

# Monitoring colonization processes in the inner Oslofjord: benthic foraminifera as a tool for ecosystem characterization

Silvia Hess, Elisabeth Alve and the PES working group\*  
Department of Geosciences, University Oslo, Norway

- Paleoecological reconstructions of marine soft-bottom Ecological Status and in situ reference conditions:  
calibrating benthic foraminifera with macrofauna and hydrographic data

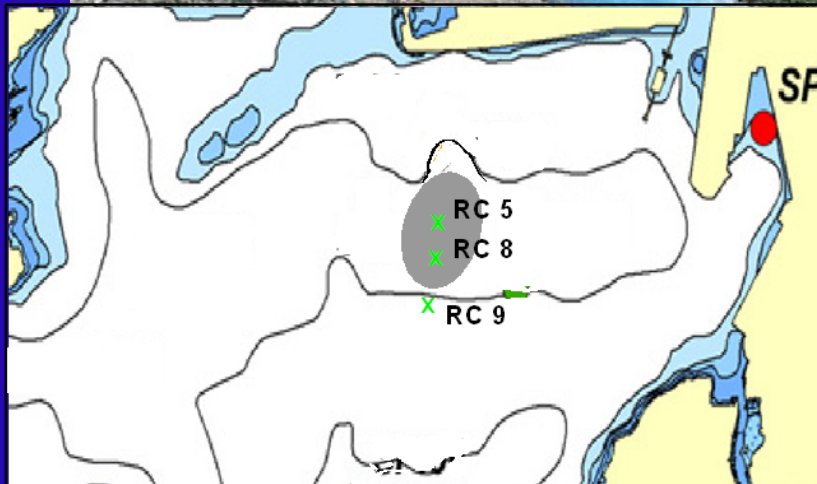
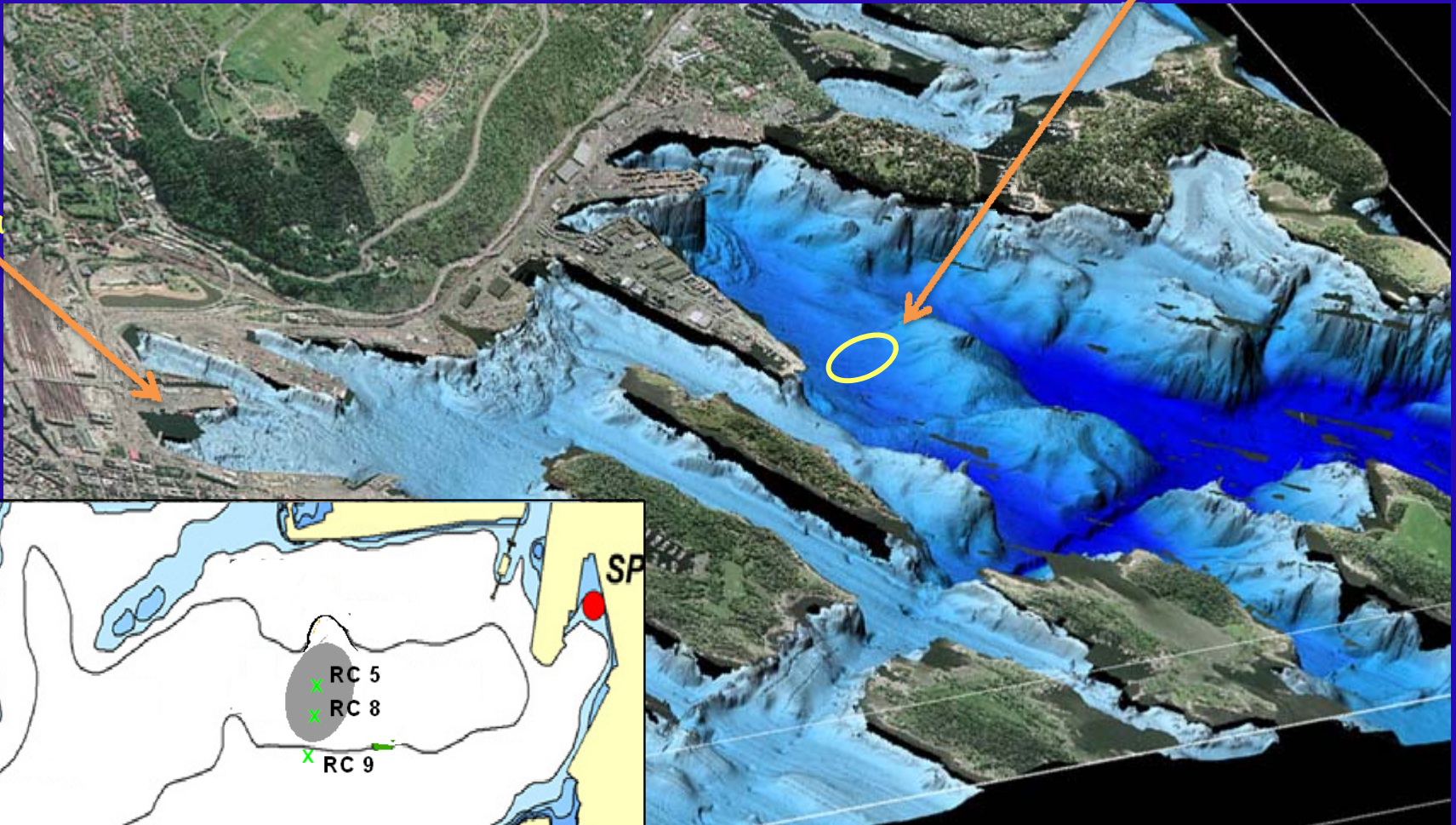
# Project information

- colonization study is a sub-project of the PES-project at the UiO  
(PES: **P**aleoecological reconstructions of marine soft-bottom **E**cological **S**tatus and in situ reference conditions: calibrating benthic foraminifera with macrofauna and hydrographic data)
- to monitor the colonization processes in the inner Oslofjord
  - a) temporary survey of an area where the anoxic bottom sediment is capped with Quaternary clay
  - b) a site in the uncapped area to observe the natural recover to oxic conditions
- Will the new assemblage be comparable with the reference assemblage or will it reflect new environmental conditions?
- How quickly can the environment recover?

# Inner Oslofjord: Bekkelagsbasseng

PES study area 2008-2010

Oslo opera



# Inner Oslo fjord: Bekkelagsbasseng

- a semi-enclosed basin surrounded by sills with depths down to 42 m
- sediments are contaminated by discharges from various sources (e.g. discharge of the sewage plant Bekkelaget, established in 1963)
- since 2001 phosphor and nitrogen concentrations in the wastewater are dramatically reduced by the initiation of a new sewage plant
- since that time the ecological conditions (e.g. heavy metal concentrations, oxygen conditions) slowly improve
- in winter 2007 heavily contaminated sediments in the Bekkelagsbasseng were capped with marine Quaternary clay that was dug out during the Bjørvika tunnel construction
- since spring 2008 we do a temporally survey of 3 study sites (1 located in the middle of the capped area (RC5), 1 in the periphery (RC 8) and 1 just outside the capped area (RC 9))
- until now samples were collected in March, June, September 2008, and March 2009; continues sampling is planned in 2009 and 2010

## Sample collection:

RV Trygve Braarud



collected at each site:

