Decadal change in soft-bottom community structure in high Arctic fjord (Kongsfjorden, Svalbard)

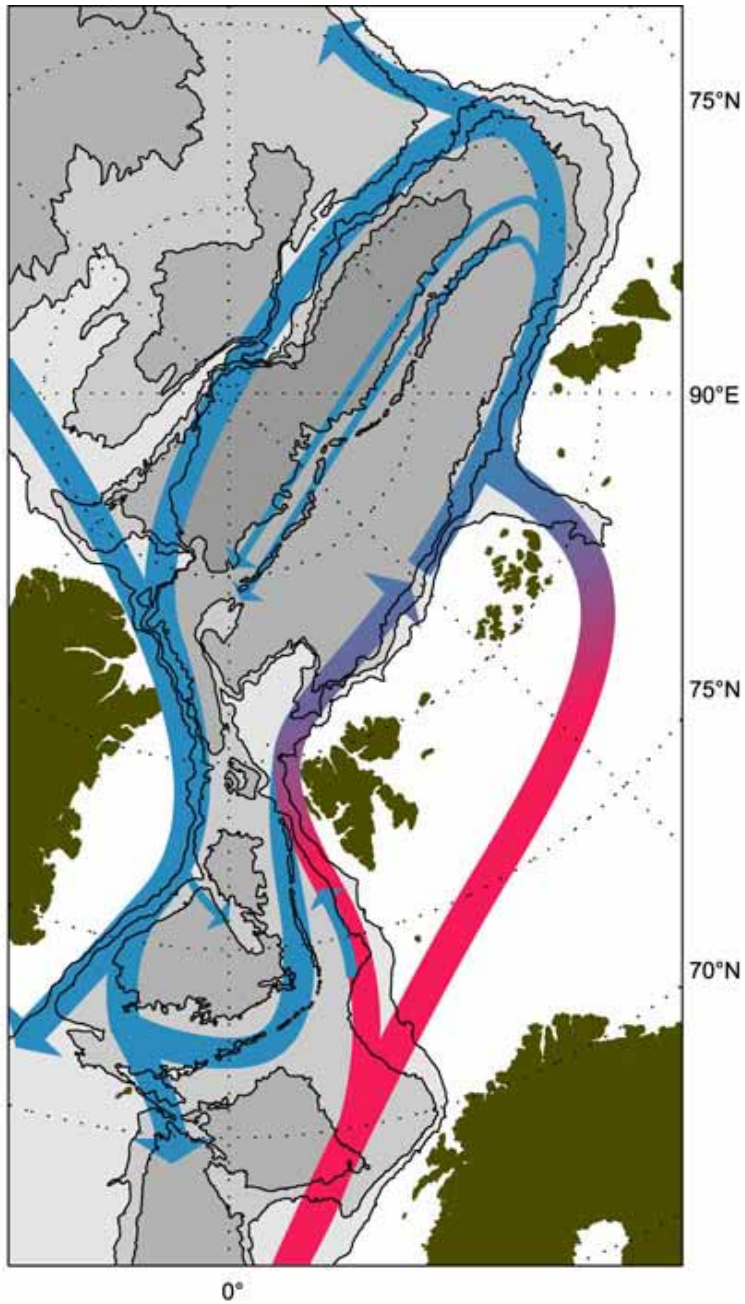
Monika Kędra,

Maria WłodarskaKowalczuk

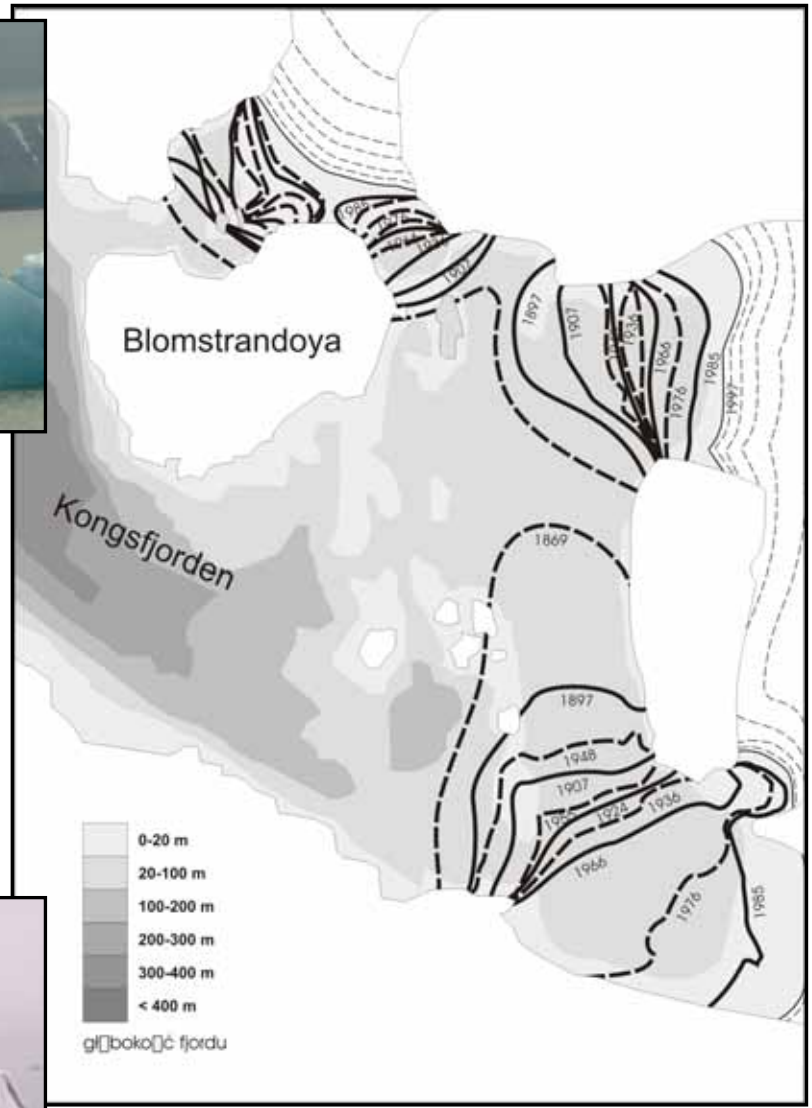
& Jan Marcin Węsławski

Institute of Oceanology PAS, Sopot, Poland

Increased input of relatively warm Atlantic waters to the Arctic Ocean is one of predicted consequences of climate change



