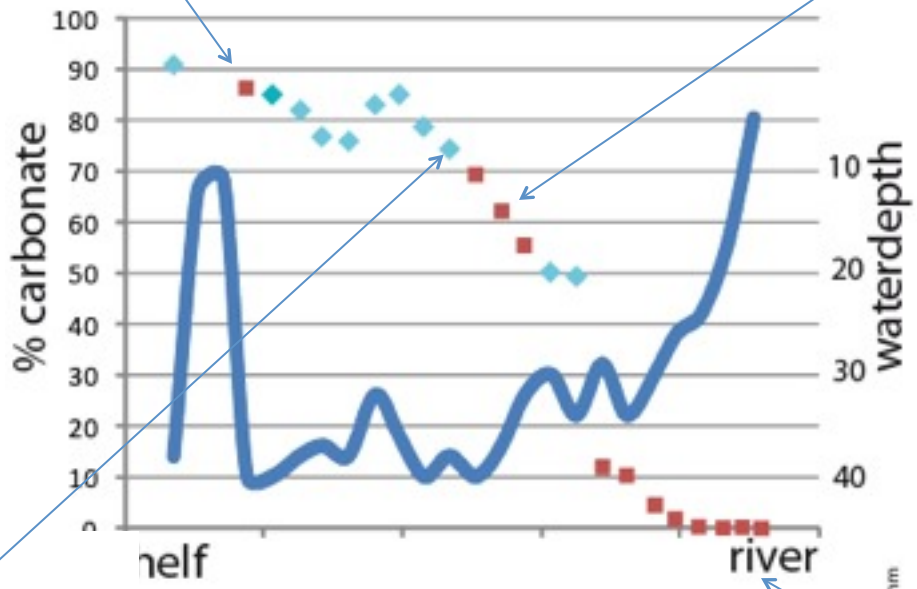

2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
0.1 % carbonate

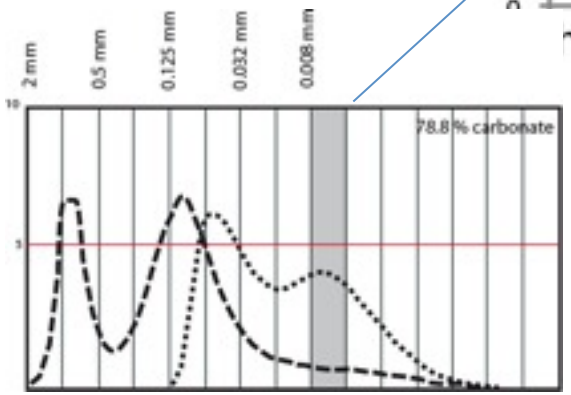

2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
69.5 % carbonate
100
90
80
70
60
50
40
30
20
10
0
% carbonate
10
20
30
40
waterdepth
shelf
river
2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
0.1 % carbonate

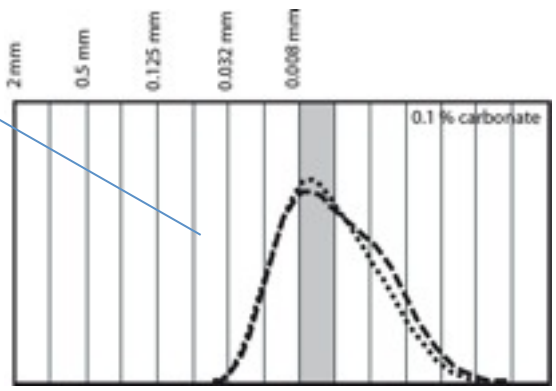

2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
69.5 % carbonate
% carbonate
waterdepth
100
90
80
70
60
50
40
30
20
10
0
10
20
30
40
river
78.8 % carbonate
0.1 % carbonate