2 grab samples for macrofaunal studies

3 cores for foraminiferal studies

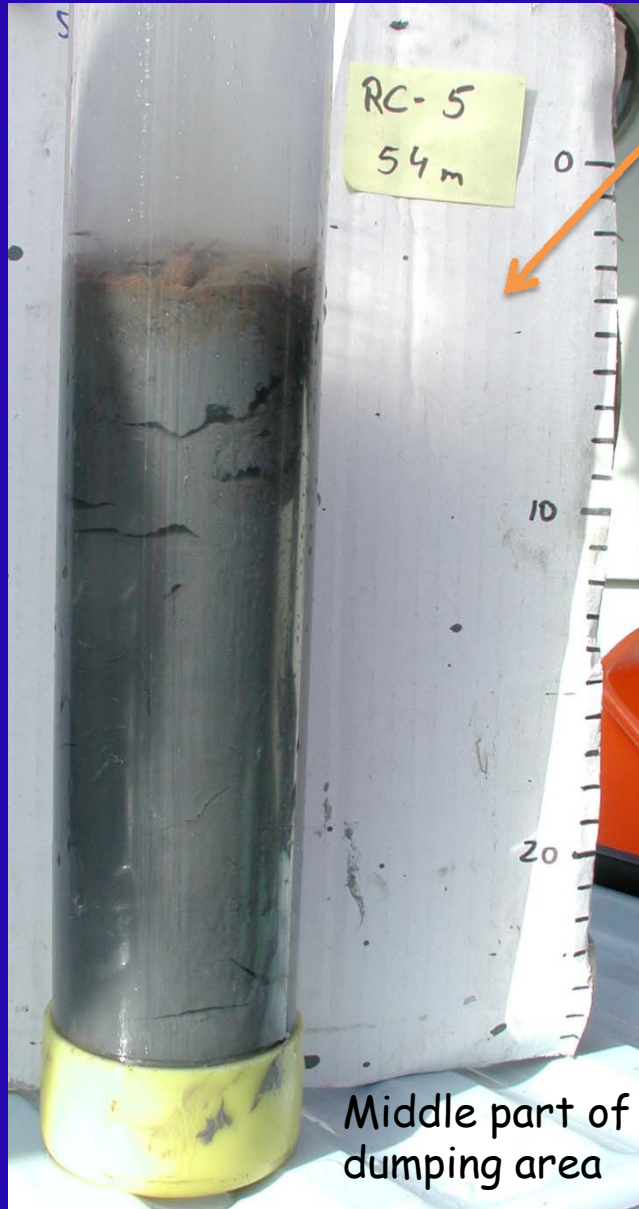
1 bottom water sample for  $O_2$  content

1 core for pigment analysis

1 core for heavy metal analysis



# Main recolonization sites in the Bekkelagsbasseng (Oslofjord)



## Site 5 :

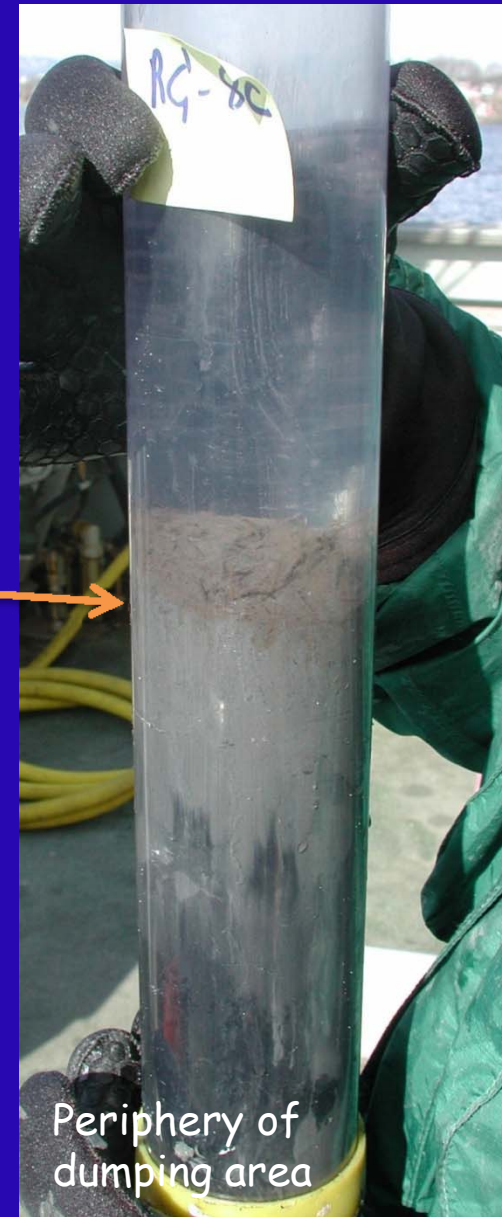
- thin brownish surface
- grey stiff clay, new substrate thicker than 25 cm and very stiff

## Site 8 :

- thin brownish surface
- new substrate c. 6cm thick
- dark soft clay with some stiff clay lumps

## Site 9 :

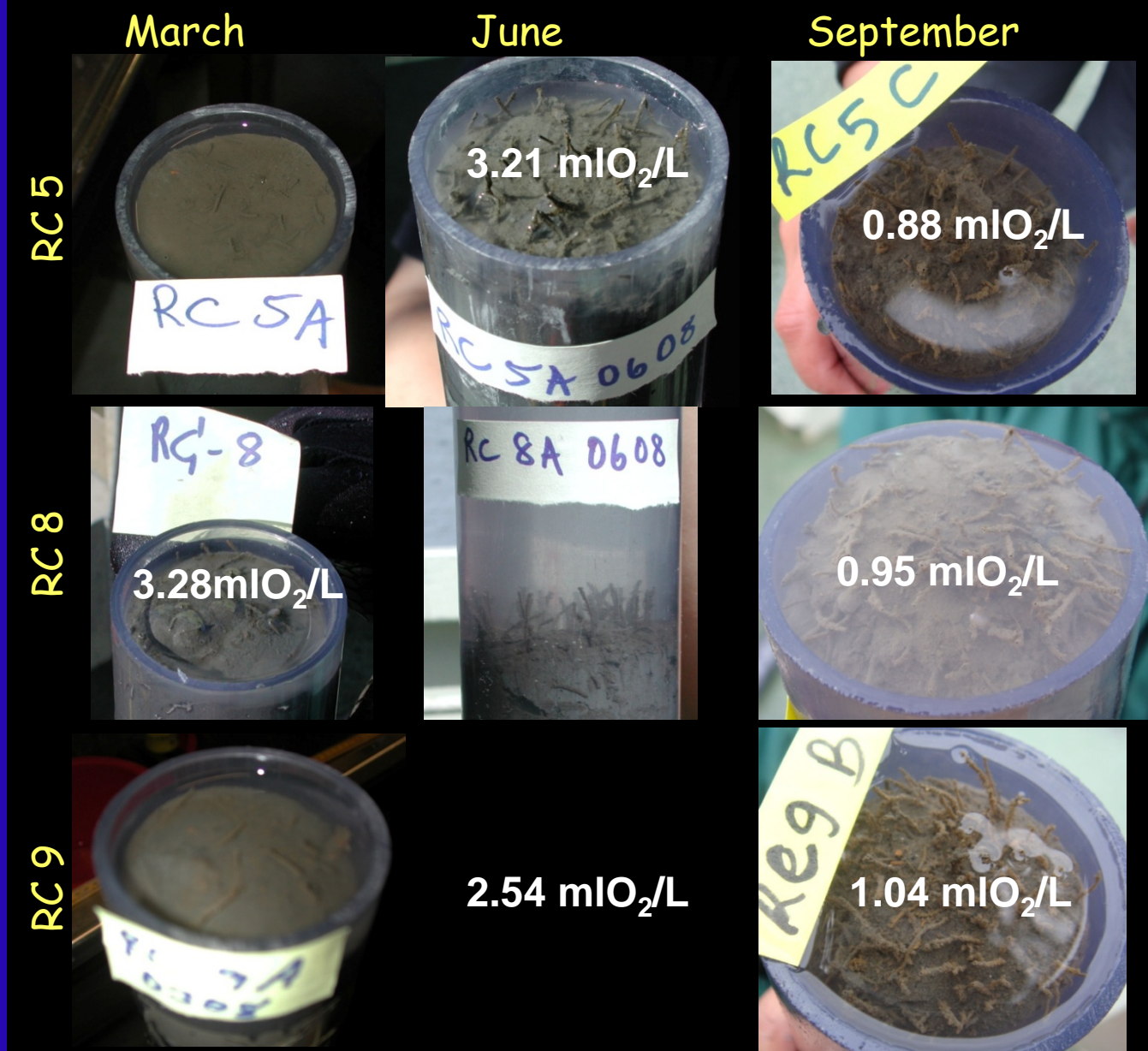
- thin brownish surface
- dark soft clay