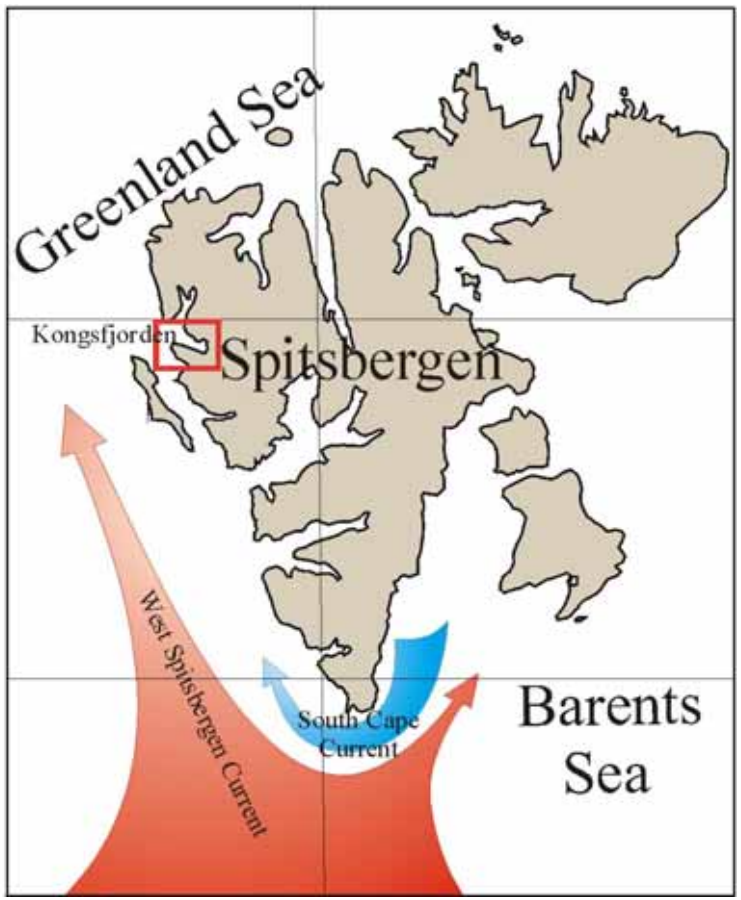
Glaciers' retreat is another consequence of climate warming



After Lefauconnier et al., 1994


12°
16°
20°
24°
28°
32°
80°
78°
Sjuøyene
Kvitøya
Nordkapp
Norden-
skjøld-
bukta
Duvefjorden
Prins
Oskars
land
Orvin land
Storøya
630
Gustav V
land
Verlegenhuken
Vestfonna
Nordaustlandet
Hinlopenstretet
Ny
Frisland
Woodfjorden
Widgefjorden
Wålenberg-
fjorden
Gustav
Adolf
land
Austfonna
Hartogbukta
Albert I
land
Andrée
land
Atomfjella
1717
Kapp
Mohn
Klerck-
bukta
Håkon VII
land
Wahlbergøya
Abeløya
Kapp
Mitra
Kongsfjorden
Newtontoppen
1717
Wilhelmøya
Erik Eriksenstredet
Kong Karls Land
320
Kongeøya
James I
land
Ny
Ålesund
Olav V
land
Kapp
Payer
Svenskeøya
Dickson
land
Oscar II
land
Pyramiden
Forlandsundet
Nord-
fjorden
Billefj.
Bünsow
land
Olgastretet
Barentsøya
Prins
Karls
forland
SPITSBERGEN
Freemannsundet
Sabine
land
Isfjorden
Longyearbyen
Barentsburg
Agardh-
bukta
Edge-
jøkulen
Nordenskiöld
land
Sveagruva
Storfjorden
Van Mijenfj.
Edgeøya
Heer
land
Nathorst
land
578
Bellsundet
1431
Hornsundtind
Kval-
vågen
Tjuvfjorden
Wedel
Jarlsberg
land
Negerpynten
Torell
land
Hornsund
Barentshavet
Hopen
Sørkapp
land
0
50
100 km
Sørkapp

Kongsfjorden



- north-west coast of Svalbard
- 25 km long and 5-10 km wide
- active tidal glacier at the head of the fjord causes environmental gradients in salinity, temperature, sedimentation rates and bottom sediment composition
- Kongsfjorden represents a border area between Atlantic and Arctic biogeographical zones

Kongsfjorden

- Kongsfjorden appears truly Arctic, with winter ice-cover in parts and resident populations of various ice-dependent marine mammals (seals, walruses and polar bears) and Arctic birds
- The water column is strongly influenced by Atlantic water masses
- The benthic macrofauna contains a greater proportion of Atlantic than Arctic taxa

Kongsfjorden as a climate indicator

- The biodiversity and faunal populations in this fjord are strongly structured by the different physical factors that influence the fjord from both ends

  (Svendsen et al., 2002)

- Because Kongsfjorden receives variable inputs of both Arctic and Atlantic influence it functions as a climate indicator on a local scale