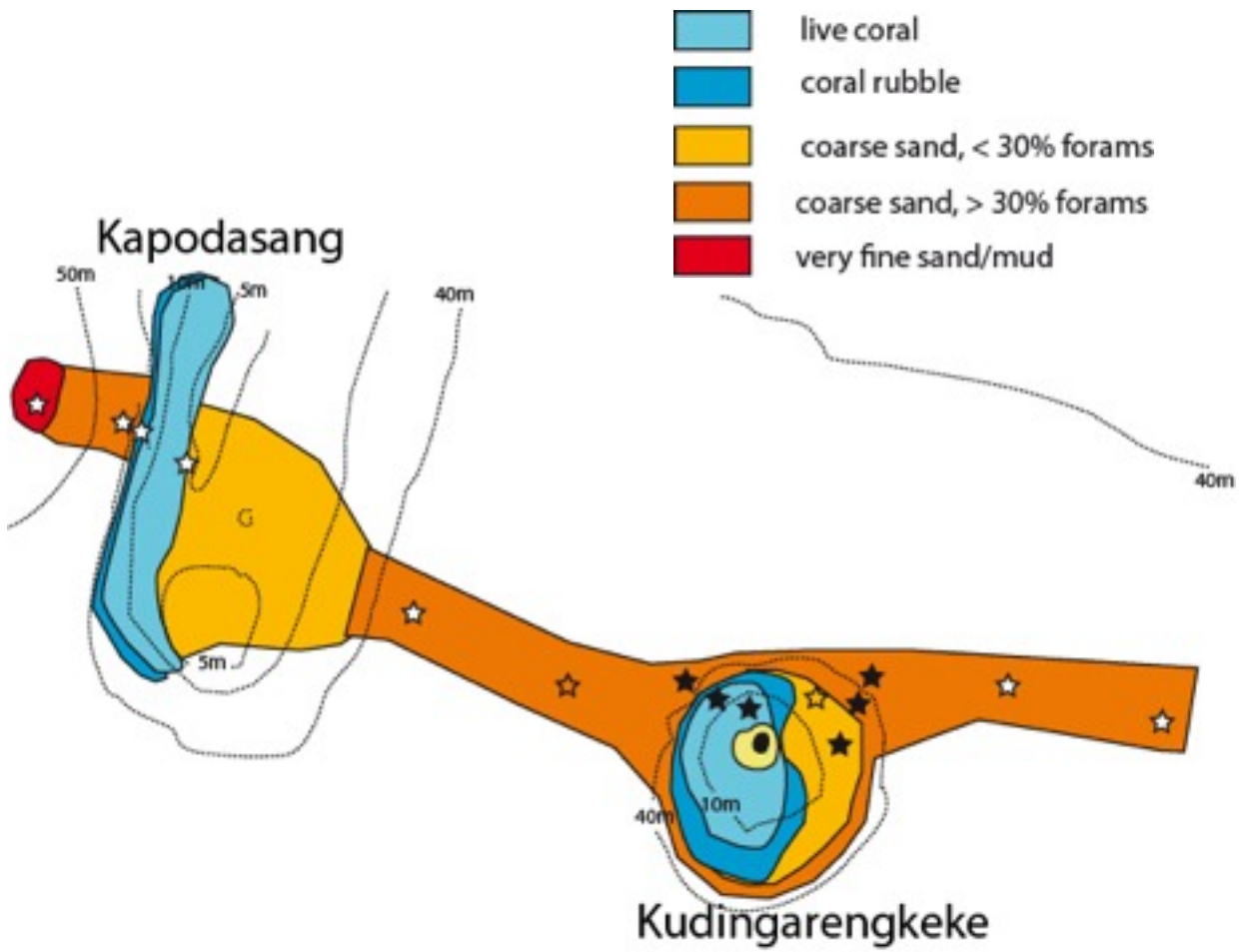

2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
86.4 % carbonate

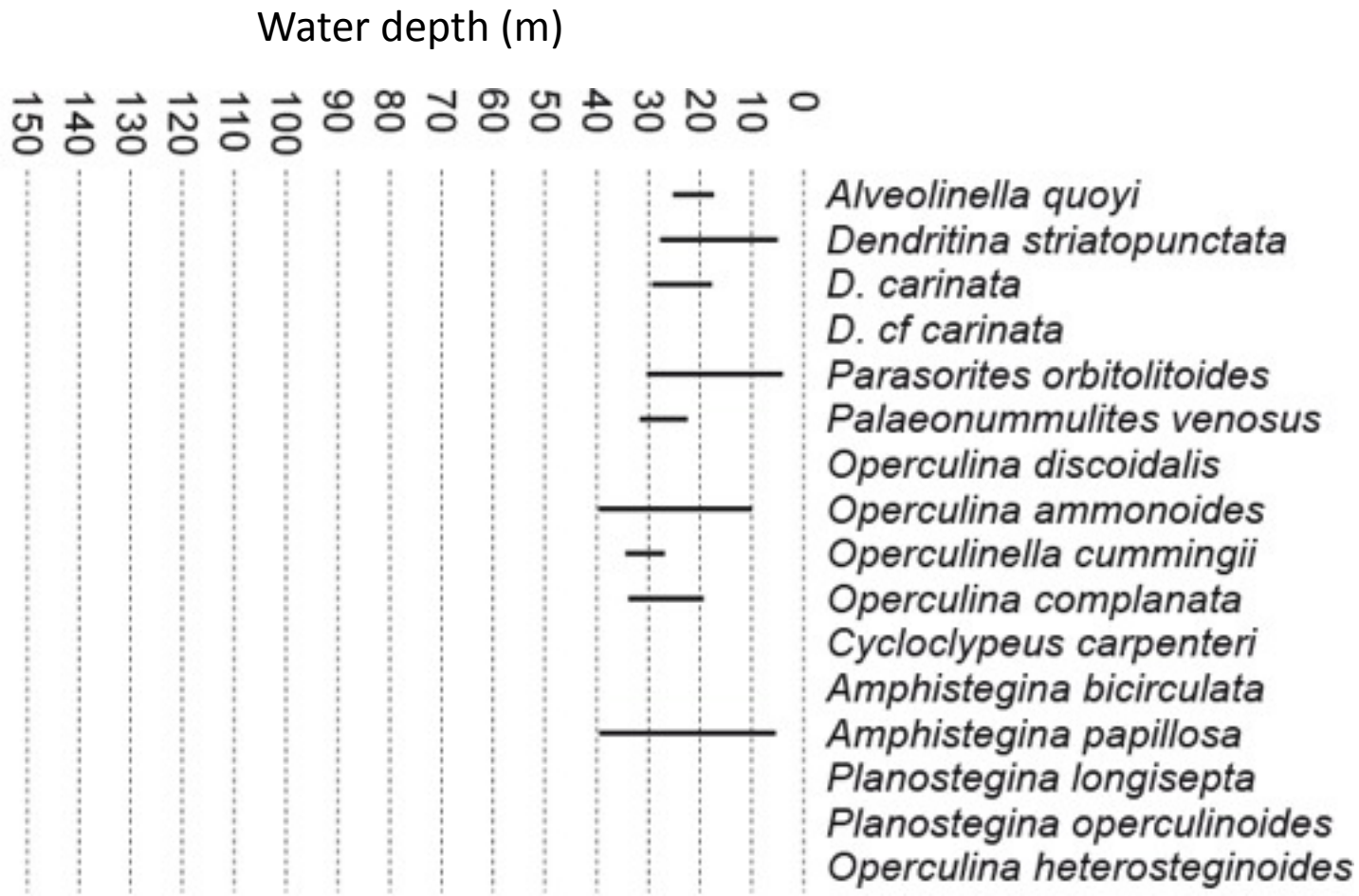

2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
69.5 % carbonate

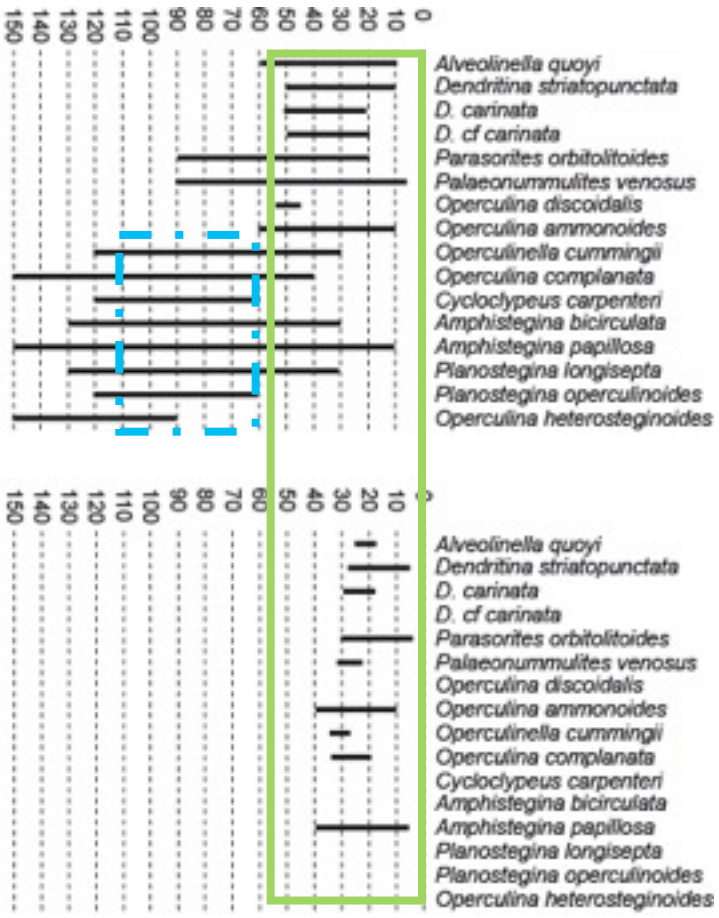

100
90
80
70
60
50
40
30
20
10
0
% carbonate
10
20
30
40
waterdepth
river


2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
78.8 % carbonate


2 mm
0.5 mm
0.125 mm
0.032 mm
0.008 mm
0.1 % carbonate


live coral
coral rubble
coarse sand, < 30% forams
coarse sand, > 30% forams
very fine sand/mud
Kapodasang
50m
5m
40m
5m
40m
10m
40m
Kudingarengkeke


Water depth (m)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Alveolinella quoyi
Dendritina striatopunctata
D. carinata
D. cf carinata
Parasorites orbitolitoides
Palaeonummulites venosus
Operculina discoidalis
Operculina ammonoides
Operculinella cummingii
Operculina complanata
Cycloclypeus carpenteri
Amphistegina bicirculata
Amphistegina papillosa
Planostegina longisepta
Planostegina operculinoides
Operculina heterosteginoides


150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
Alveolinella quoyi
Dendritina striatopunctata
D. carinata
D. cf carinata
Parasorites orbitolitoides
Palaeonummulites venosus
Operculina discoidalis
Operculina ammonoides
Operculinella cummingii
Operculina complanata
Cycloclypeus carpenteri
Amphistegina bicirculata
Amphistegina papillosa
Planostegina longisepta
Planostegina operculinoides
Operculina heterosteginoides
150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
Alveolinella quoyi
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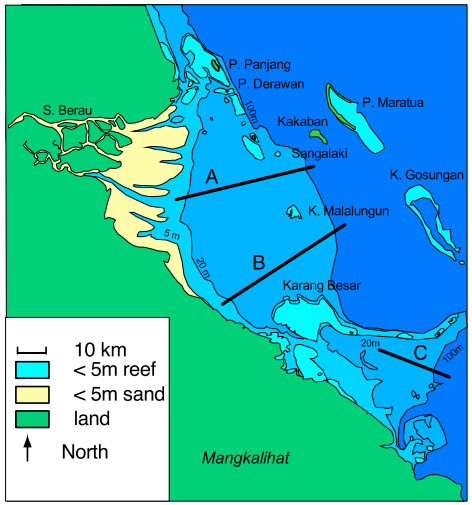
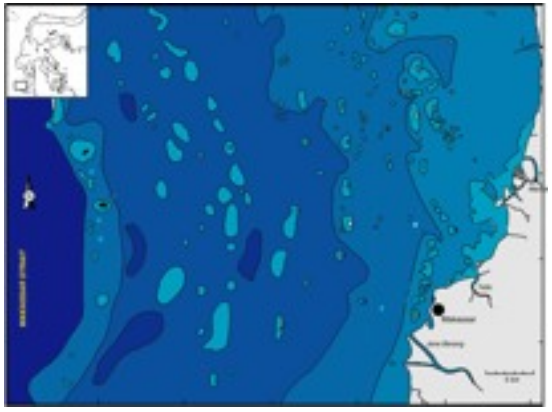
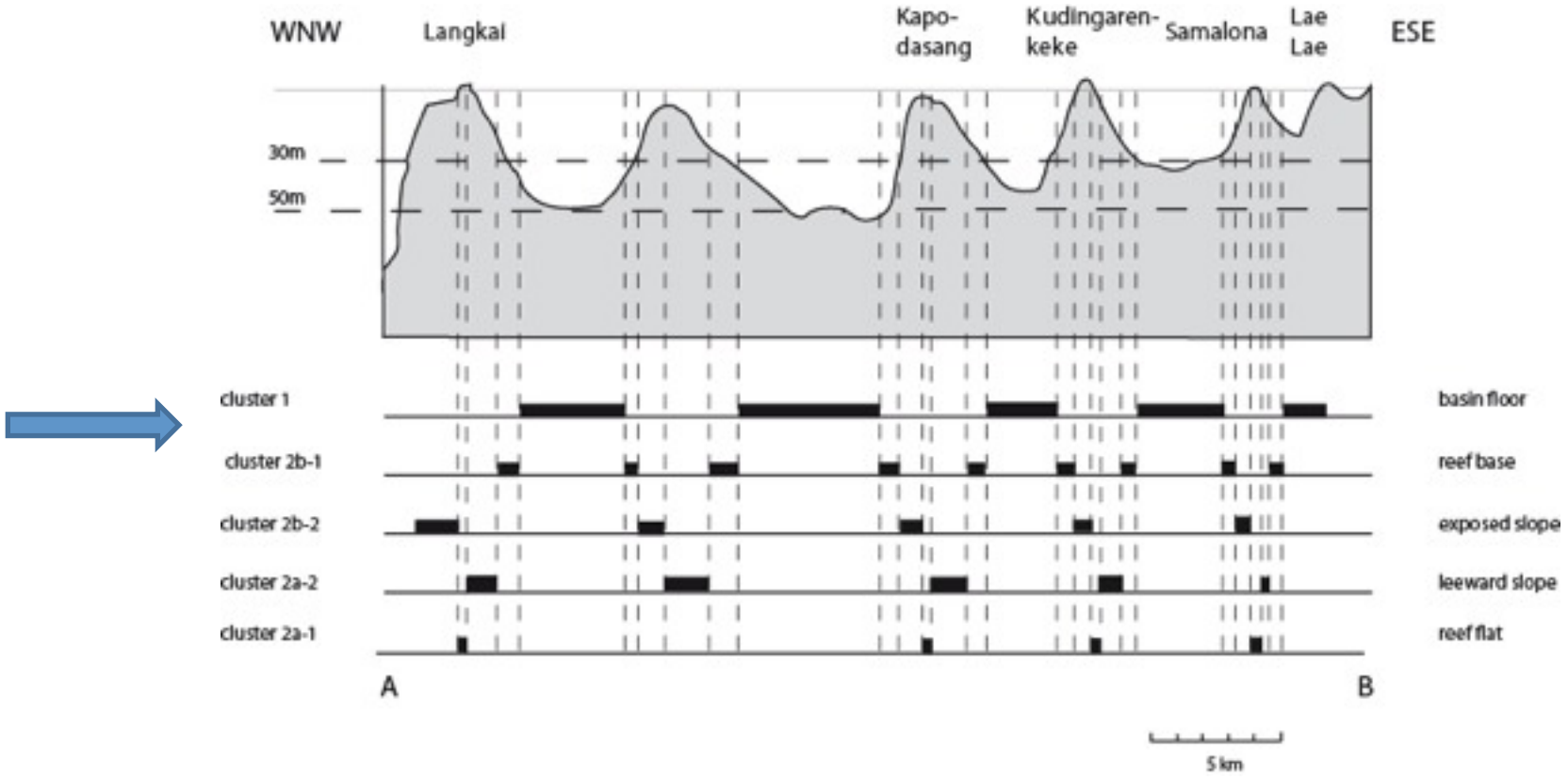
Planostegina operculinoides
Operculina heterosteginoides


P. Panjang
P. Derawan
S. Berau
P. Maratua
Kakaban
Sangalaki
K. Gosungan
A
K. Malalungun
B
Karang Besar
C
10 km
< 5m reef
< 5m sand
land
North
Mangkalihat





- Inter reef assemblage almost the same over entire shelf
  - *Operculina* dominated in depth range with year long light reaching sea floor
  - *Elphidium* dominated in depth range with seasonal light
  - only smaller benthics in deepest parts
- LBF only below wave base
- Reef associated taxa only very close to reef core

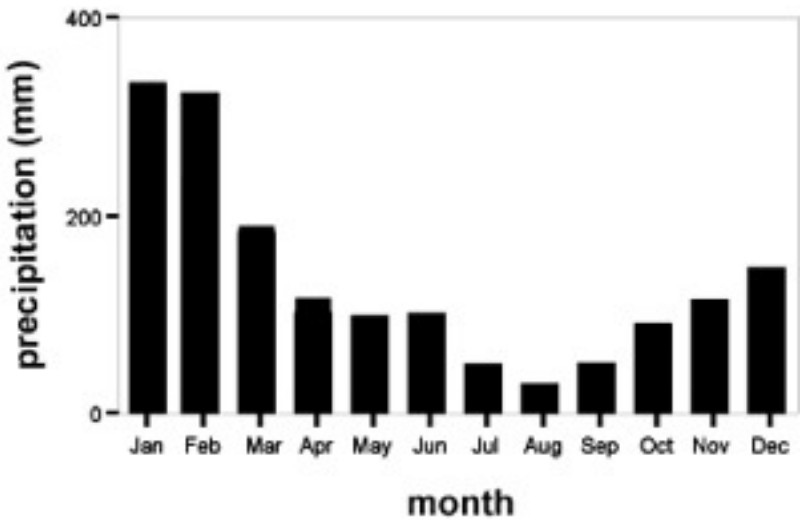
Miri section, Pliocene coastal plane with very similar assemblages to Berau

