GEOMAR
Helmholtz Centre for Ocean Research Kiel
BIOACID

2015 Aquatic Sciences Meeting
Aquatic Sciences: Global And Regional Perspectives — North Meets South
Session: 067 CLIMATE CHANGE IN THE BALTIC SEA

Interaction between intraspecific genetic diversity and environmental stress in early life-stage macroalgae

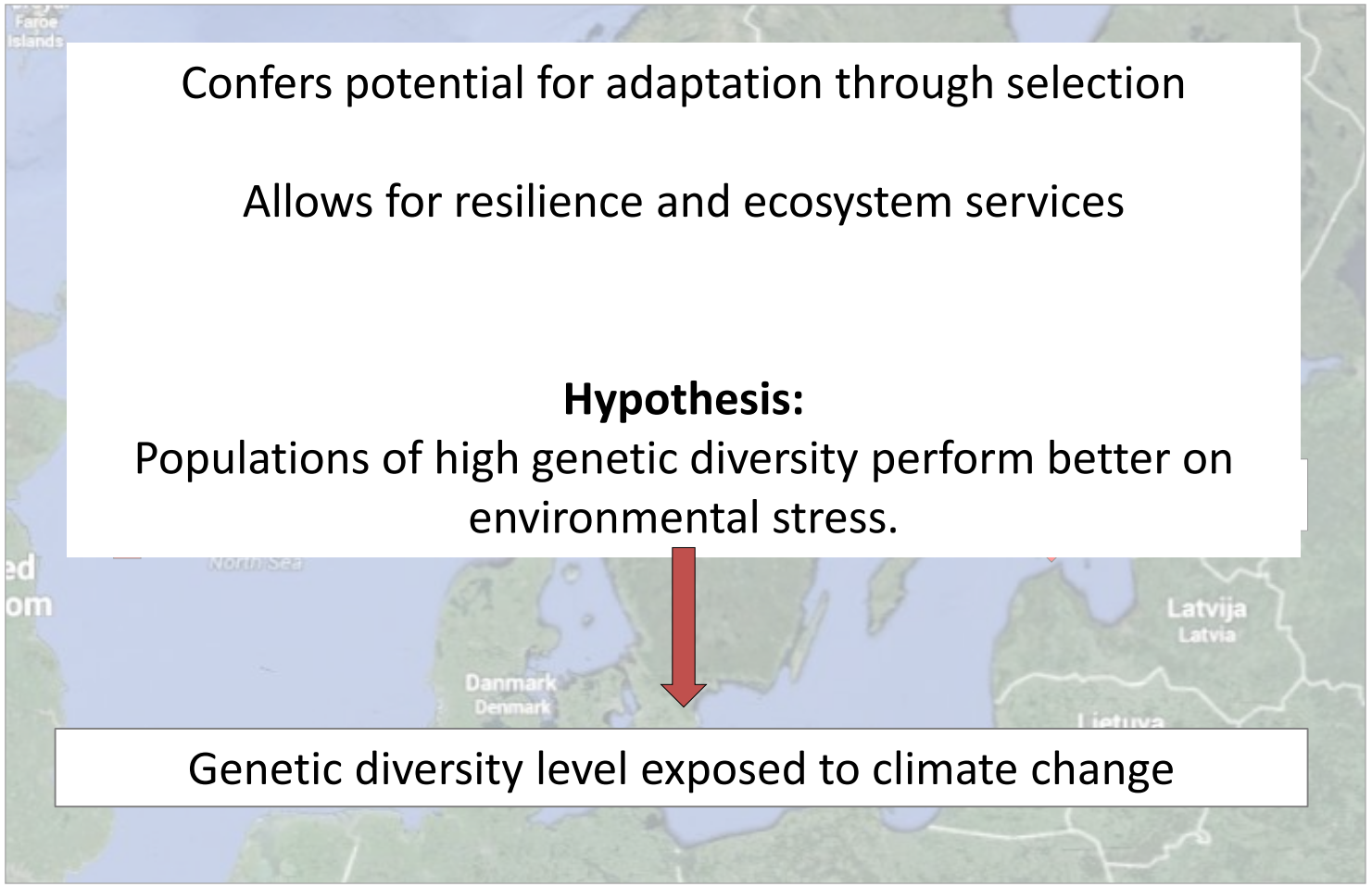
Al-Janabi, B., Kruse, I., Wahl, M.
Helmholtz Center for Oceean Research, Kiel, Germany

Genetic diversity

Atlantic > Baltic Sea

Genetic diversity

Atlantic > Baltic Sea



Confers potential for adaptation through selection

Allows for resilience and ecosystem services

Hypothesis:
Populations of high genetic diversity perform better on environmental stress.