# Surface fauna at the recolonization sites in 2008:

Bottom water oxygen content:

No. of polychaet tubes:



	March	June	Sept.
RC 5	12	31	41
RC 8	27	35	36
RC 9	15	24	31

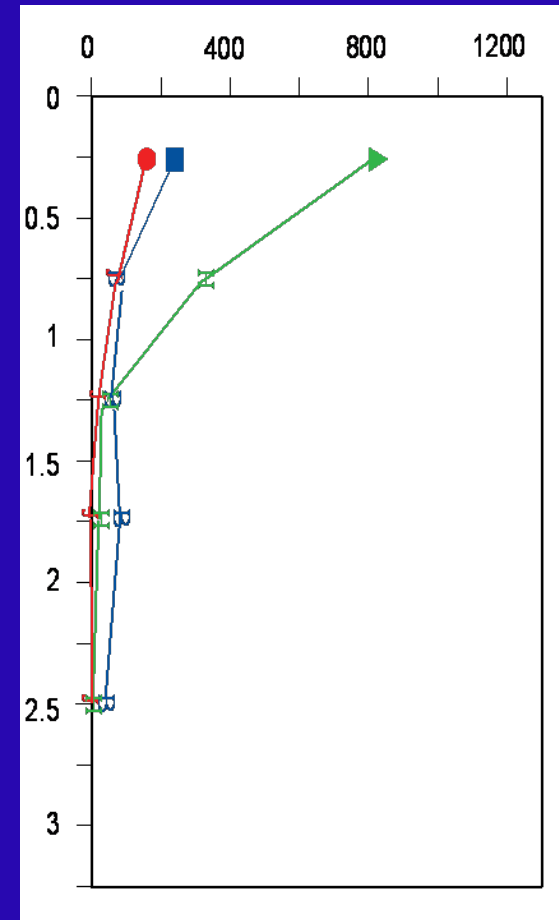
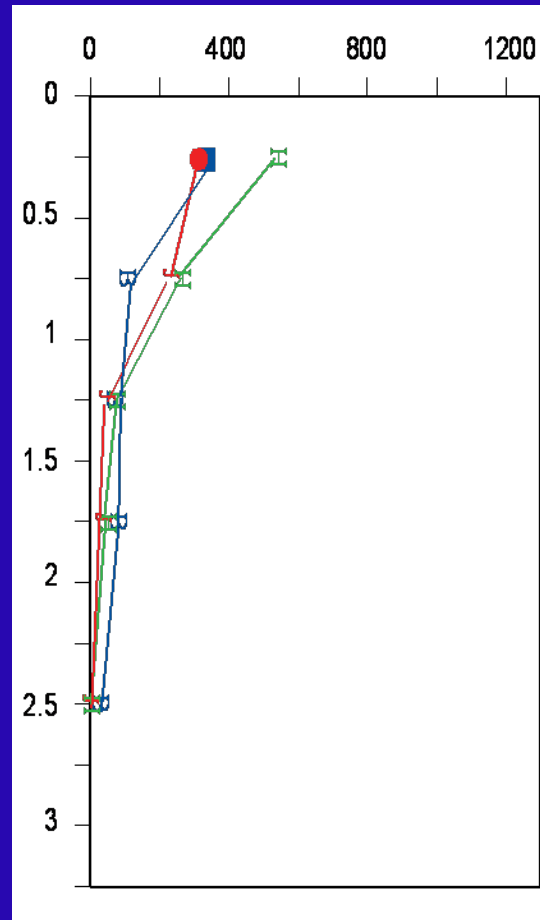
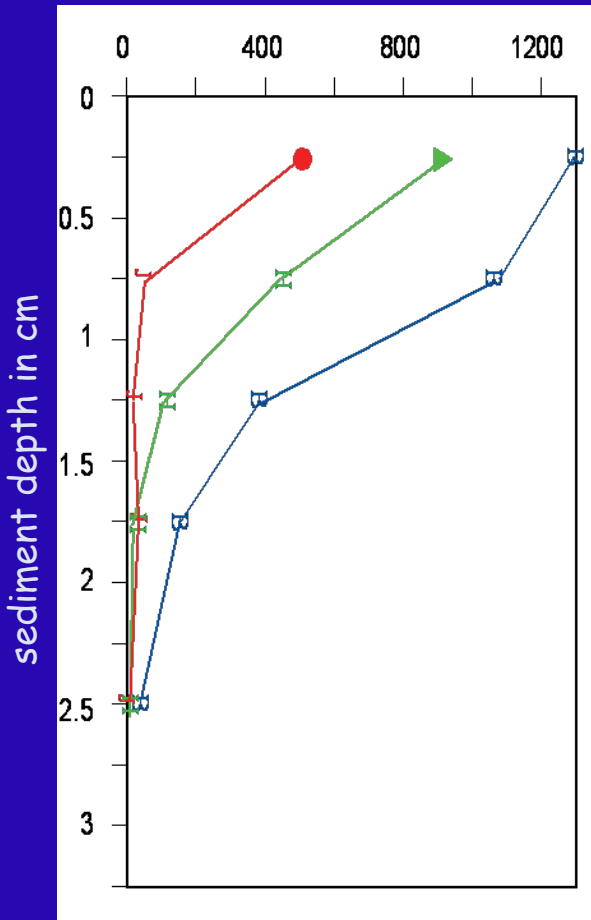
# Standing stock at 3 recolonization sites in 2008