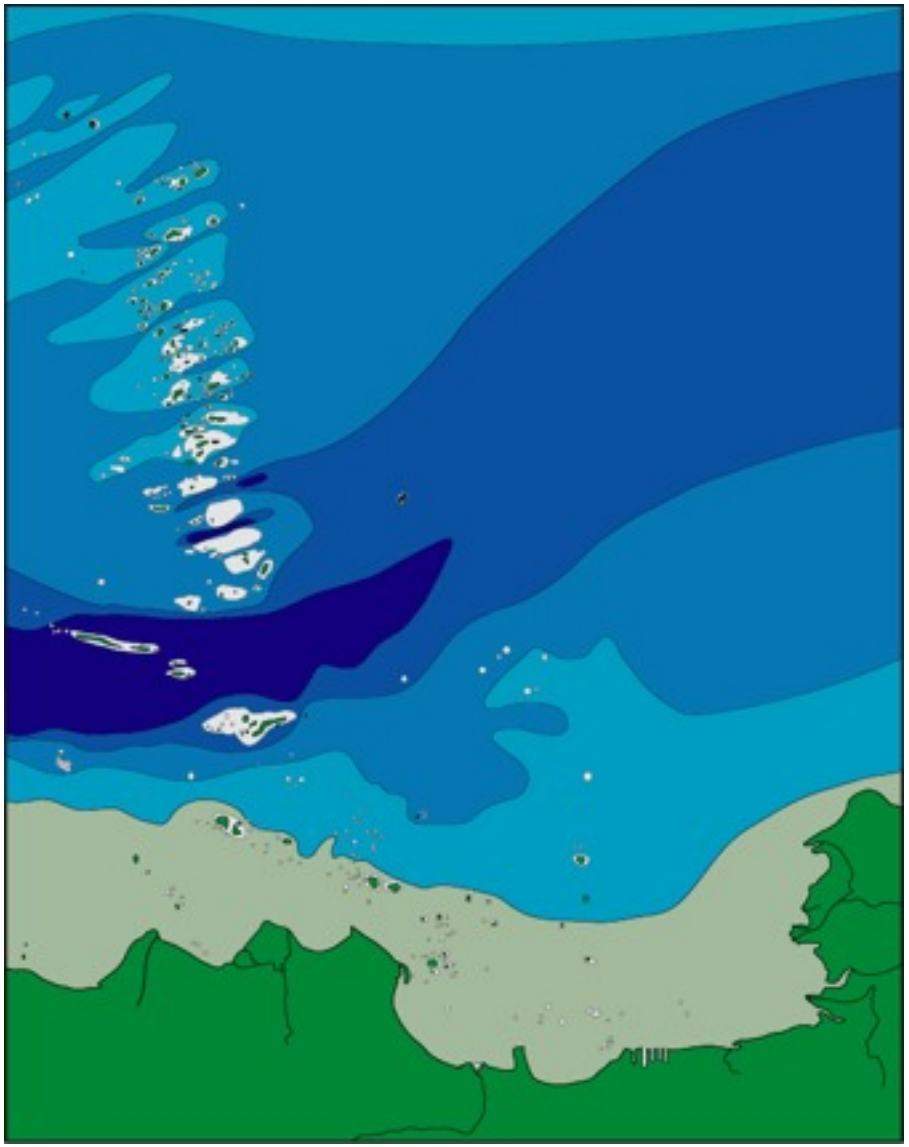
Stadium section with coastal assemblage

Sungai Harapan section with the Operculina assemblage

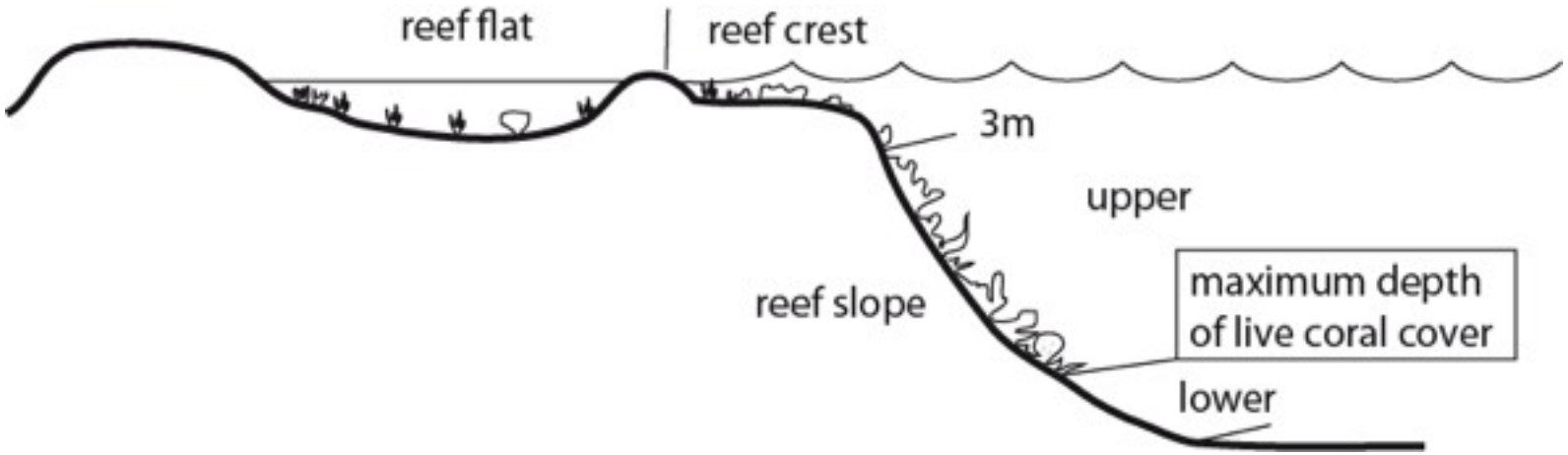
Thousand Islands

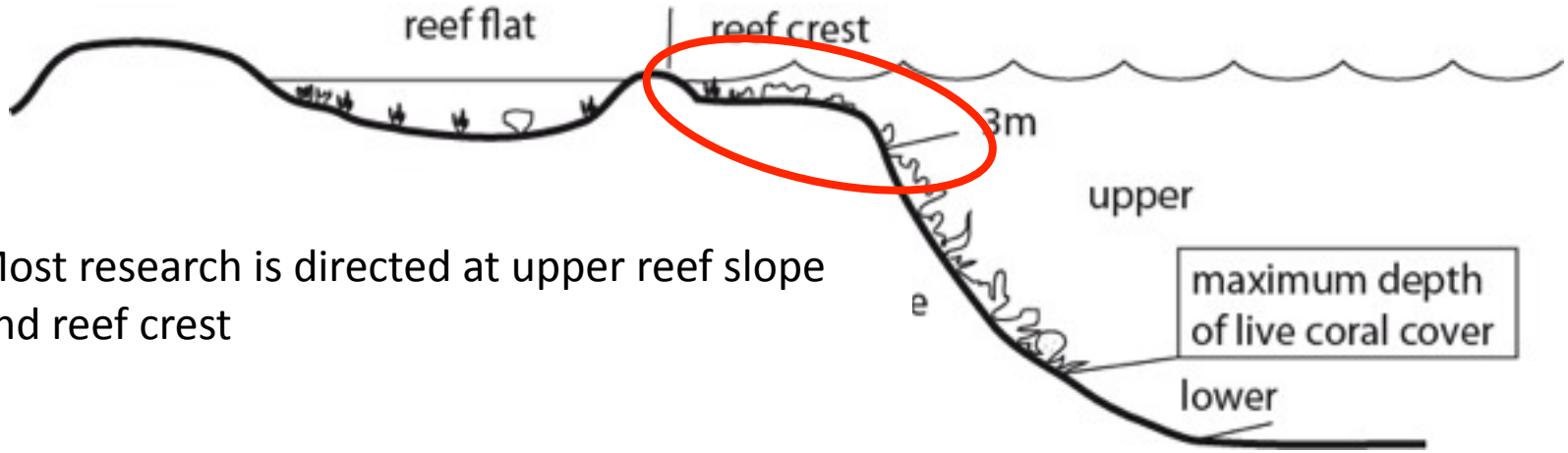
- Island chain on Sunda shelf, about 50 km long
- Up to 90 m deep in central part
- City of 15 million people in hinterland