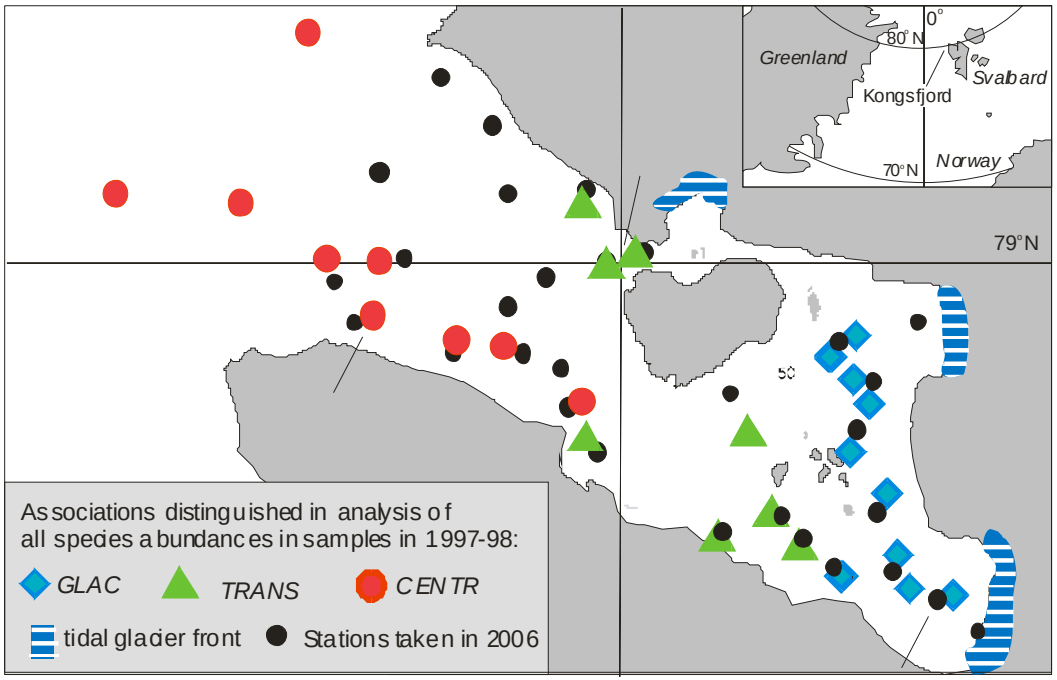
  (Hop et al., 2002)

The following question was addressed in the presentation:

Did the patterns of community structure, diversity and dominant species composition of Kongsfjorden soft-bottom benthos change after a decade?

Has the recent warming influenced on the soft-bottom community structure in high arctic fjord?

Kongsfjorden: material



Material was collected during cruises of r/v Oceania (IOPAS) in 1997-98 and 2006.

In 1997-98 27 stations located throughout the fjord at depths varying from 38 to 380 m were sampled.

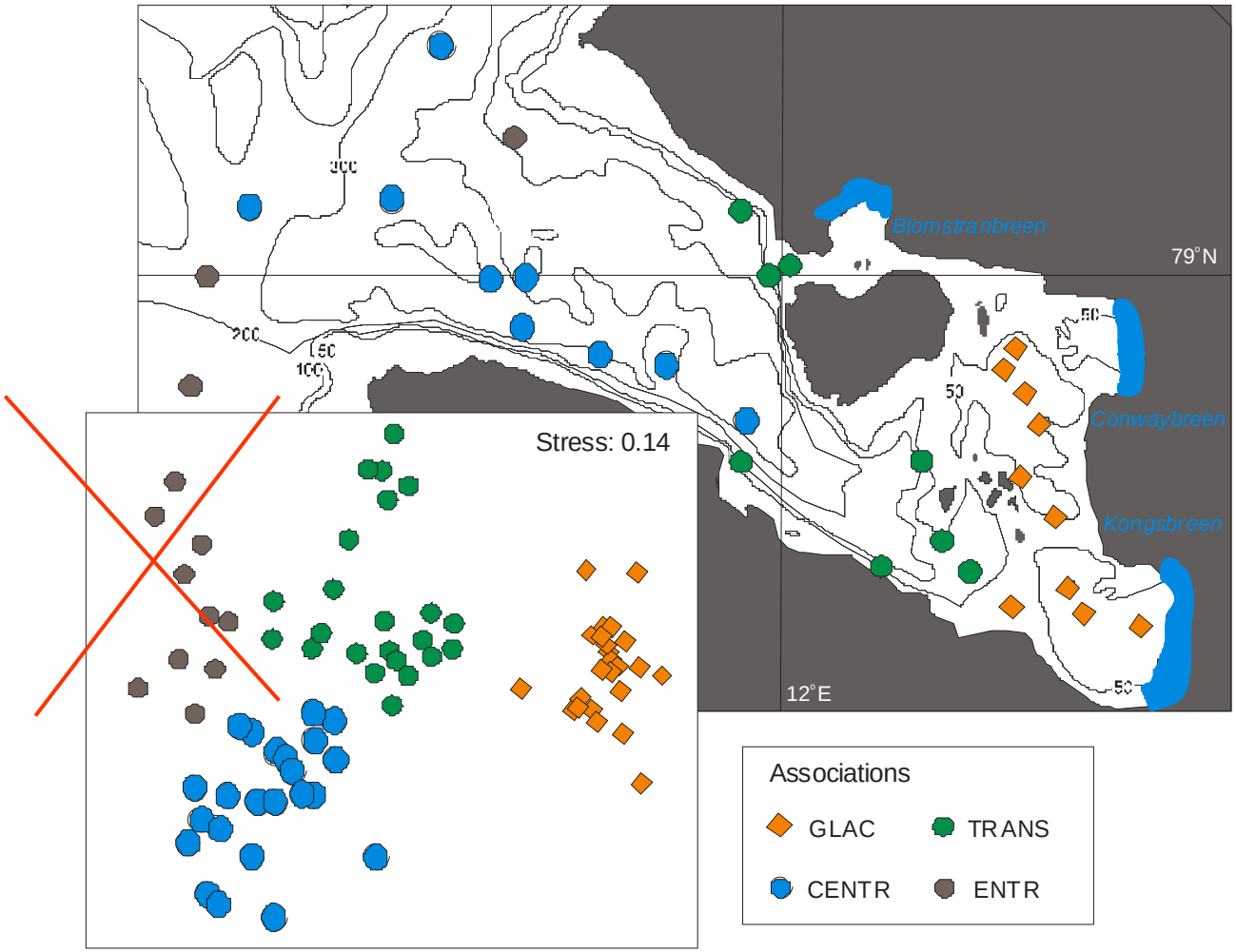
Whole fjord was resampled after a dacade (1997-98 and 2006).