station RC5

station RC8

station RC9

total no. of stained individuals per 12 cm<sup>3</sup>



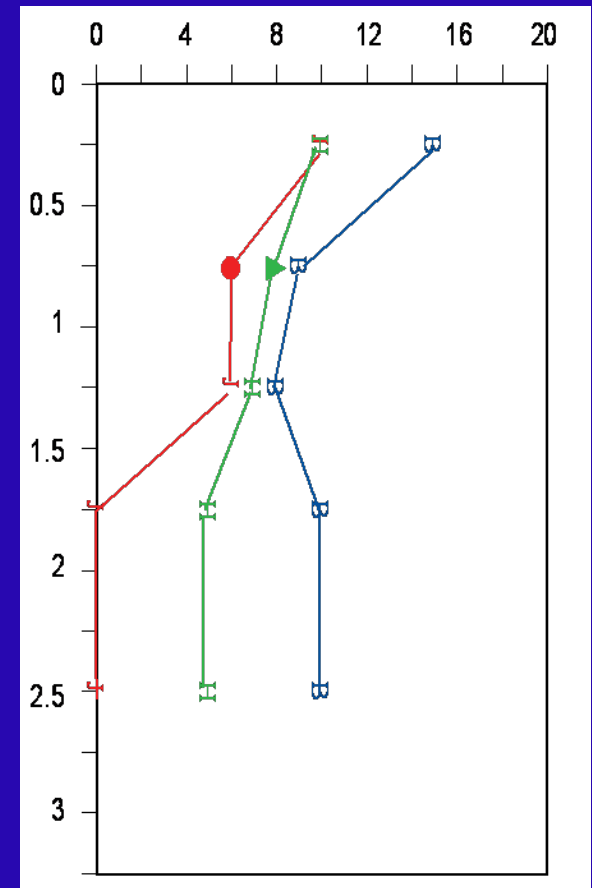
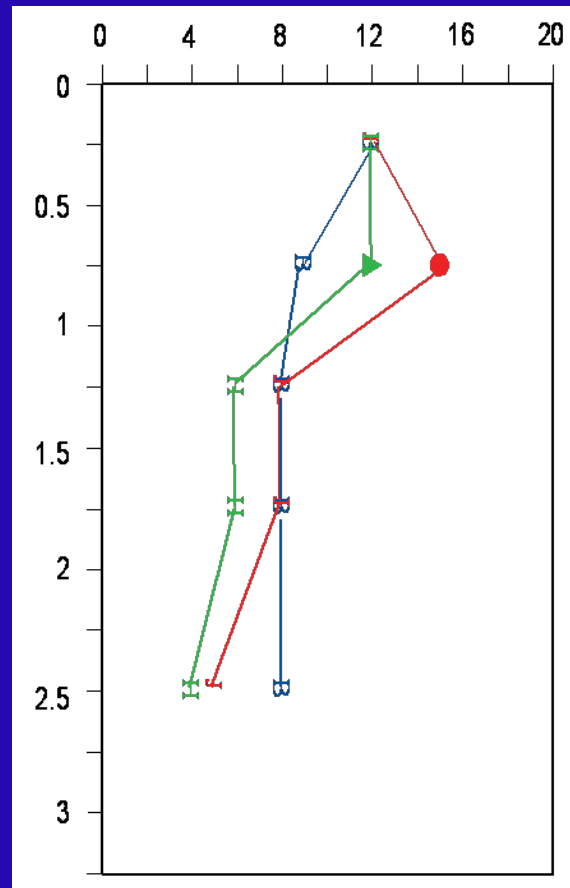
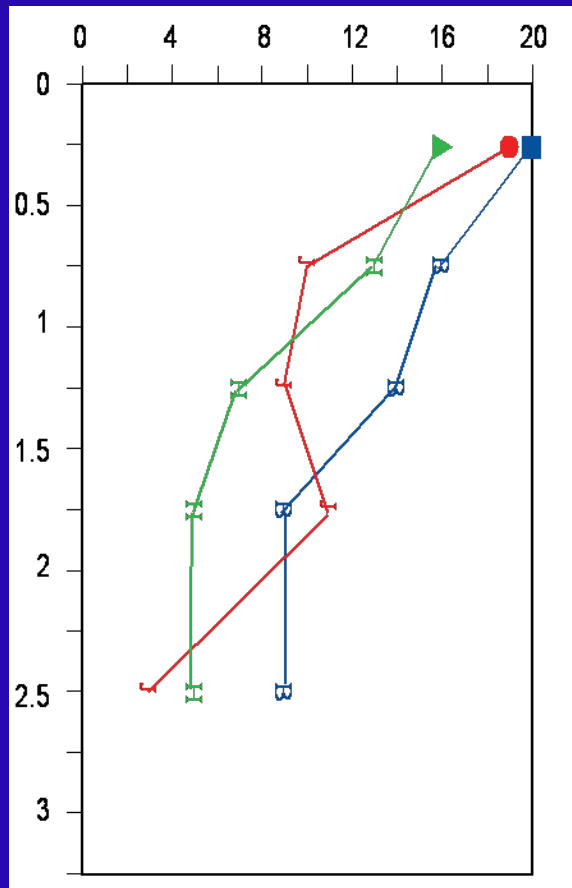
# Simple diversity at 3 recolonization sites in 2008

station RC5

station RC8

station RC9

no. of stained species



# Dominant species at recolonization sites

*Leptohalysis scotti*



*Textularia earlandi*



*Bulimina marginata*



*Stainforthia fusiformis*



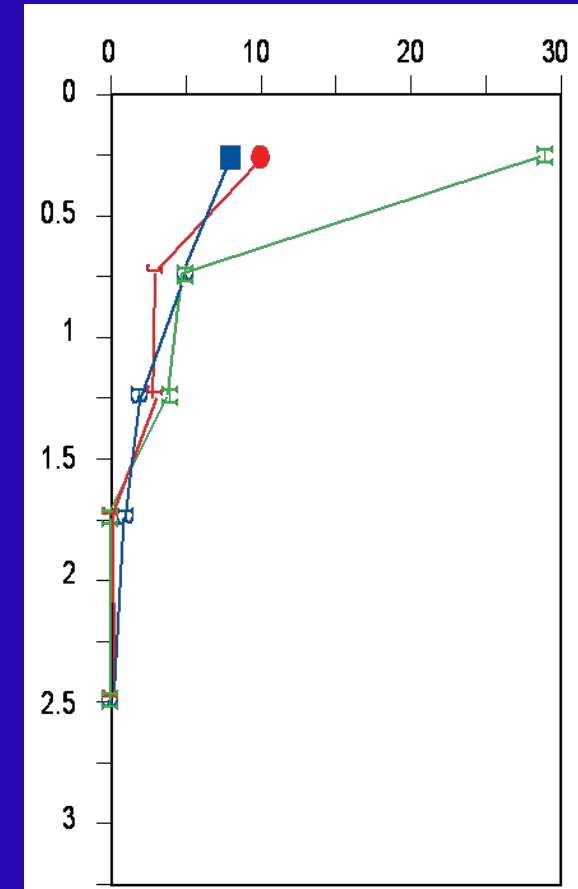
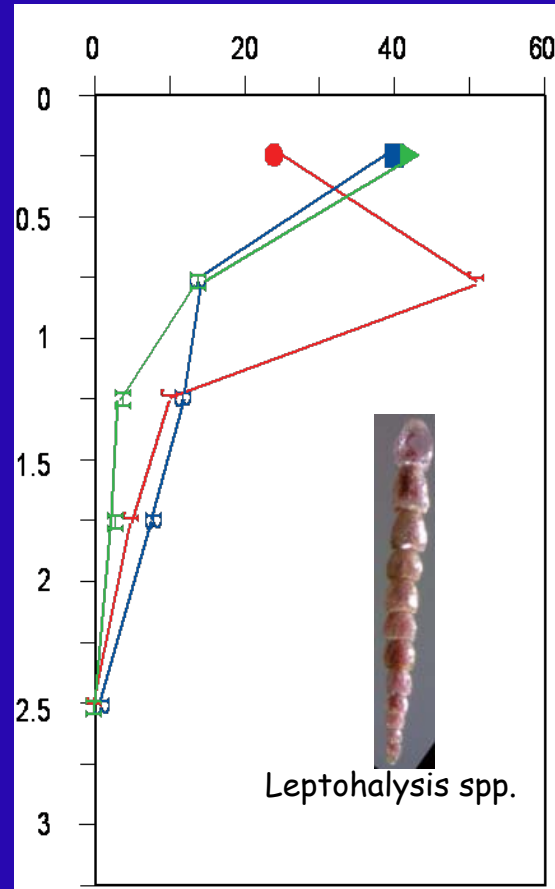
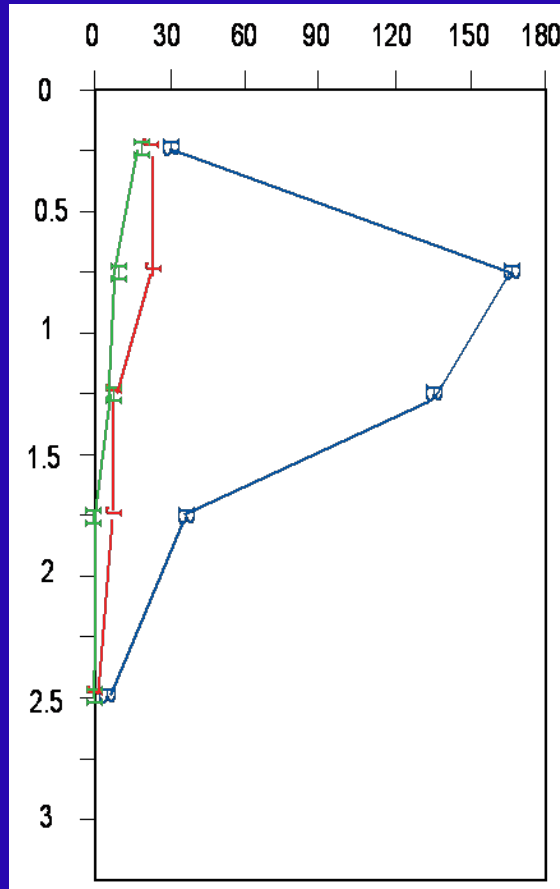
# Downcore distribution of *Leptohalysis* spp.