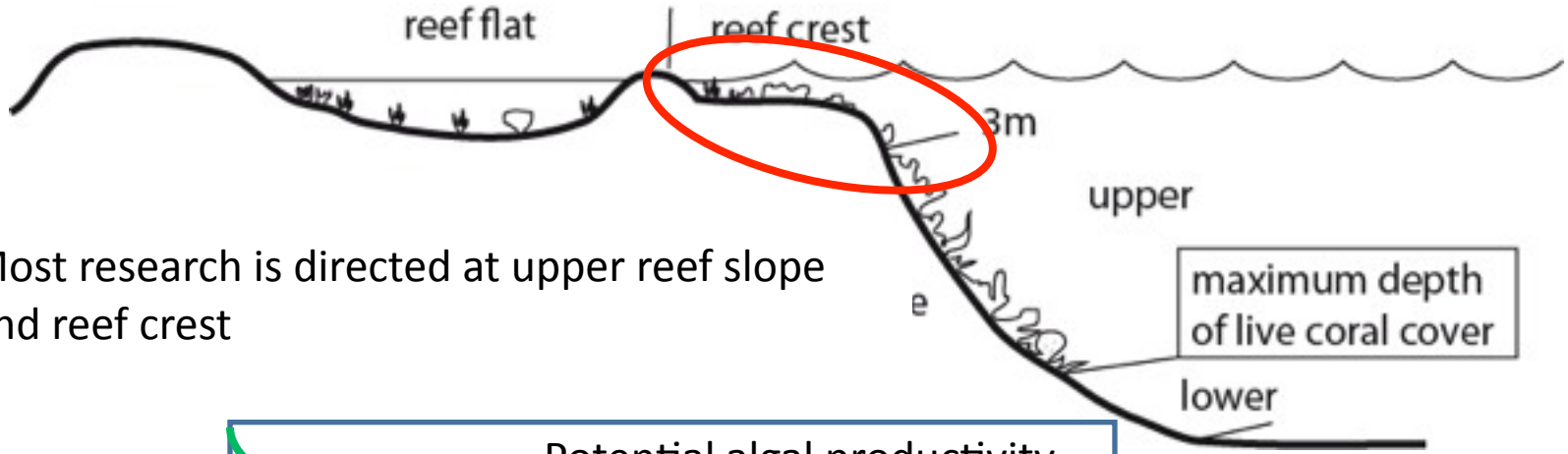


Friday, 7 October 2011

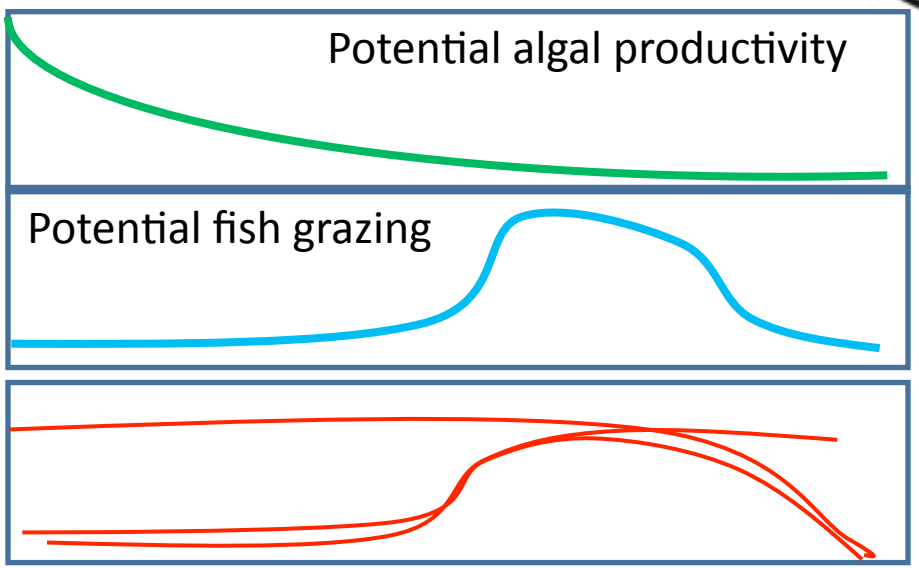

reef flat
reef crest
3m
upper
reef slope
maximum depth
of live coral cover
lower



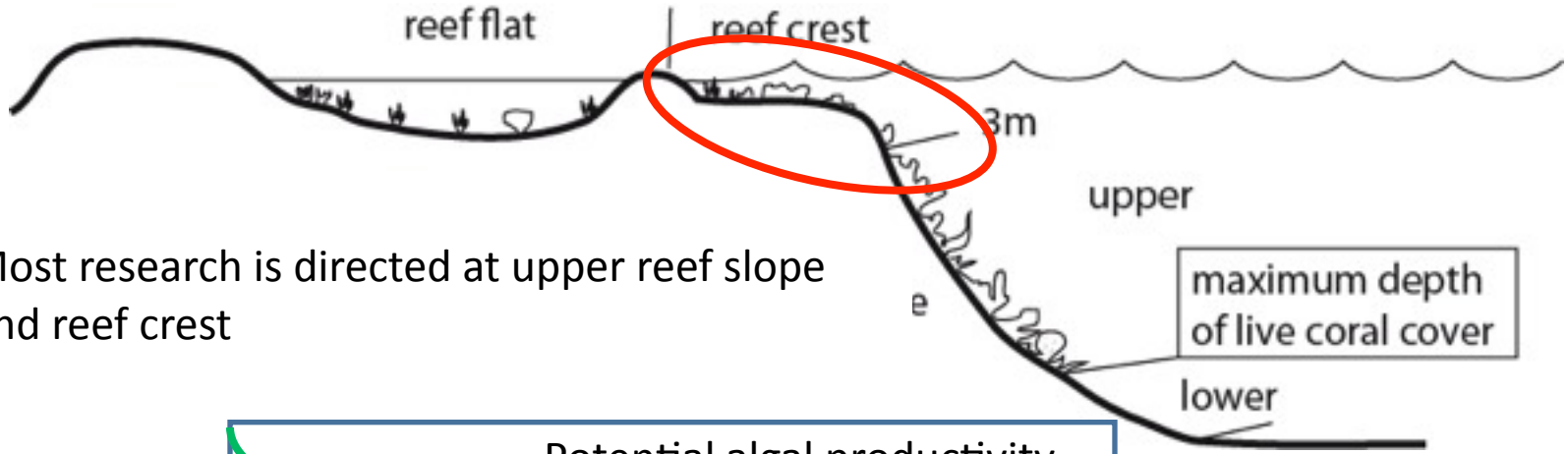
Most research is directed at upper reef slope and reef crest



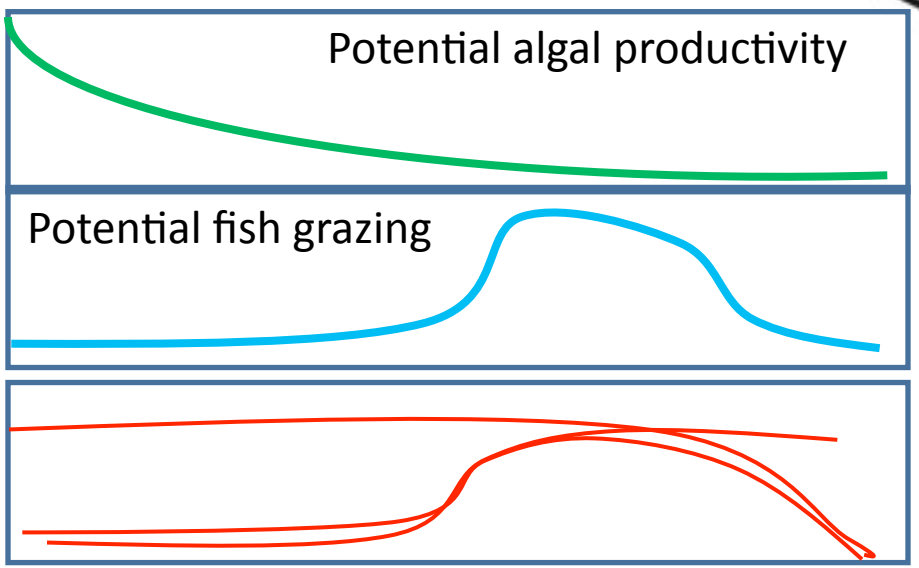
Most research is directed at upper reef slope and reef crest



Disturbance potential



Most research is directed at upper reef slope and reef crest



A different response within different part of the reef system can be expected

Can assemblage be defined?
… and can they be helpful for interpreting the fossil record