Material and methods

- Samples were taken with Van Veen grab (0,1 $m^{2)}$ with three replications per station
- The material was sieved by 0,5 mm sieve and fixed in 4 % buffered formaldehyde
- The animals were sorted, indentified to the lowest possible level and counted

photo A. Weydmann

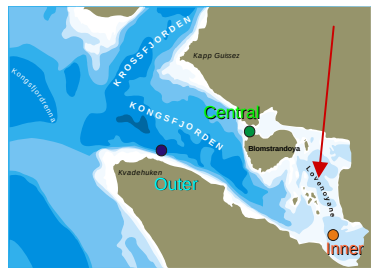
Benthic communities distribution patterns: **results**



Benthic communities distribution patterns: **results** ***GLAC*** **association**

- Fauna in glacial bays is exposed to chronic physical disturbance and therefore is well adopted to the harsh and unstable conditions.

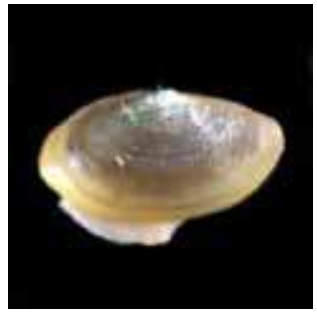
- It is dominated by deposit-feeding polychaetes and bivalvia. These are mainly small, surface detritus-feeders with polychaete *Chone* cf. *paucibranchiata* and some thyasirid and nuculanid bivalves (*Thyasira dunbari*, *Yoldiella solidula*, *Yoldiella lenticula*) as characteristic species.

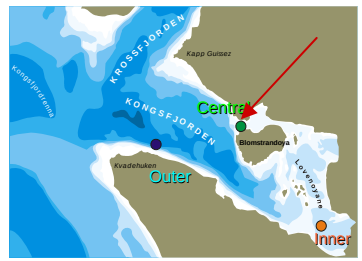


Benthic communities distribution patterns: **results**
TRANS **association**

- Fauna in the central part of the fjord has transitional and ecotonic character. Fauna consists of species of both adjacent communities (*GLAC* and *CENTR*).

- It is dominated by mobile deposit feeding bivalvia *Yoldia hyperborea, Ennucula tenuis* and *Axinopsida orbiculata* and polychaeta *Leitoscoloplos mammosus*, *Maldane sarsi* and *Lumbrineris* sp.

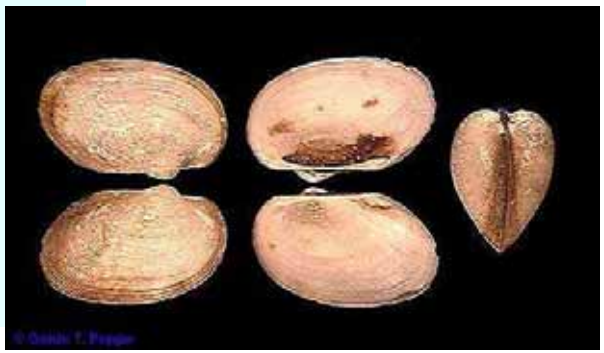


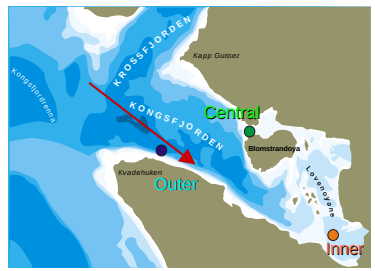


Benthic communities distribution patterns: **results** ***CENTR*** **association**

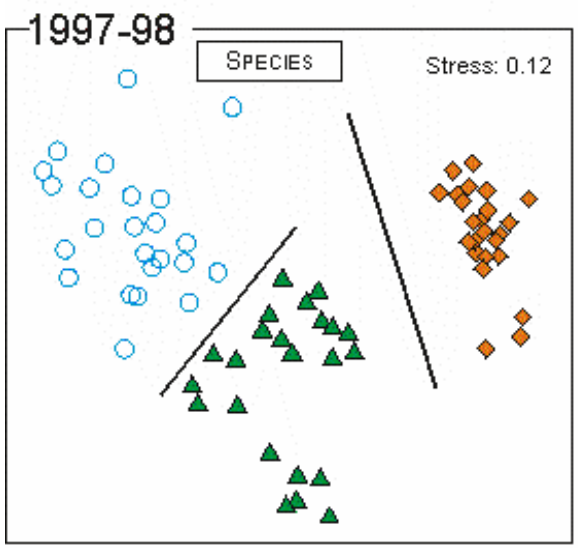
- Fauna in outer part of the Arctic fjord is mainly structured by biological interactions between populations of species of different sizes and functional groups