## Station RC5

## Station RC8

## Station RC9

no. of stained *Leptohalysis* spp. per 12 cm<sup>3</sup>



- March 2008
- June 2008
- September 2008

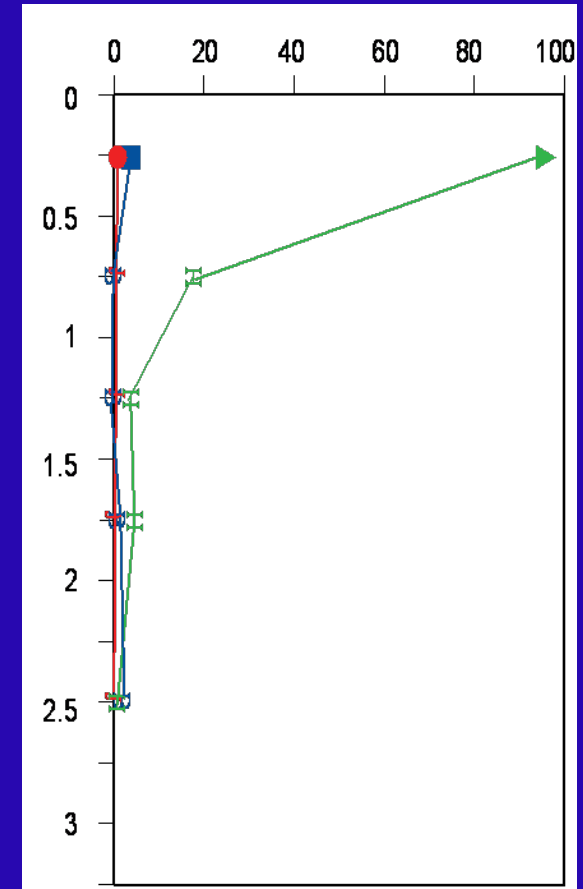
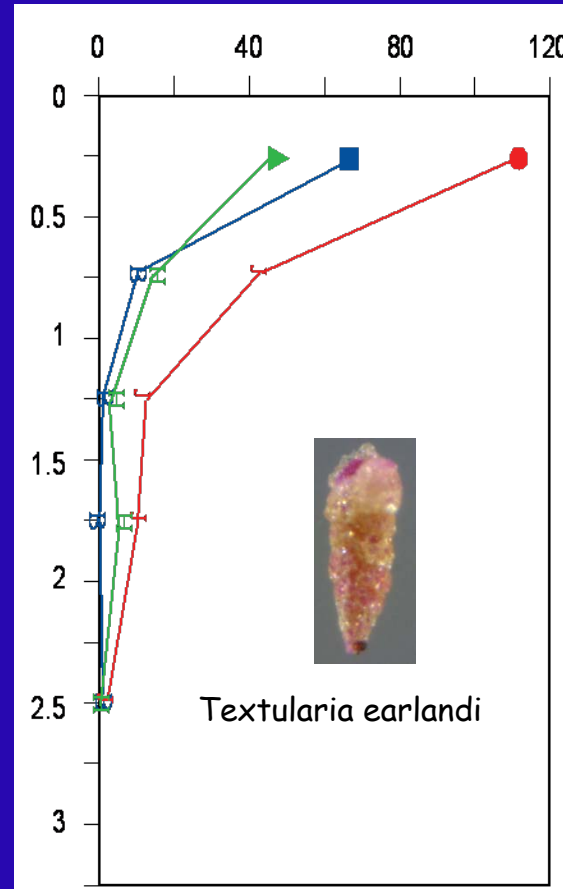
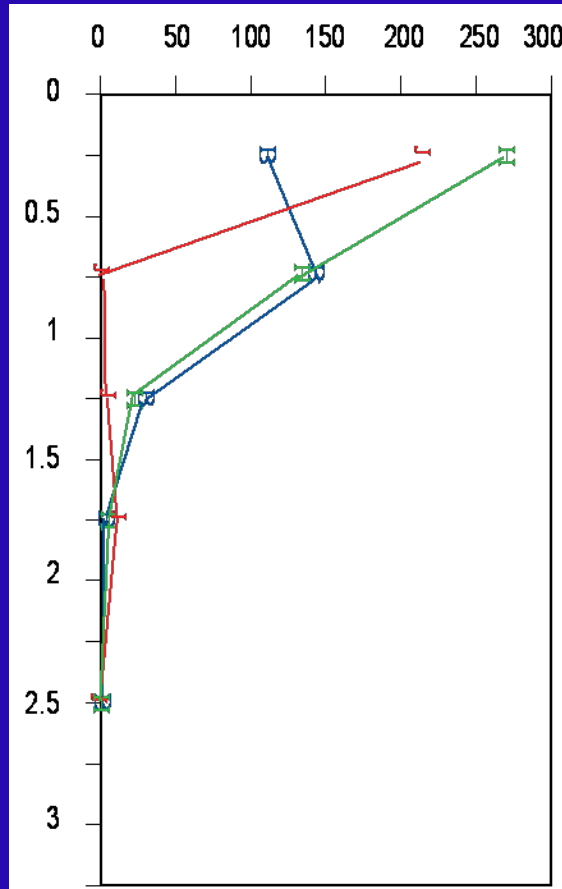
# Downcore distribution of *Textularia earlandi*