Can assemblage be defined? … and can they be helpful for interpreting the fossil record

- Rubble
  - shallow (with *Amphisorus*)
  - intermediate *(*with *Calcarina spengleri)*
  - *deep (*with *Baculogypsinoides)*

Can assemblage be defined?
… and can they be helpful for interpreting the fossil record

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  - shallow (with *Amphisorus*)
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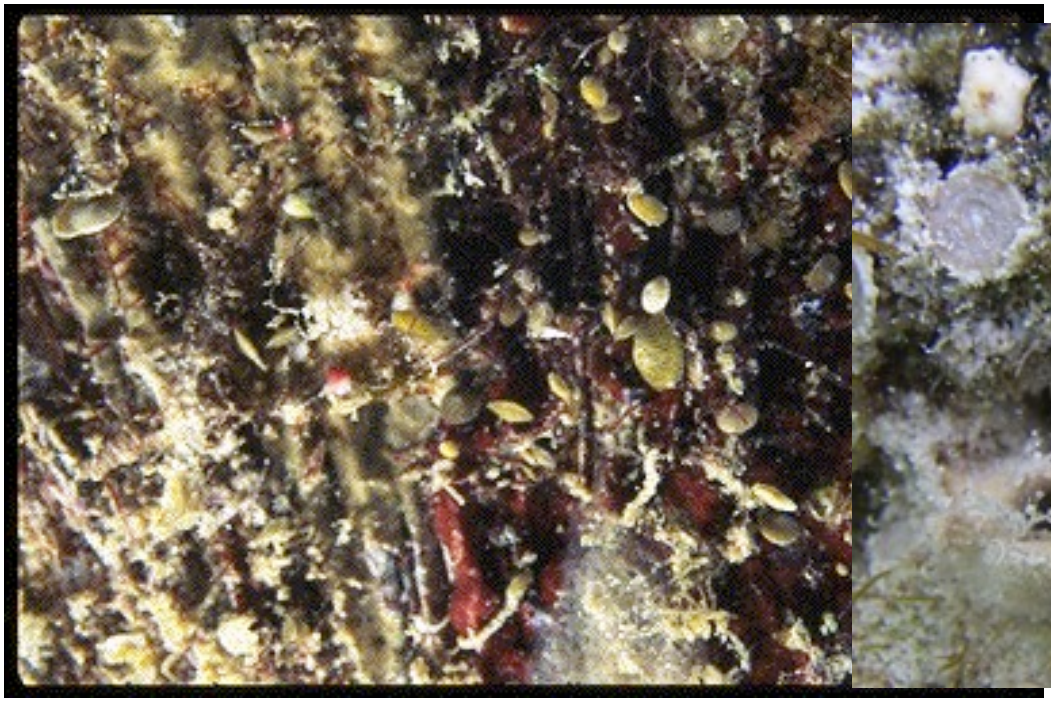
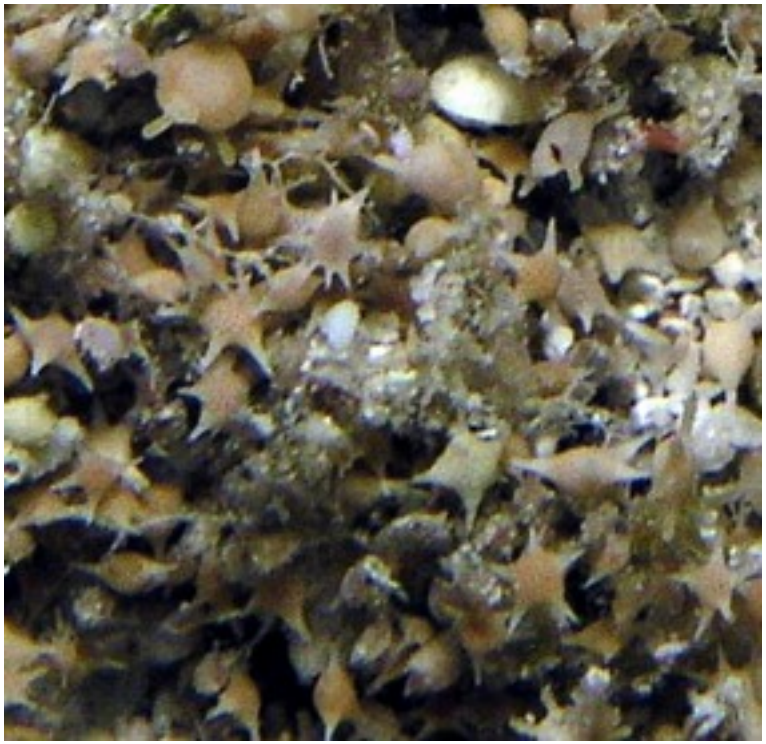
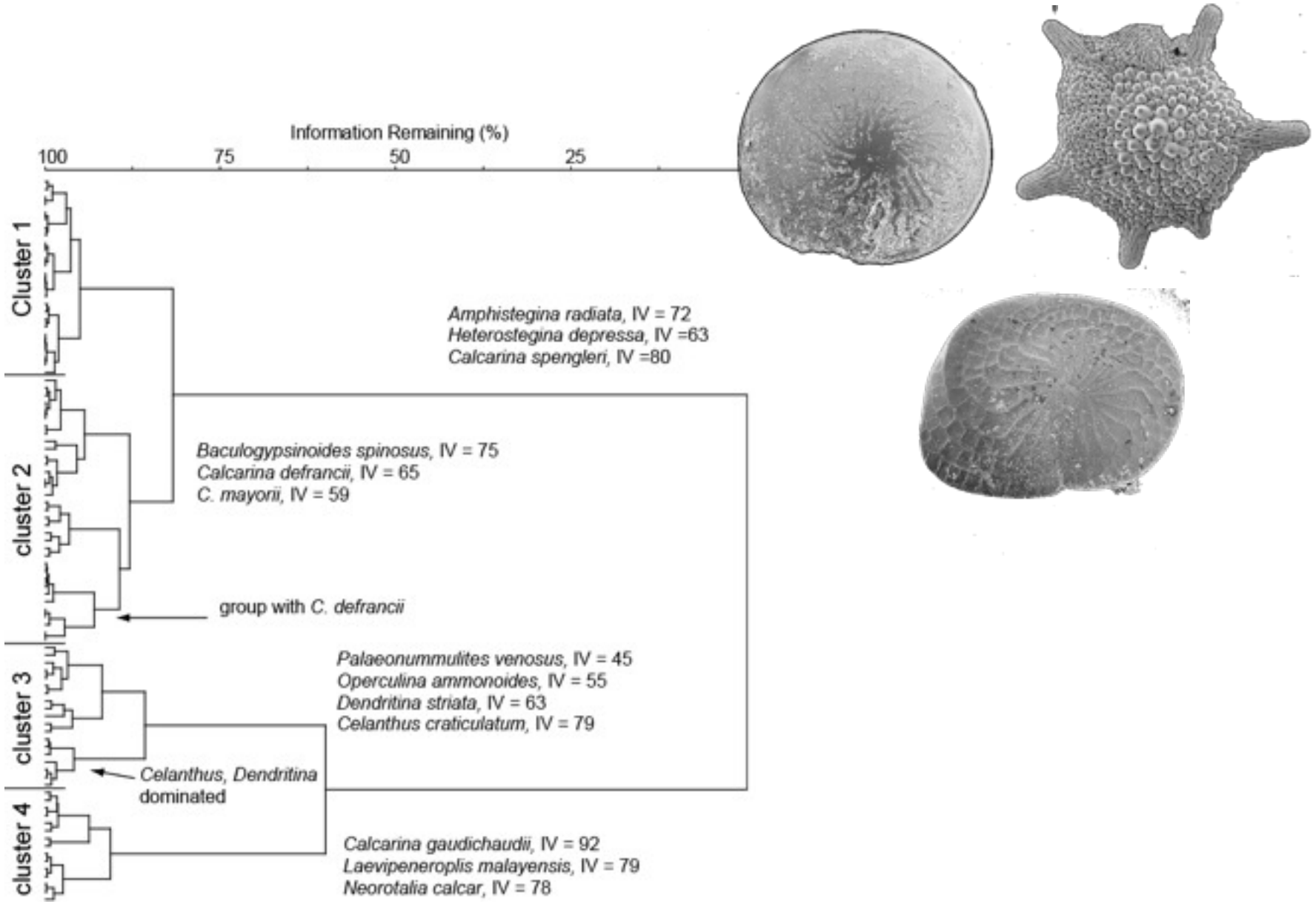
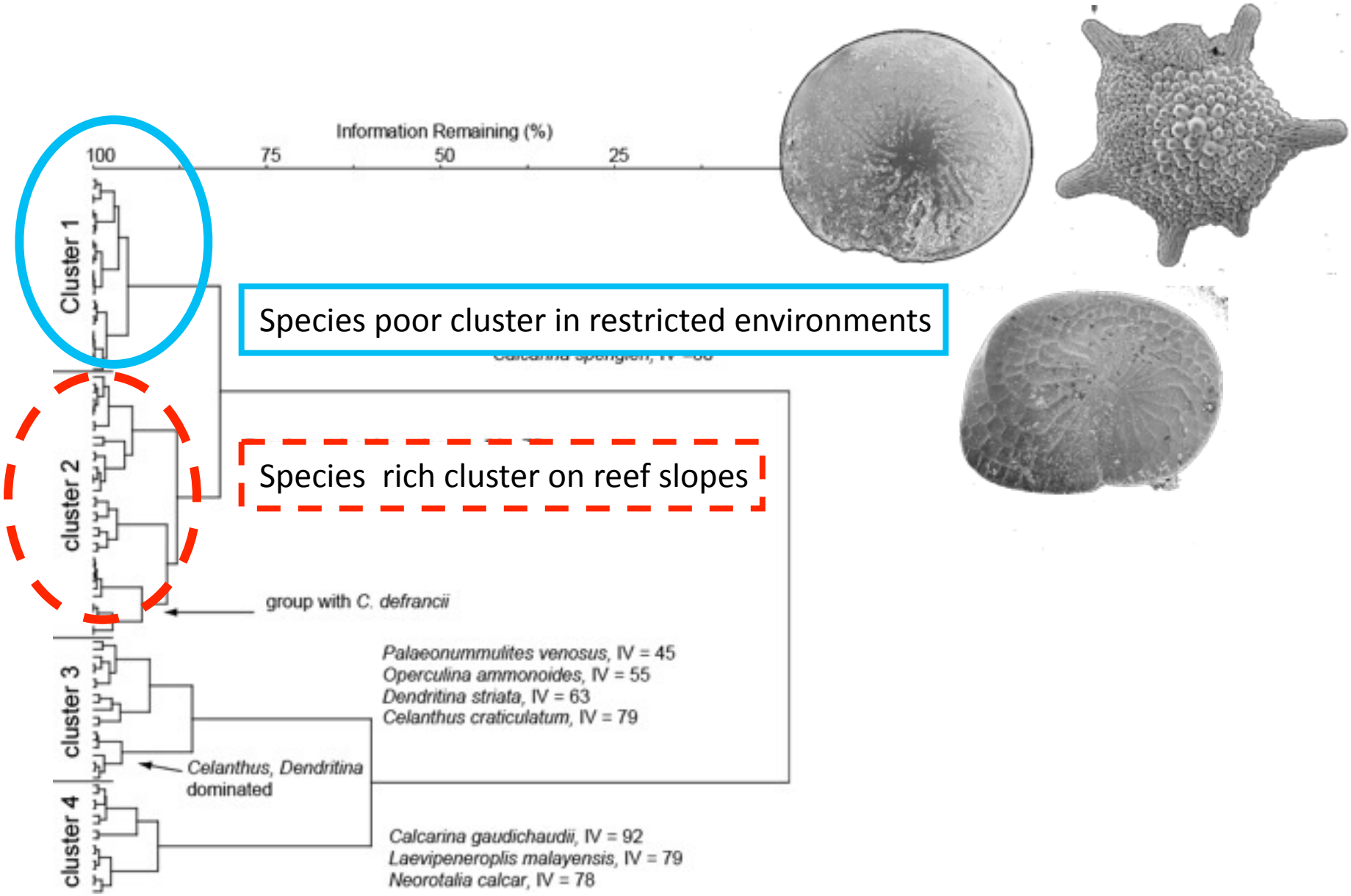