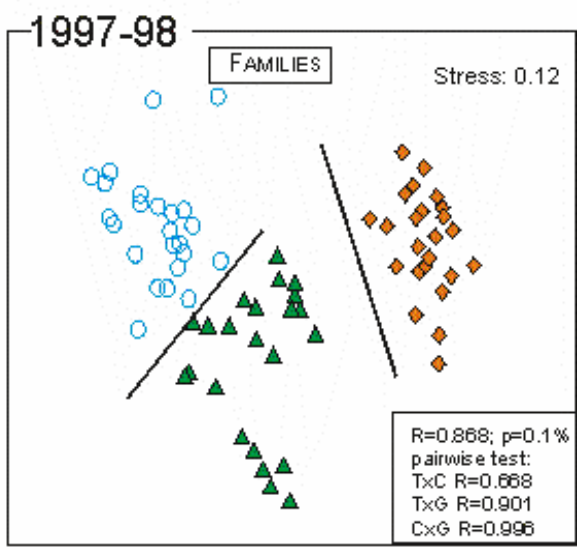
- It is dominated by tube dwelling polychaetes *Spiochaetopterus tipicus, Prionospio* cf. *cirrifera, Leiochone polaris, Galathowenia oculata* and bivalvia *Bathyarca glacialis*

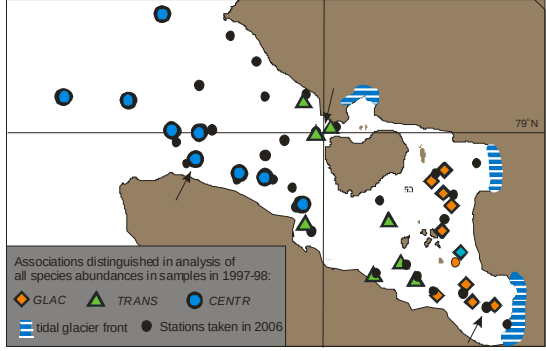




Benthic communities distribution patterns: **results**

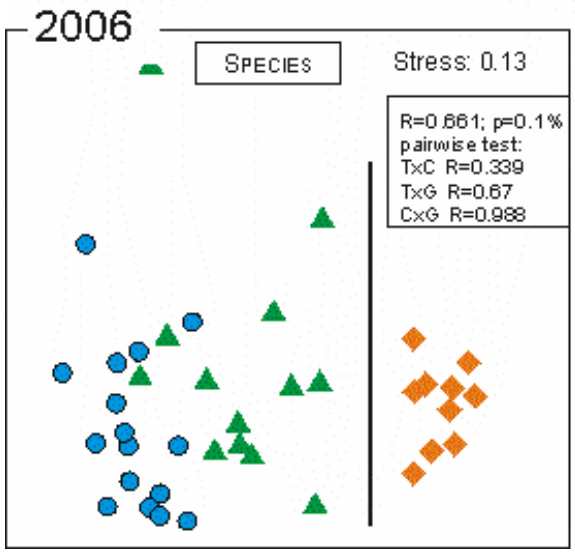


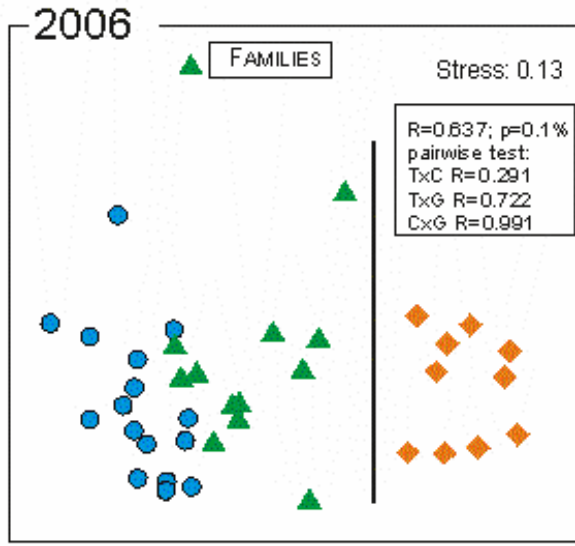