Station RC5

Station RC8

Station RC9

no. of stained *T. earlandi* per 12 cm<sup>3</sup>

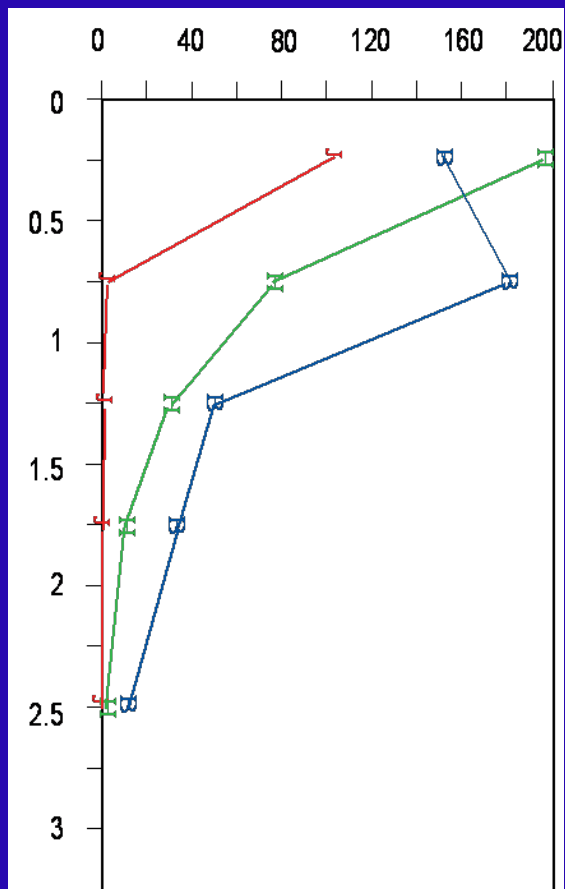


- B— March 2008
- J— June 2008
- H— September 2008

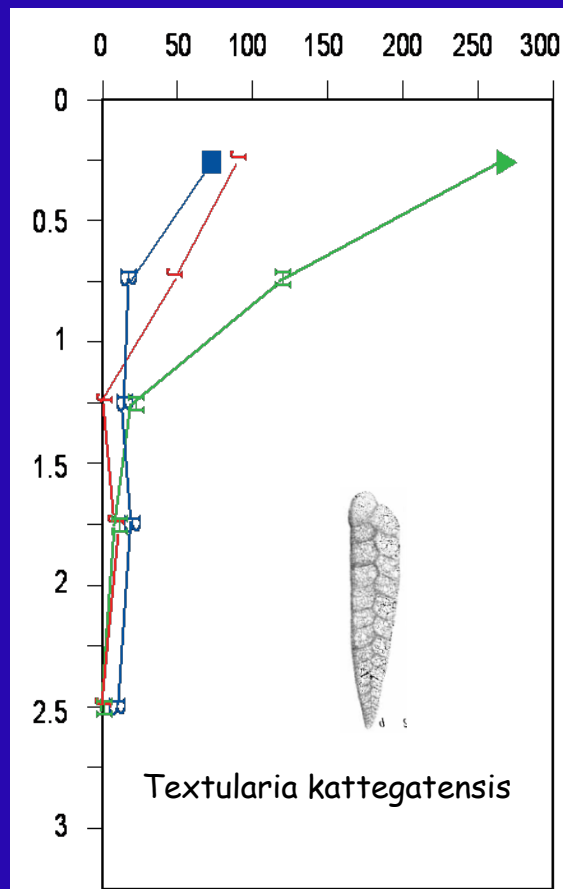
# Downcore distribution of *Textularia kattedgatensis*

## Station RC5

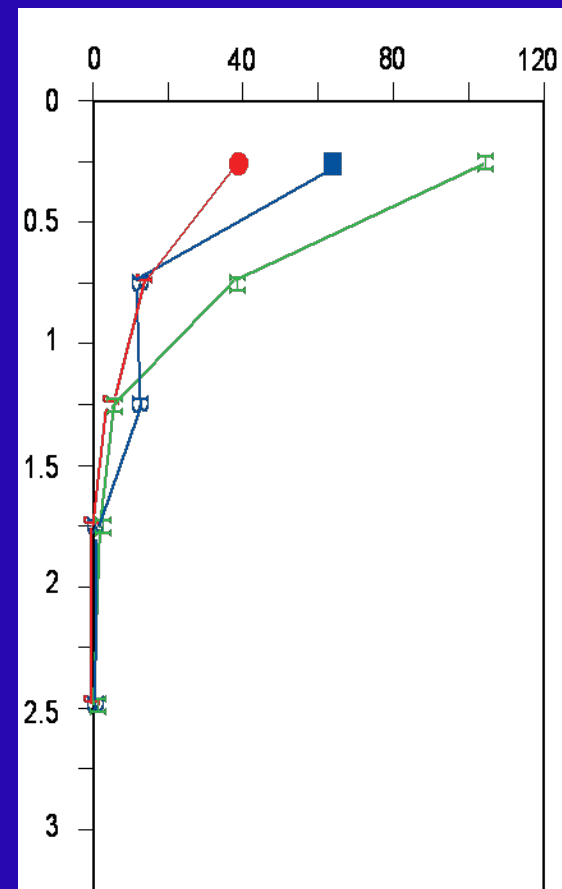
no. of stained *T. kattedgatensis* per 12 cm<sup>3</sup>



## Station RC8



## Station RC9

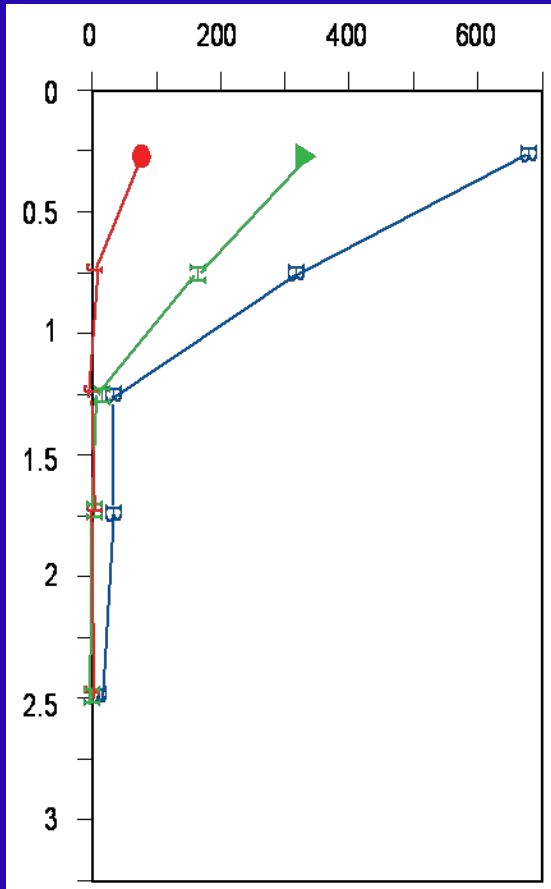


- March 2008
- June 2008
- September 2008

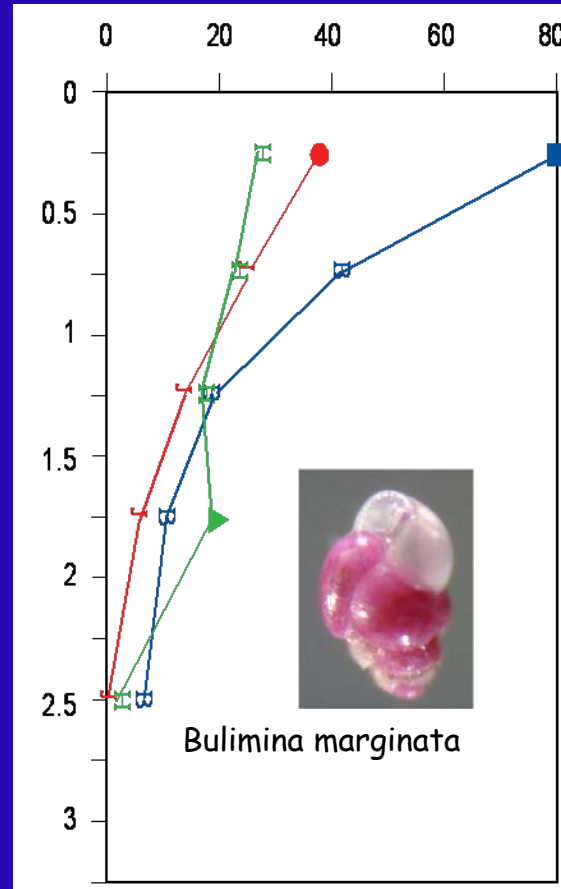
# Downcore distribution of *Bulimina marginata*