- Rubble
  - shallow (with *Amphisorus*)
  - intermediate *(*with *Calcarina spengleri)*
- Rubble with algae / sand (barrier region)

- Rubble
  - shallow (with *Amphisorus*)
  - intermediate *(*with *Calcarina spengleri)*
- Rubble with algae / sand (barrier region)
- Reef flat: turf forming algae, reefrock with crustaceous calcareous algae




Information Remaining (%)
100
75
50
25
Cluster 1
cluster 2
cluster 3
cluster 4
Amphistegina radiata, IV = 72
Heterostegina depressa, IV =63
Calcarina spengleri, IV =80
Baculogypsinoides spinosus, IV = 75
Calcarina defrancii, IV = 65
C. mayorii, IV = 59
group with C. defrancii
Palaeonummulites venosus, IV = 45
Operculina ammonoides, IV = 55
Dendritina striata, IV = 63
Celanthus craticulatum, IV = 79
Celanthus, Dendritina dominated
Calcarina gaudichaudii, IV = 92
Laevipeneroplis malayensis, IV = 79
Neorotalia calcar, IV = 78


Information Remaining (%)
100
75
50
25
Cluster 1
cluster 2
cluster 3
cluster 4
Species poor cluster in restricted environments
Species rich cluster on reef slopes
group with C. defrancii
Palaeonummulites venosus, IV = 45
Operculina ammonoides, IV = 55
Dendritina striata, IV = 63
Celanthus craticulatum, IV = 79
Celanthus, Dendritina dominated
Calcarina gaudichaudii, IV = 92
Laevipeneroplis malayensis, IV = 79
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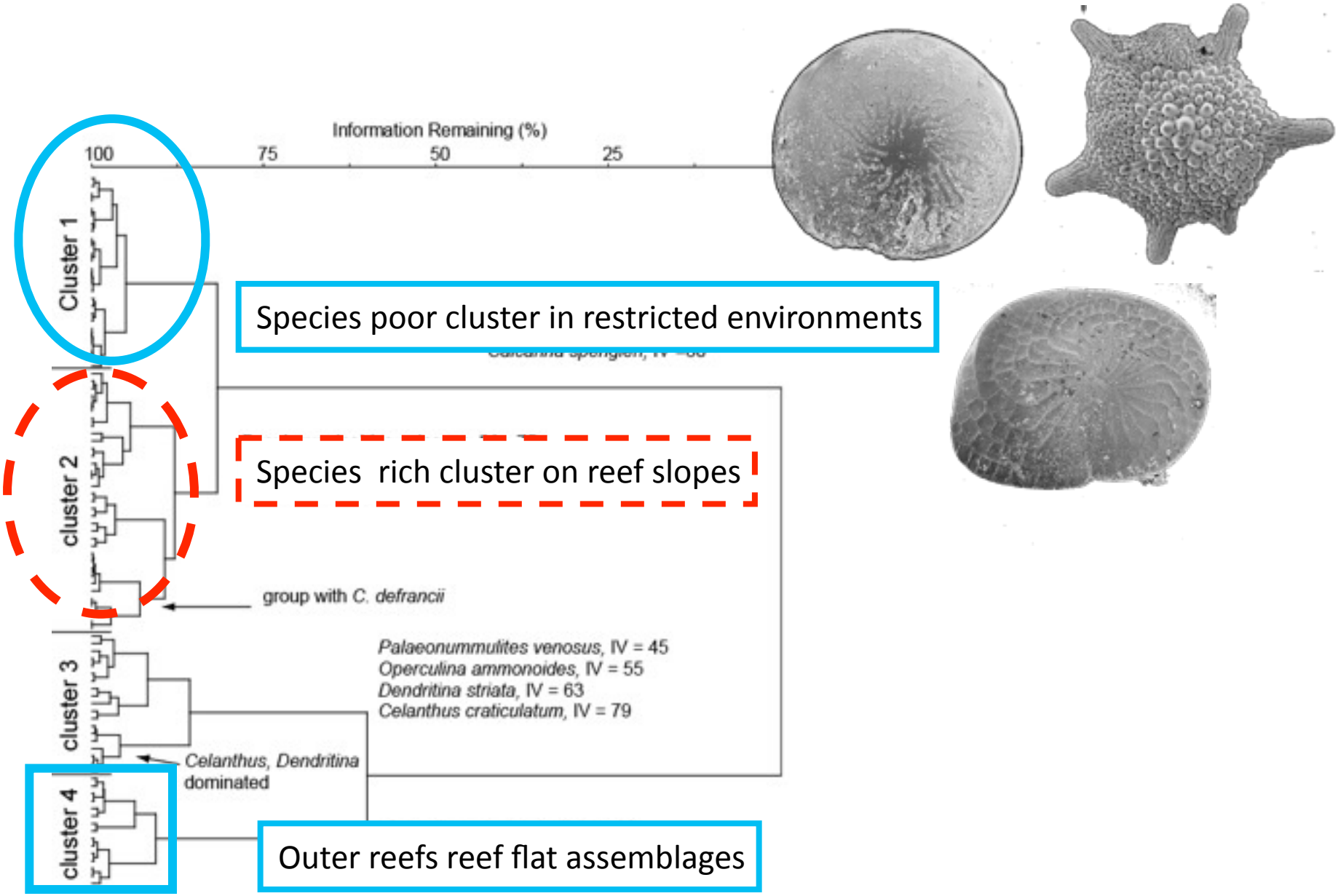
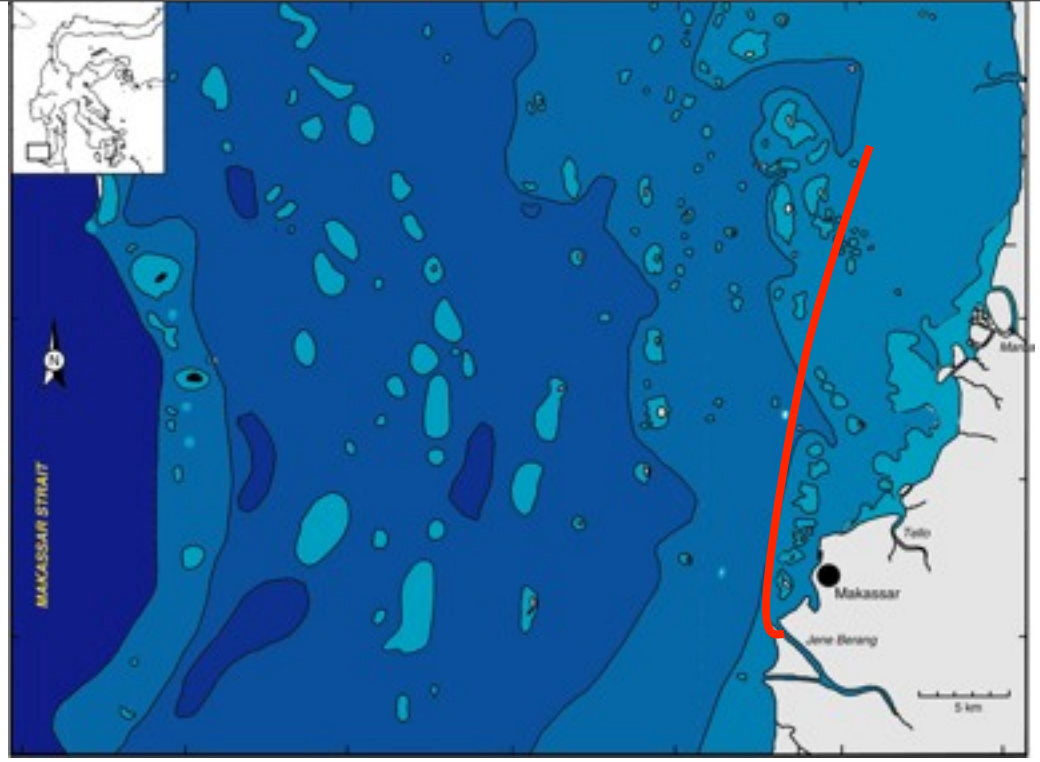
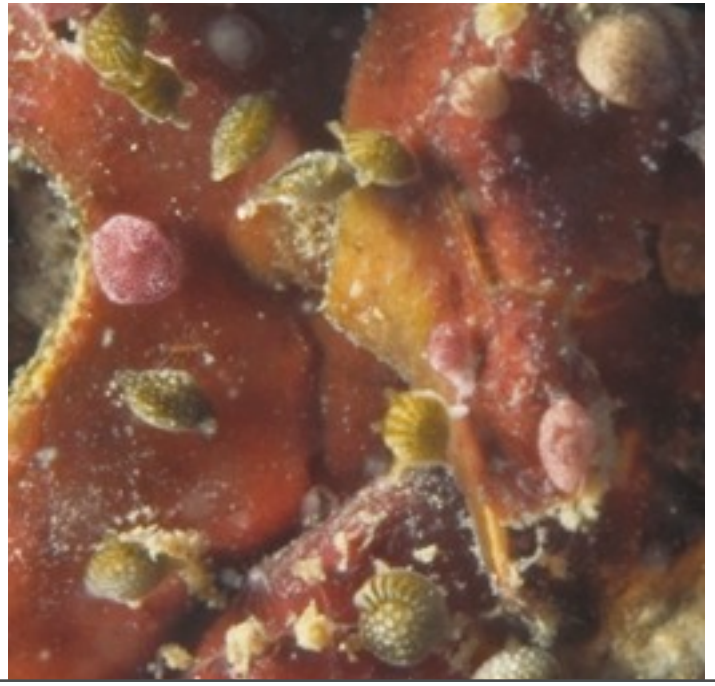
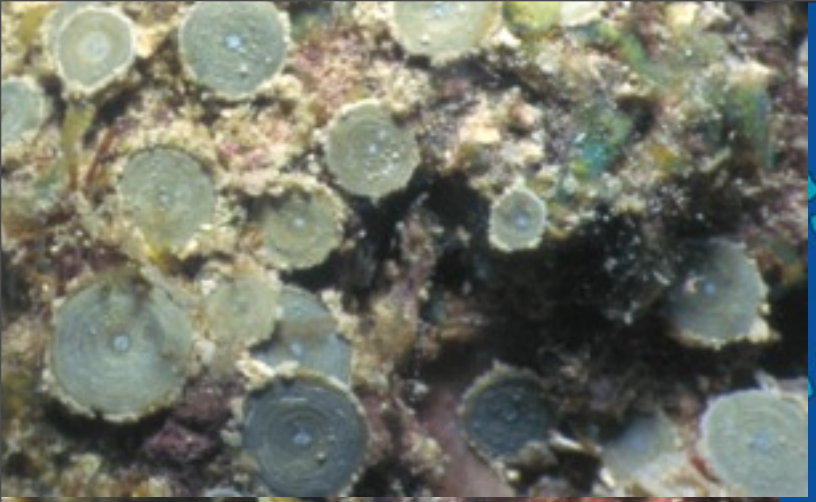
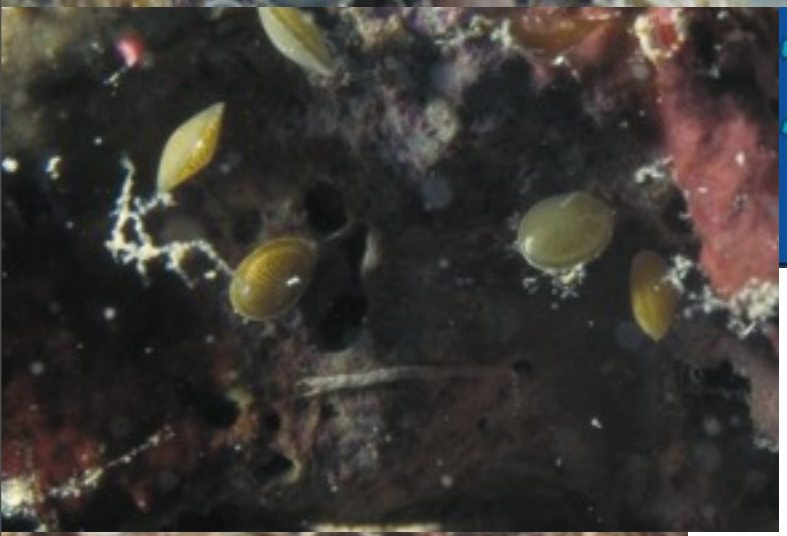

Information Remaining (%)
100
75
50
25
Cluster 1
cluster 2
cluster 3
cluster 4
group with C. defrancii
Palaeonummulites venosus, IV = 45
Operculina ammonoides, IV = 55
Dendritina striata, IV = 63
Celanthus craticulatum, IV = 79
Celanthus, Dendritina dominated
Species poor cluster in restricted environments
Species rich cluster on reef slopes
Outer reefs reef flat assemblages