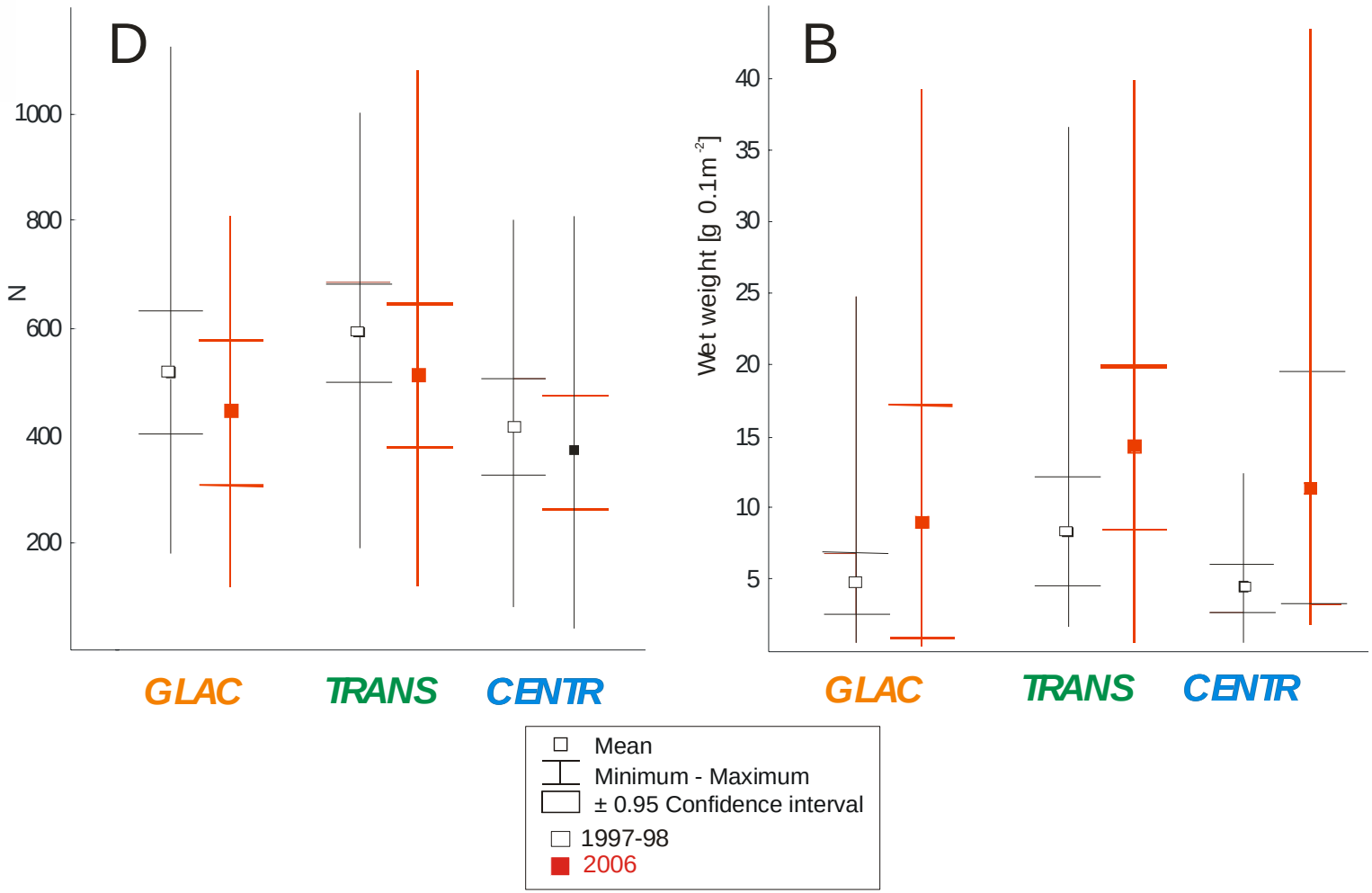
WłodarskaKowalczuk & Pearson, 2004
WłodarskaKowalczuk et al., 2005

Spatial patterns in community structure and species diversity are significantly different in the central basin of Kongsfjorden after a decade while there is no change in the inner part of the fjord.





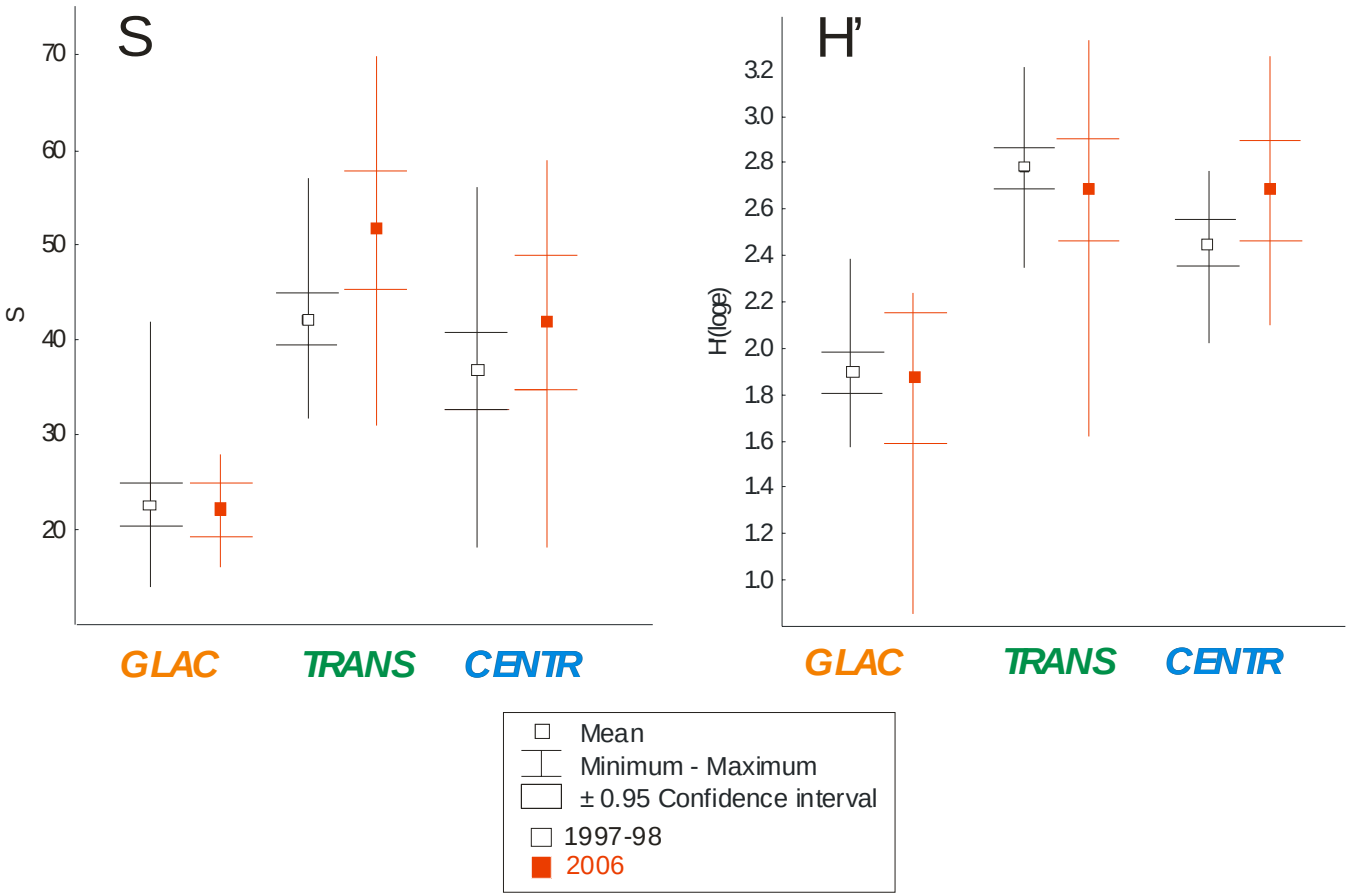
Benthic communities distribution patterns: **results**