## Station RC5

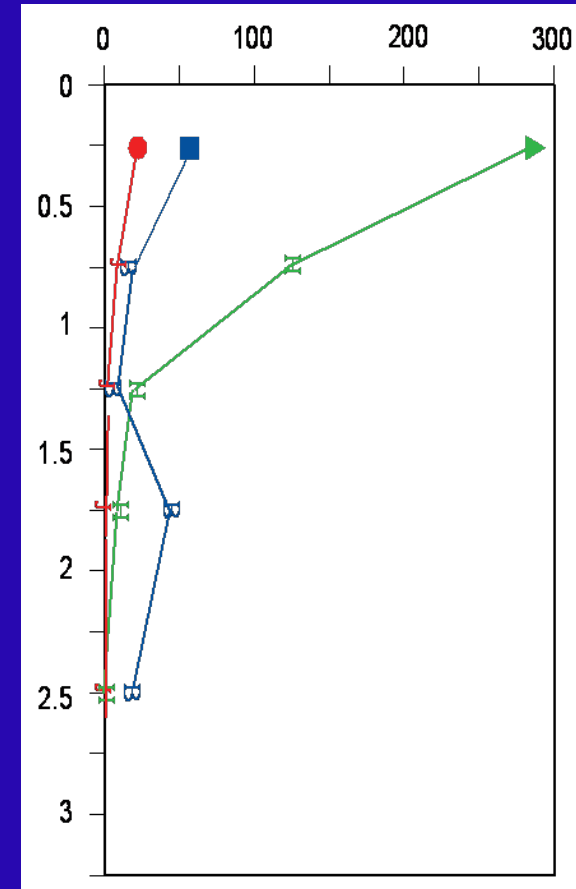
no. of stained *B. marginata* per 12 cm<sup>3</sup>



## Station RC8



## Station RC9



- March 2008
- June 2008
- ▲— September 2008

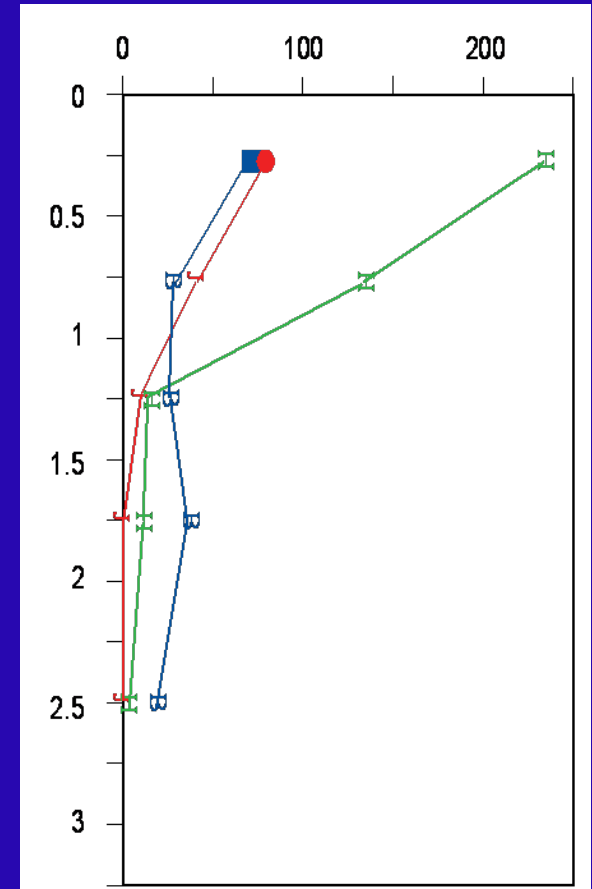
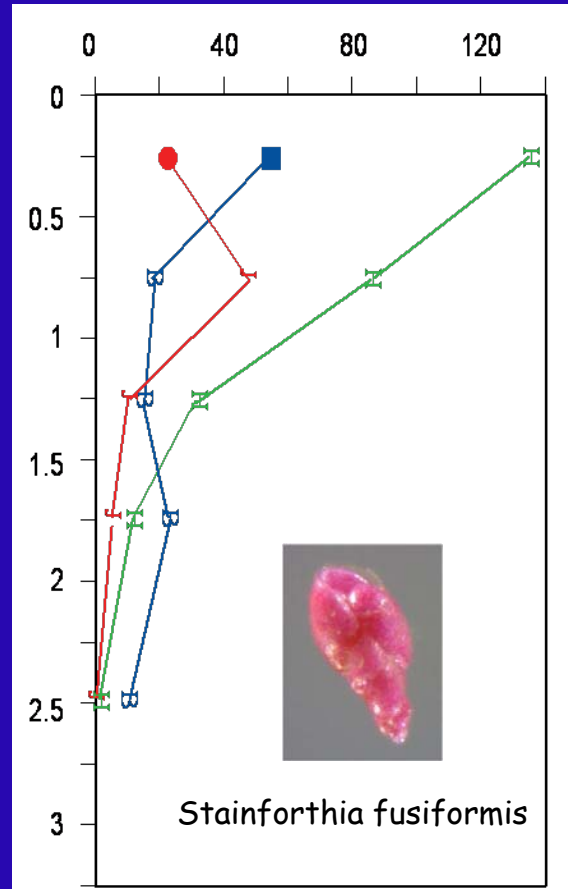
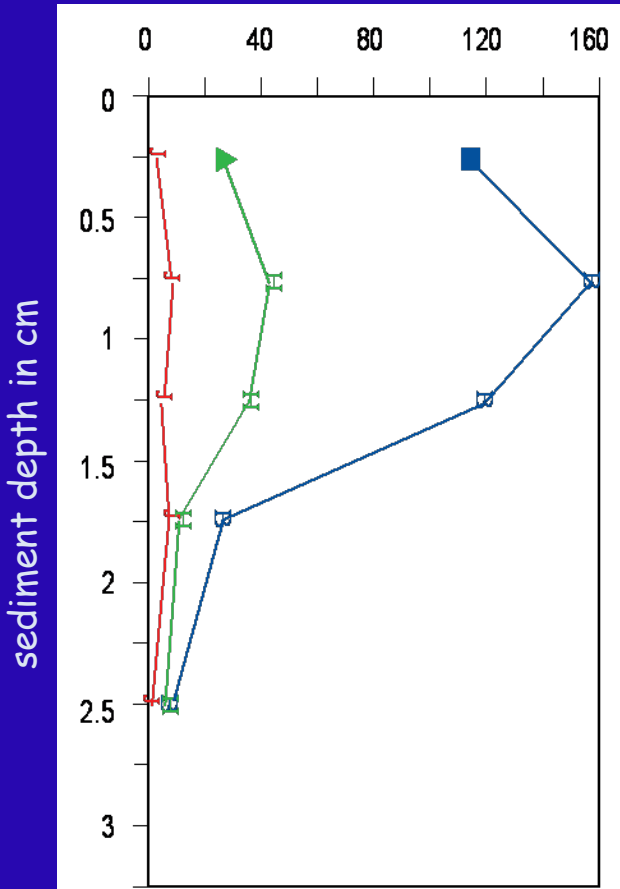
# Downcore distribution of *Stainforthia fusiformis*