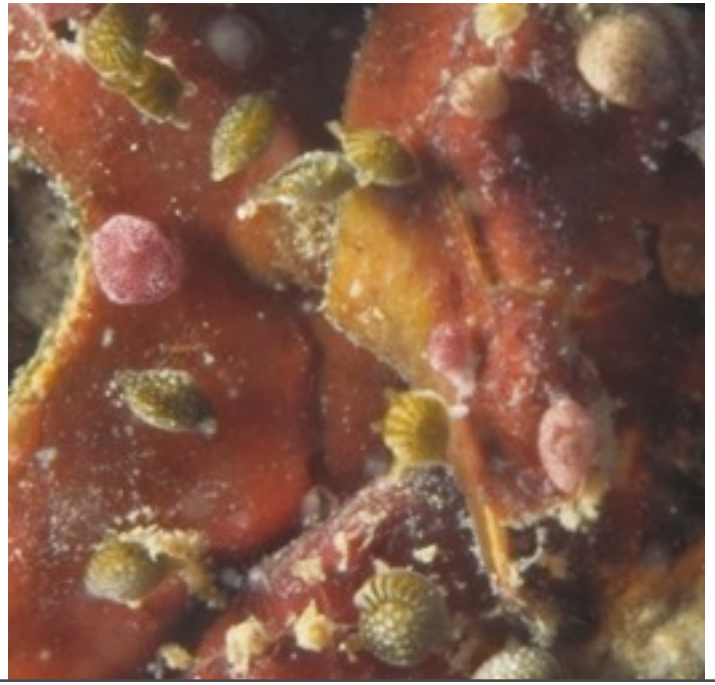

MAKASSAR STRAIT
Makassar
Jene Berang
5 km



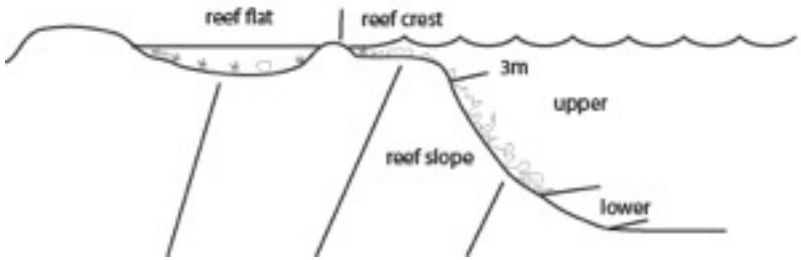


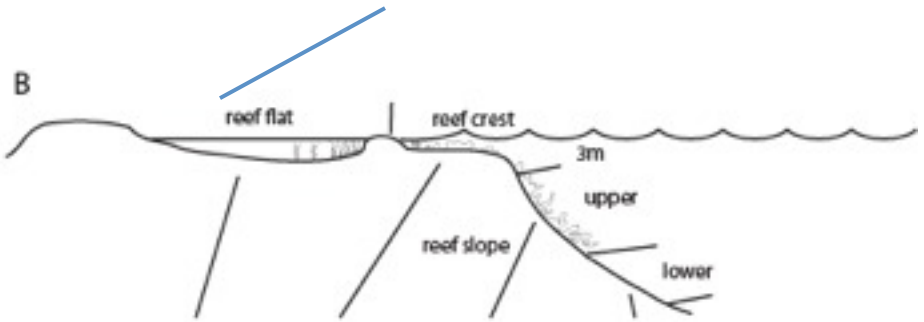


Makassar
Jene Berang
5 km

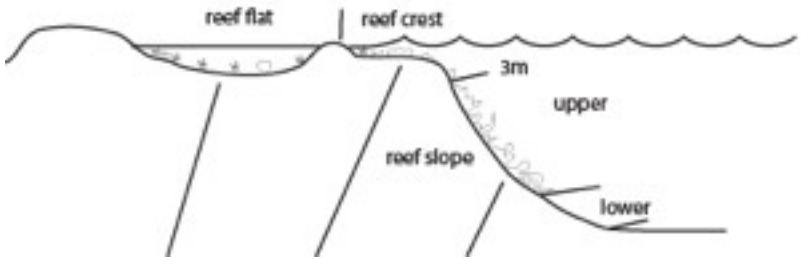


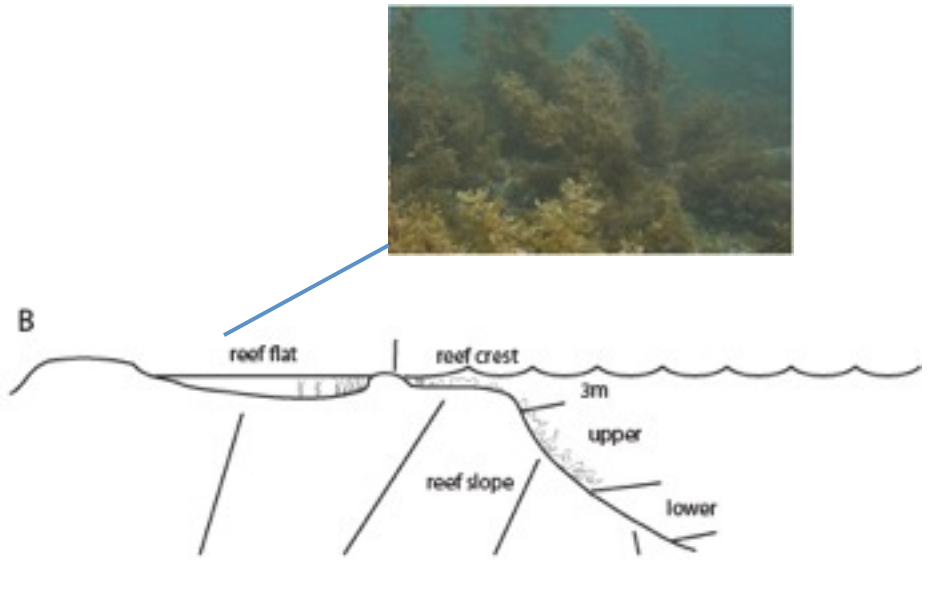
Reefprofile





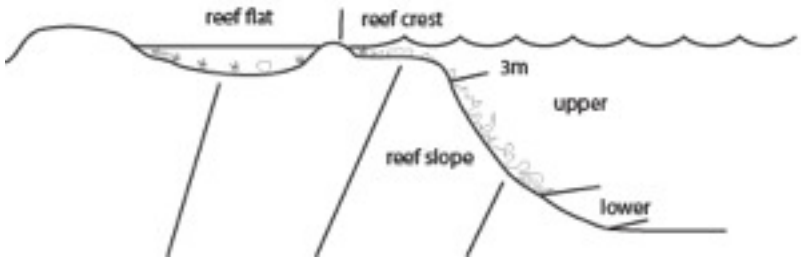
Reefprofile

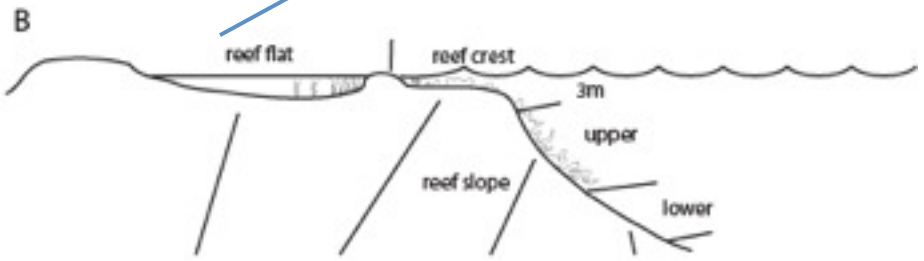




Benthic environment

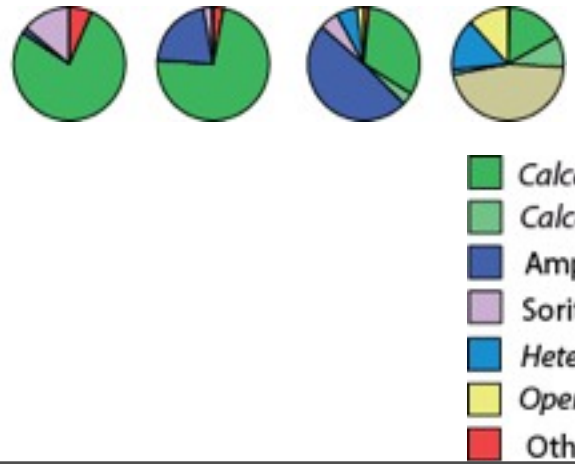
Reefprofile

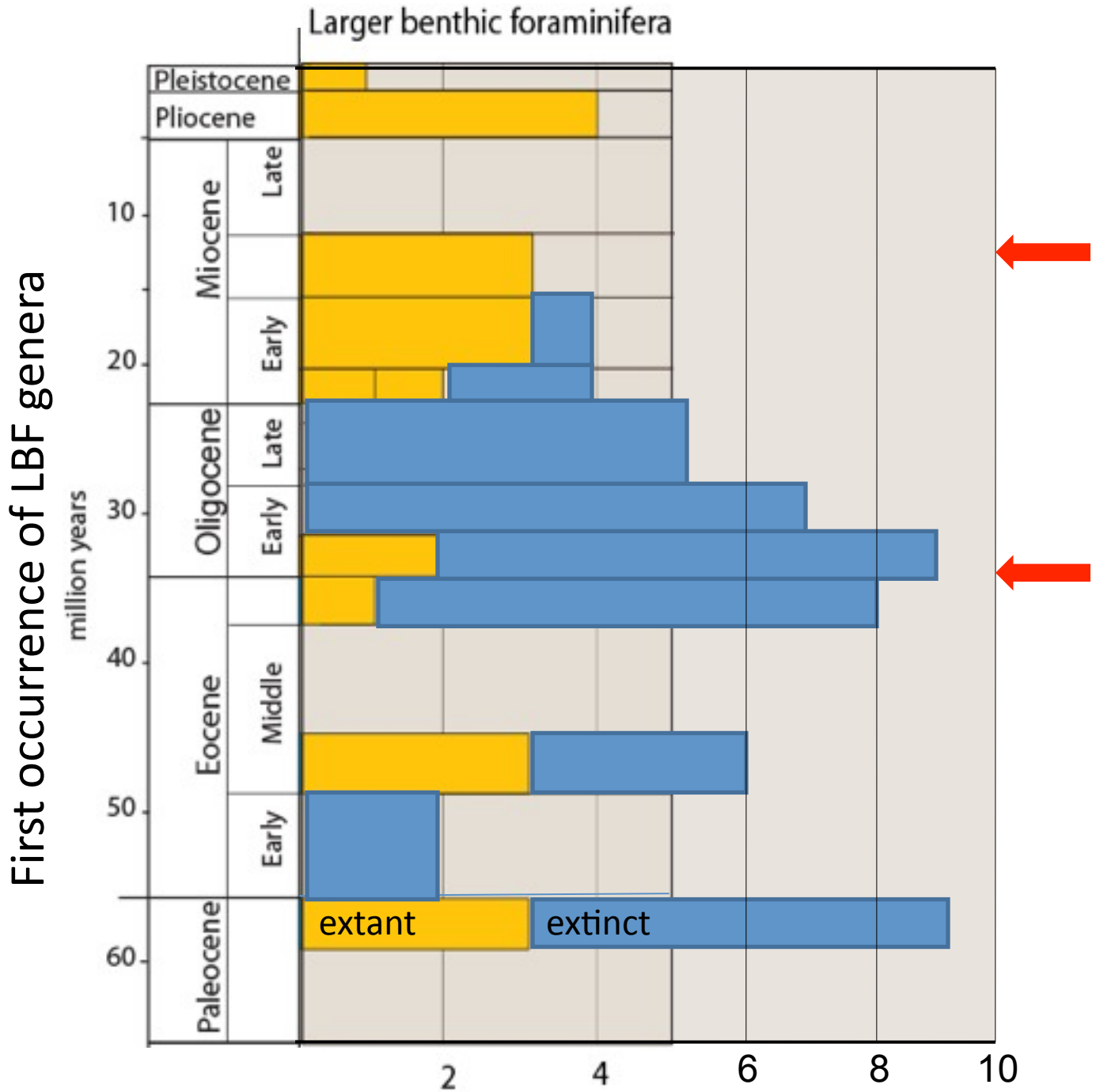


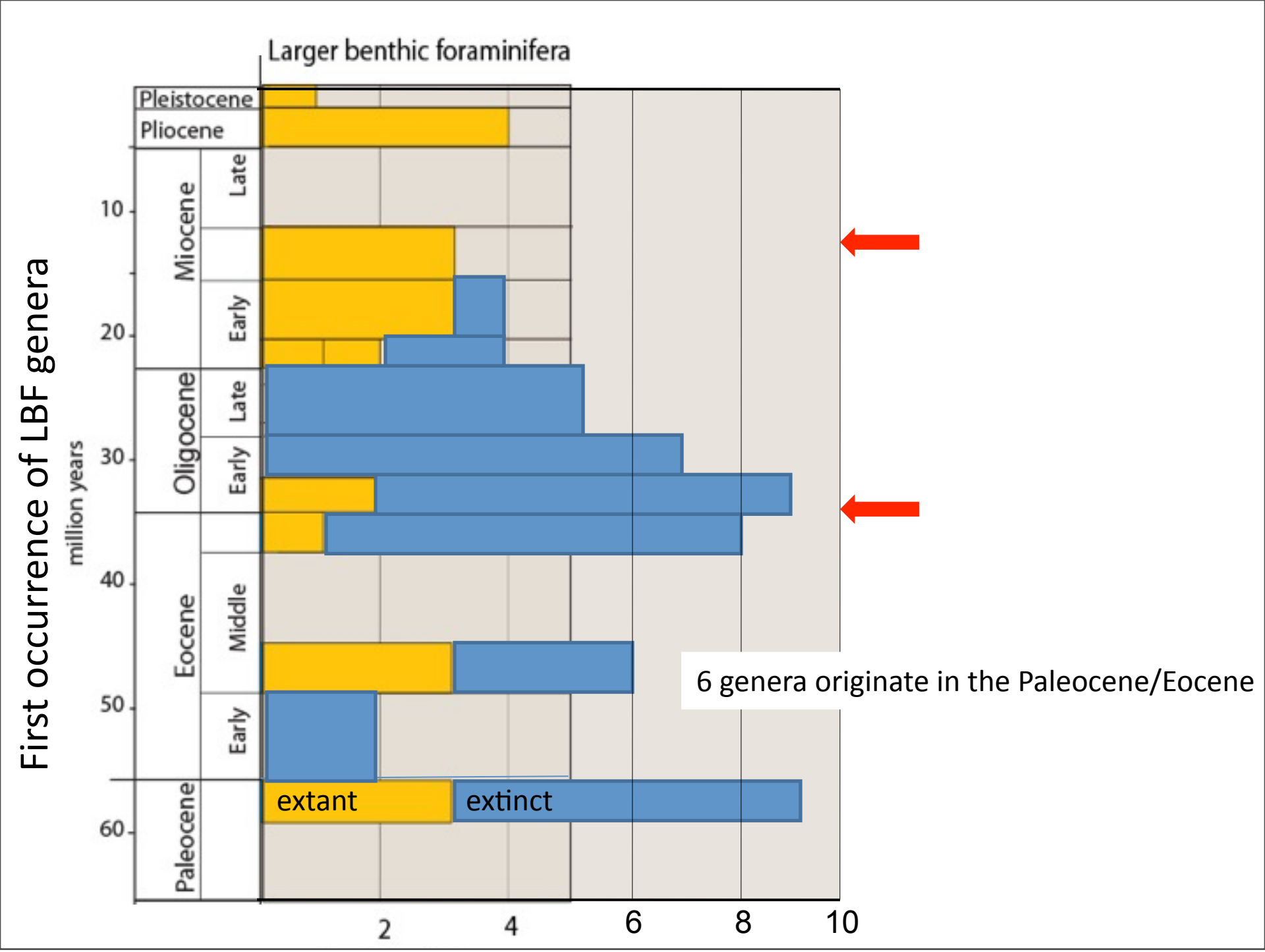


Benthic environment

Foraminifera assemblage




First occurrence of LBF genera
Larger benthic foraminifera
Pleistocene
Pliocene
Miocene
Late
Early
Oligocene
Late
Early
Eocene
Middle
Early
Paleocene
million years
10
20
30
40
50
60
2
4
6
8
10
extant
extinct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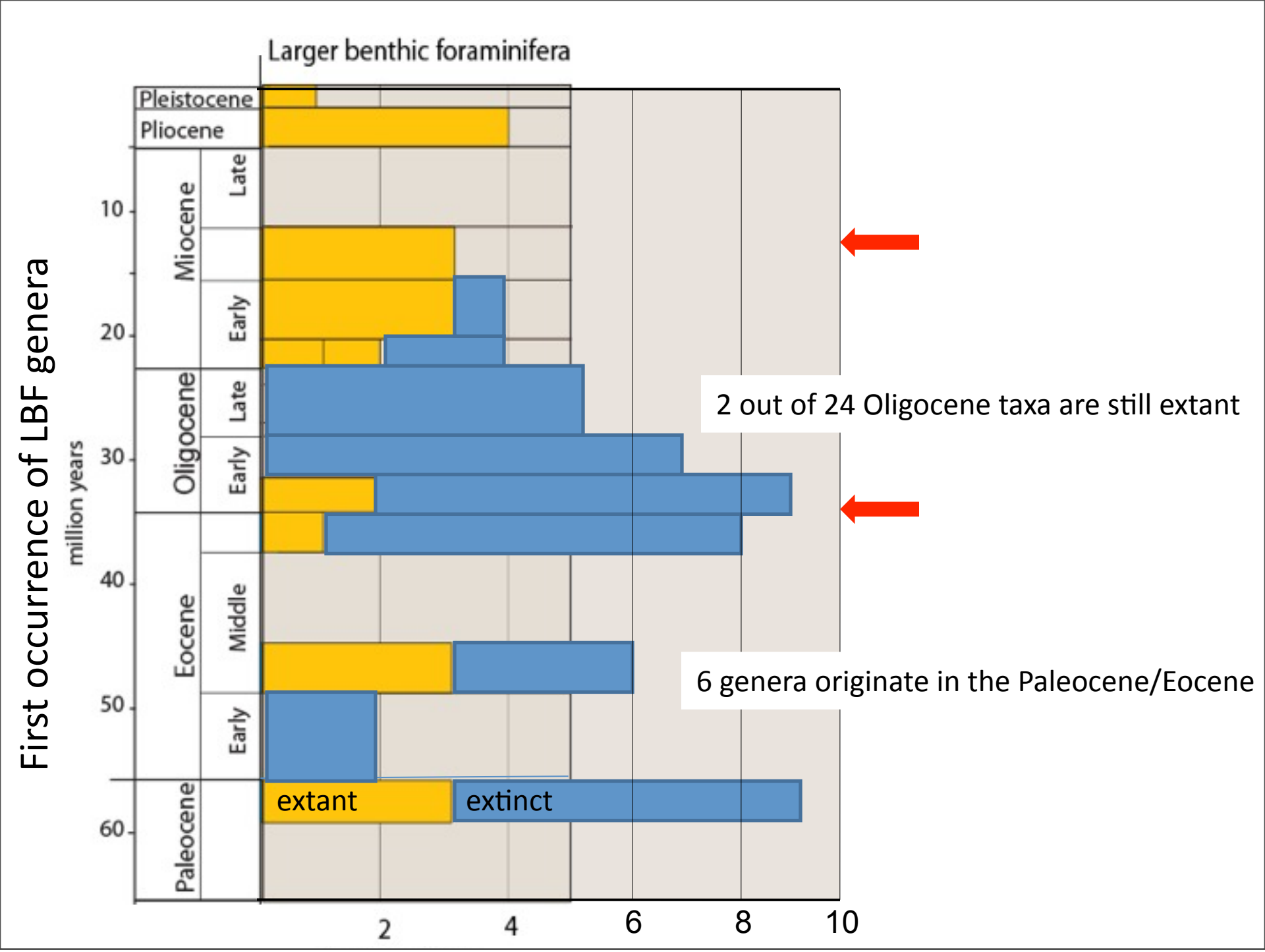
First occurrence of LBF genera
million years
Pleistocene
Pliocene
Miocene
Late
Early
Oligocene
Late
Early
Eocene
Middle
Early
Paleocene
10
20
30
40
50
60
2
4
6
8
10