In 1997-98 there were significant differences in in abundance (D) between *TRANS* and *CENTR* associations. There were no significant differences in biomass (Kruskal- Wallis test).

In 2006 there were no significant differences in abundance nor biomass (Kruskal- Wallis test).

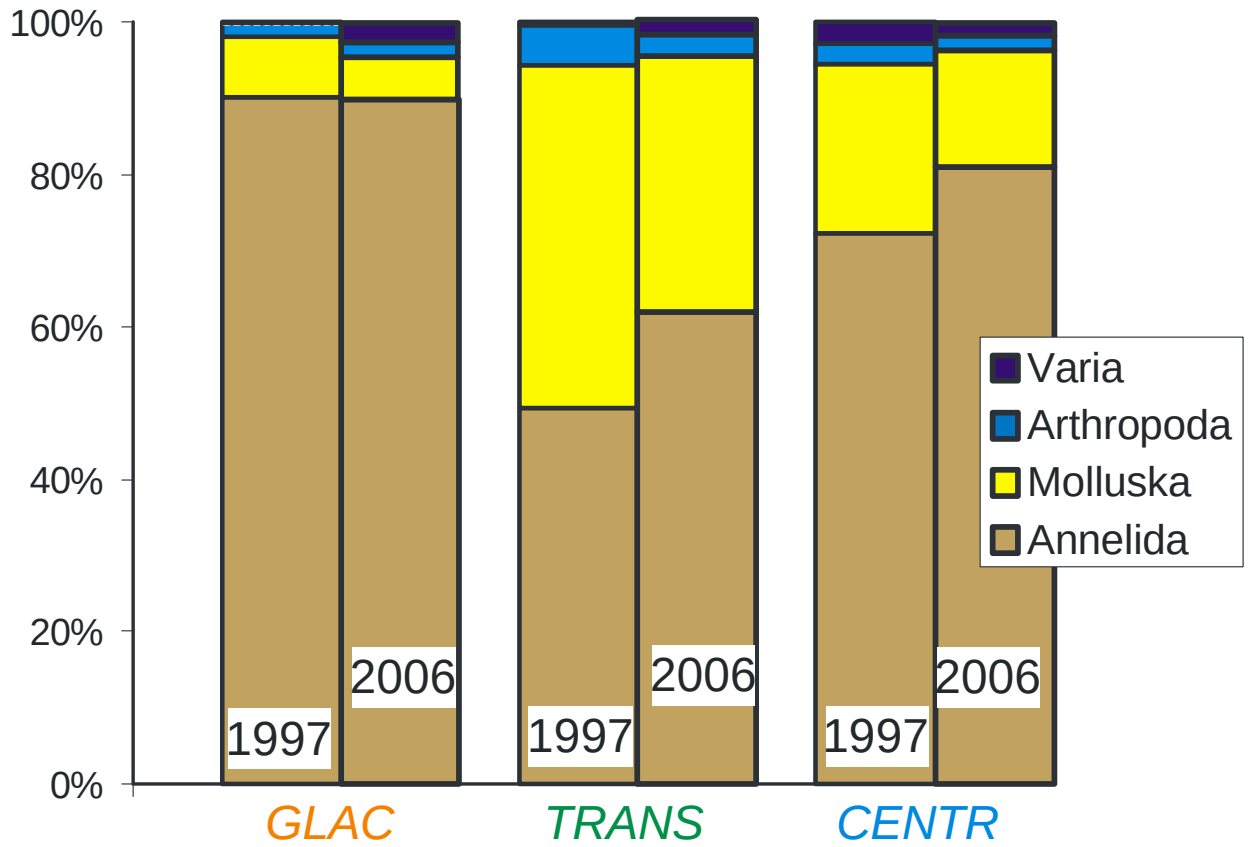
Benthic communities distribution patterns: **results**



In 1997-98 there were significant differences in diversity (H') of the three associations. There were significant differences in species richness between *GLAC* and *TRANS* and *GLAC* and *CENTR* associations (Kruskal-Wallis test).