## Station RC5

## Station RC8

## Station RC9

no. of stained *S. fusiformis* per 12 cm<sup>3</sup>



- March 2008
- June 2008
- September 2008

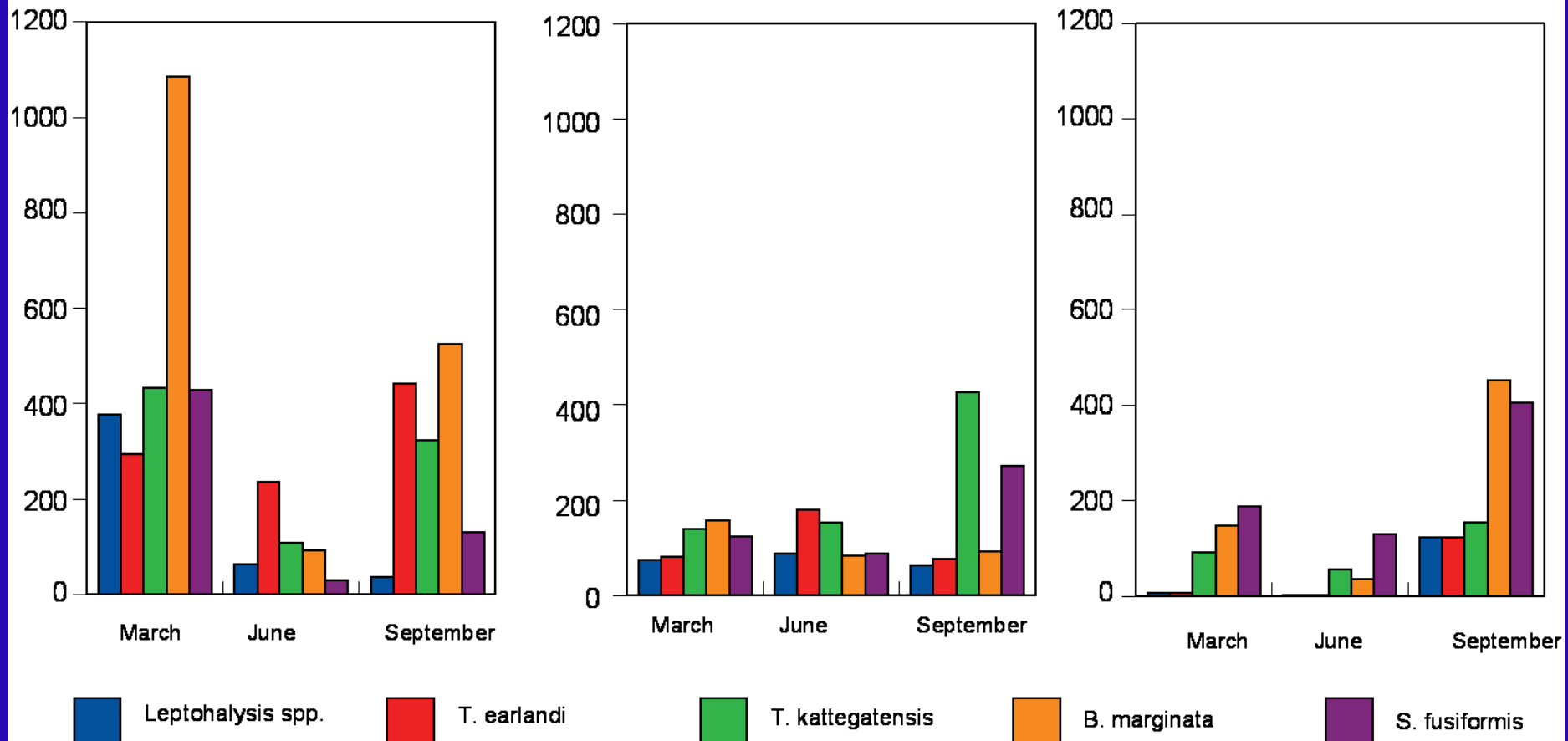
# Dominant species distribution

## Station RC5

## Station RC8

## Station RC9

no. of stained per 12 cm<sup>3</sup>



# Trace elements at recolonization site RC5

Station	Sediment depth	Cd (µg/g)	Cu (µg/g)	Pb (µg/g)	Zn (µg/g)
RC5F 0308	0-0.5	0.4	24.7	20.9	49.7
RC5F 0308	0.5-1	0.2	16.8	15.8	39.4
RC5F 0308	1-1.5	0.2	17.1	14.7	40.6
RC5F 0308	1.5-2	0.2	15.9	14.7	38.2
RC5F 0608	0-0.5	0.4	23.5	30.4	55.3
RC5F 0608	0.5-1	0.2	22.5	19.7	51.7
RC5F 0608	1-1.5	0.2	16.1	14.7	41.9
RC5F 0608	1.5-2	0.2	14.6	12.9	39.0
RC5F 0908	0-0.5	0.6	34.4	36.0	88.9
RC5F 0908	0.5-1	0.4	20.9	18.7	51.7
RC5F 0908	1-1.5	0.2	18.1	16.1	45.8
RC5F 0908	1.5-2	0.2	14.8	12.5	38.1

environmental  
quality classification:



# Trace elements at recolonization sites RC8 and RC9

Station	Sediment depth	Cd (µg/g)	Cu (µg/g)	Pb (µg/g)	Zn (µg/g)
RC8F 0308	0-0.5	0.5	45.1	40.5	89.6
RC8F 0308	1-1.5	0.6	27.5	27.5	85.9
RC8F 0608	0-0.5	0.5	58.7	51.3	108.5
RC8F 0608	1.5-2	0.2	17.2	16.1	46.5
RC8F 0908	0-0.5	0.7	47.3	47.3	95.5
RC8F 0908	1.5-2	0.6	28.6	36.9	100.7
RC9F 0608	0-0.5	1.2	60.0	48.6	135.4
RC9F 0608	1.5-2	2.0	103.7	92.5	296.4
RC9F 0908	0-0.5	1.2	73.9	61.8	160.9
RC9F 0908	1.5-2	1.4	43.3	64.3	179.7

environmental  
quality classification:



# Preliminary results:

- the total no. of stained foraminifera is highest in the samples taken from the middle of the recently capped area (station RC5)
- the total no. of stained foraminifera is highest in September (due to autumn bloom)
- the simple species no. is highest in the samples from site RC5
- specific foraminiferal assemblage composition is comparable at all three stations indicating that the colonizers of the new substrate immigrated from the surroundings
- most common species in the assemblages are *Bulimina marginata*, *Textularia earlandi*, *Stainforthia fusiformis* and *Leptohalysis* spp. but the relative abundance of species shows significant differences between stations

## Preliminary results:

- *Stainforthia fusiformis* is the most common species at the previously anoxic station which is not influenced by the new substrate (RC9). It is regarded as a successful colonizer of formerly anoxic environments and can tolerate low oxygen contents in the sediment
- *Bulimina marginata* is the most common species at the station from the middle of the capped area (RC5). It flourishes best on the new substrate and prefers well oxygenated habitats.

## Future work:

- complete living data set : addition of replicates and samples from 2009 and 2010
- analyse the macrofaunal assemblages and compare the data
- add additional environment data: pigment data, sediment grain size information, seasonal effects
- analyse the dead assemblages
- collect more samples from the inner Oslofjord for systematic distribution mapping of living benthic foraminifera