extant
extinct
6 genera originate in the Paleocene/Eocene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First occurrence of LBF genera
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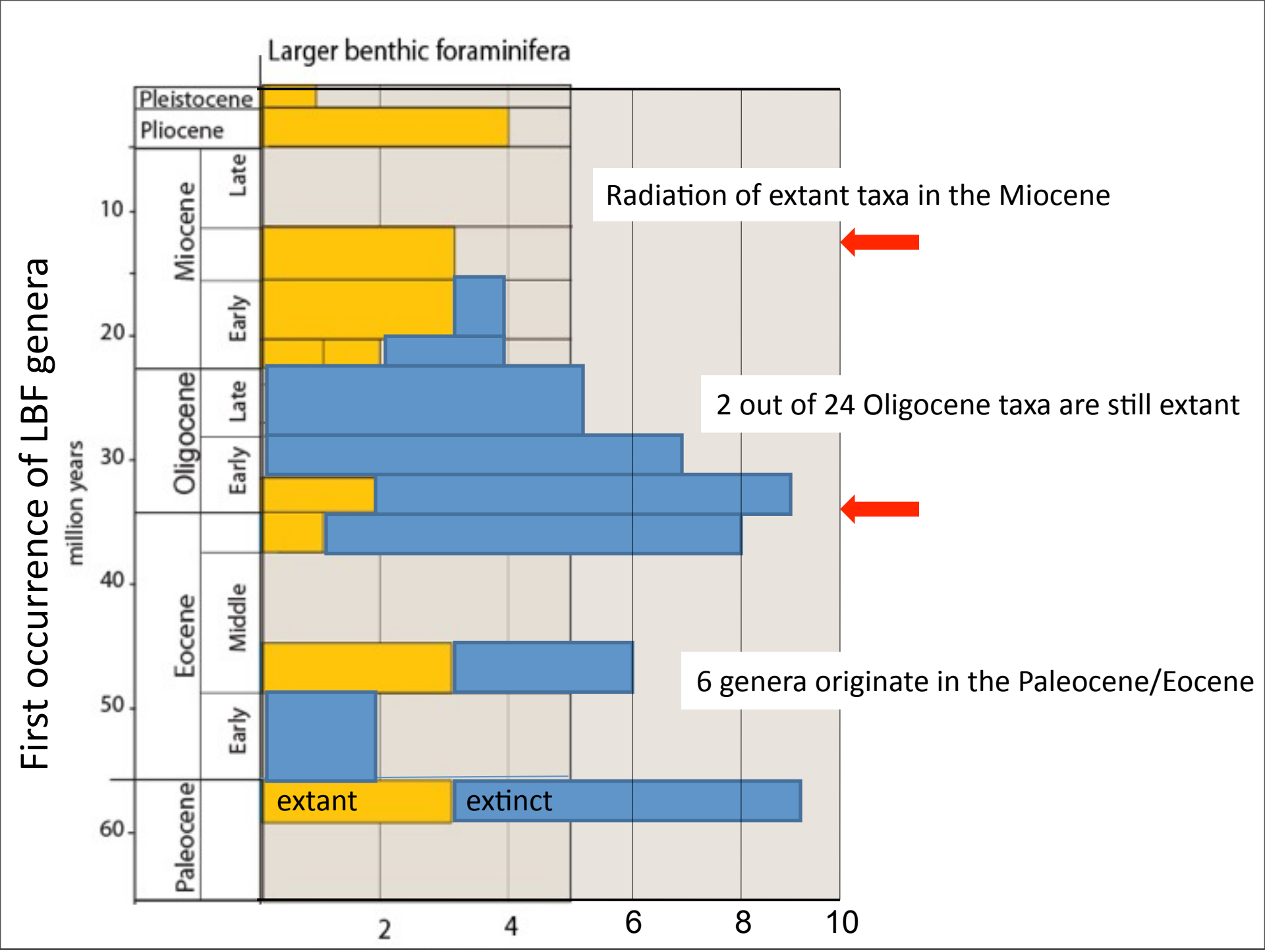
40
50
60
2
4
6
8
10
extant
extinct
2 out of 24 Oligocene taxa are still extant
6 genera originate in the Paleocene/Eocene


Larger benthic foraminifera
First occurrence of LBF genera
million years
Pleistocene
Pliocene
Miocene
Late
Early
Oligocene
Late
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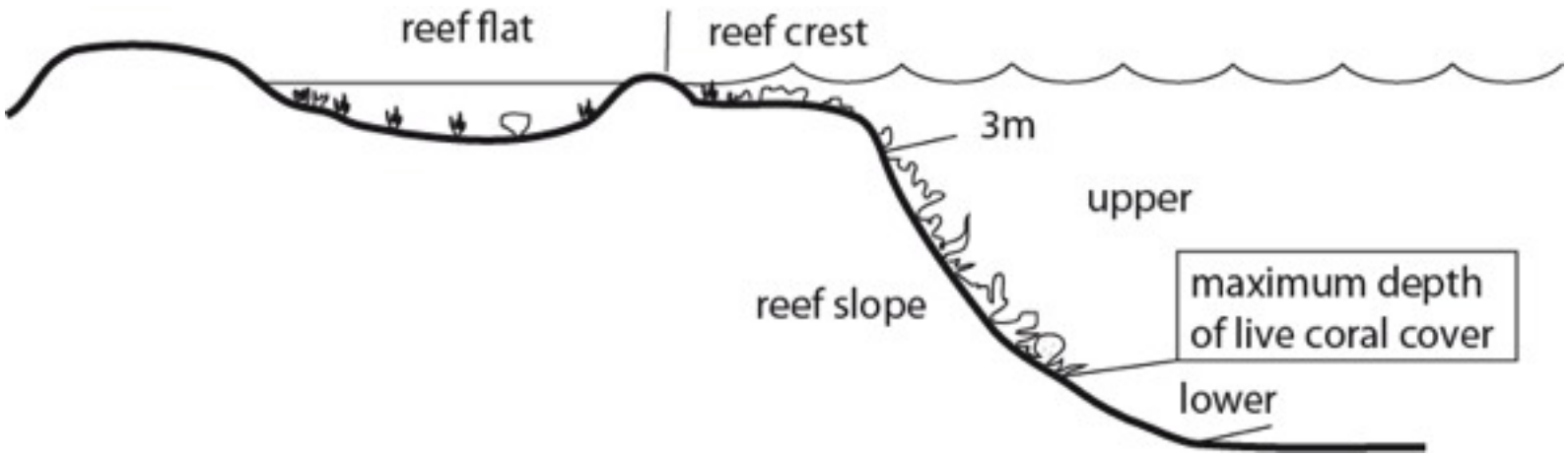
Eocene
Middle
Early
Paleocene
10
20
30
40
50
60
2
4
6
8
10
extant
extinct
Radiation of extant taxa in the Miocene
2 out of 24 Oligocene taxa are still extant
6 genera originate in the Paleocene/Eocene

line of log at locality 5
BED 1
BED 2 & 3
BED 4
BED 5
BED 6
BED 8
BED 8
BED 11

Small scale carbonate platform in a coastal shelf sea
• LBF dominated
• corals very localized along the margin


reef flat
reef crest
3m
upper
reef slope
maximum depth
of live coral cover
lower

Friday, 7 October 2011