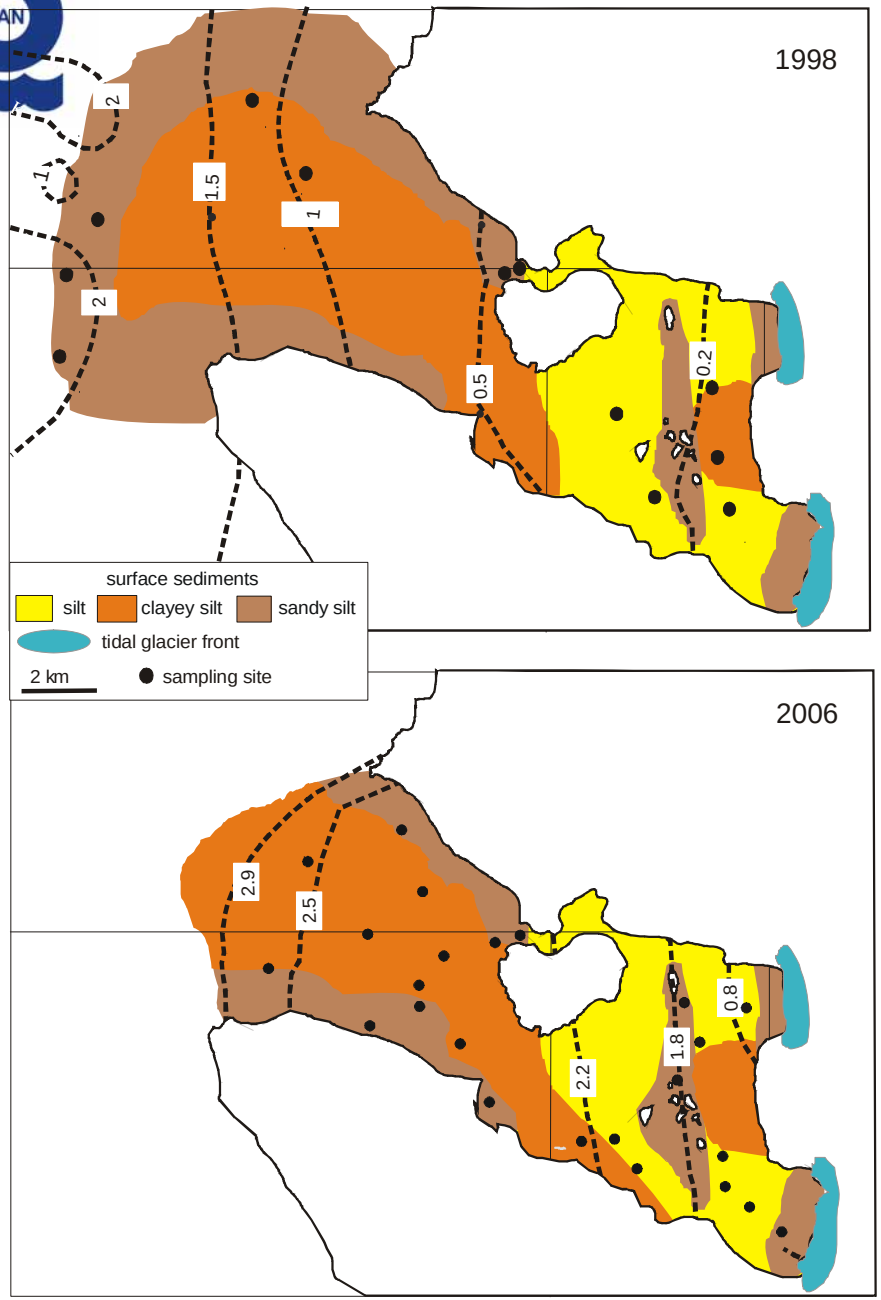
In 2006 significant differences in diversity and species richness were found only between *GLAC* and *TRANS* and *GLAC* and *CENTR* (Kruskal- Wallis test).

Benthic communities distribution patterns: **results**



It was mainly opportunistic polychaeta belonging to Cirratulidae family that added to the increased dominance of polychaetes in 2006 in *TRANS* association. Typical for glacial influenced bivalvia *Axinopsida orbiculata* decreased in numbers.

Benthic communities distribution patterns: **results**



Compared to 1998 there were no changes in surface sediment distribution in 2006. However, the distribution of Particulate Organic Carbon (POC) in surface sediments has changed and higher values were observed in 2006. Also POC patterns in the main basin of Kongsfjorden were more homogenous than in 1998.

This is very likely the effect of increased primary production resulting from warmer water temperatures and lack of ice cover during winter.

Benthic communities distribution patterns: **discussion**

During the Arctic winter of 2005/2006 the temperature of the West Spitsbergen Shelf reverted to that typical of fall, interrupting the normal cycle of sea ice formation in the region (Cottier et al. 2007).

The mean temperature of the Nordic seas in June-July 2000-2005 was much higher than average (Walczowski et al. 2006, 2007).

It is known that amount of the warm Atlantic water transported with West Spitsbergenian Current increased and may have an impact on local hydrology and fauna (Berge et al. 2005, Beuchel et al., 2007, Beuchel and Gulliksen 2008, own data).

Benthic communities distribution patterns: **discussion**

Much of the hard bottom (Beuchel et al. 2006) and soft bottom (own data) community structure in Kongsfjorden was explained by increased surface water temperature correlated with positive NAO index.

The same mechanism was proposed by (Berge et al. 2005) to explain changes in Isfjord, more southern open fjord in west Spitsbergen.

Other results were obtained in VanMijen, a silled fjord system in the west Spitsbergen where no significant changes in community structure were observed after 2 decades (Renaud et al. 2007) .

Benthic communities distribution patterns: **conclusions**

- In 1997-98 three faunal associations were distinguished along the fjord axis while in 2006 only two were identified. After a decade there were no significant differences between two central basin faunal associations (*TRANS* and *CENTR*) while there is no change in the inner part of the fjord

- With no sill at the entrance, Kongsfjord is strongly influenced by increasing input of warm Atlantic waters carried by West Spitsbergen Current, which could be the reason for unification of the previously observed two associations. Better separated glacial bay association managed to resist.

- Kongsfjorden as an open type of fjord and its fauna is more vulnerable to increased input of Atlantic water masses than semi- or closed one types.

- Climate change effects may differ between different types of Arctic fjords, those differences should be taken into account when monitoring studies results are discussed.

Thank you for your attention

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