Genetic diversity level exposed to climate change

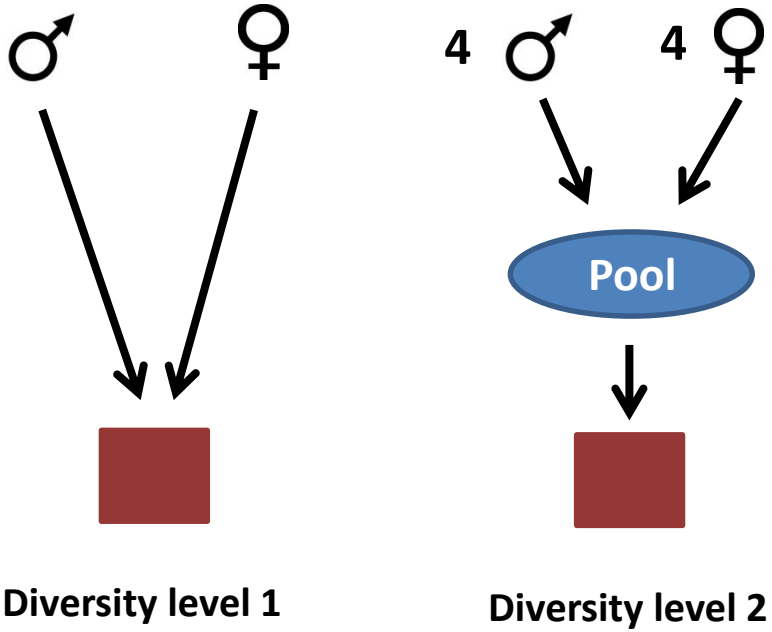
Settlement of germlings

Highly mature adult *Fucus* were collected.

Release of gametes was induced.

Settling of germlings on limestones cubes: edge length 2 cm.

Cohort 1



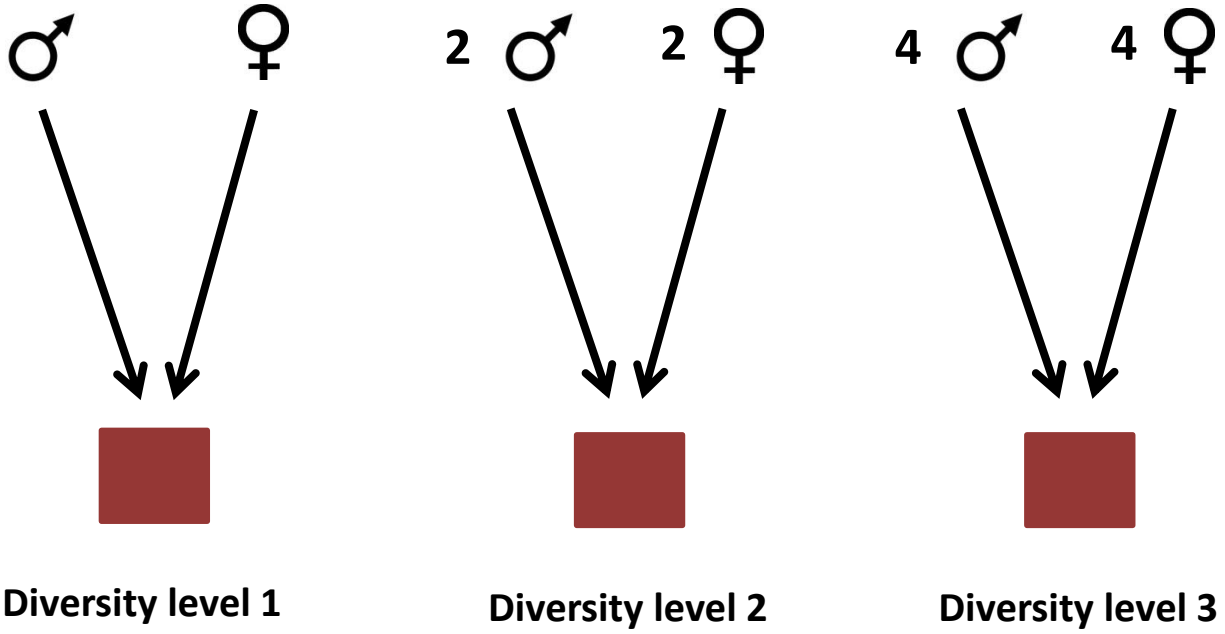
Settlement of germlings

Highly mature adult *Fucus* were collected.

Release of gametes was induced.

Settling of germlings on limestones cubes: edge length 2 cm.

Cohort 2



Three diversity levels of Fucus germlings

GEOMAR

BIOACID

Diversity level 1 **offspring of 1 parental pair each**

1	2	3	4	5	6	7	8

versus

Diversity level 2 **offspring of 2 parental pairs each**

1, 2	3, 4	5, 6	7, 8

versus

Diversity level 3 **offspring of 3 parental pairs**

1, 2, 3, 4	**5, 6, 7 , 8**

Kiel Benthocosms – Climate change simulation

GEOMAR

BIOACID

Bioacid 2 project: Benthic consortium

↑ **Temperature:** + 5 °C

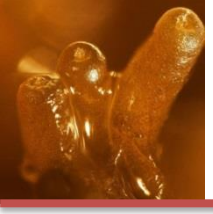
↑ **pCO_2:** + 600 µatm

2013: A seasonal comparison

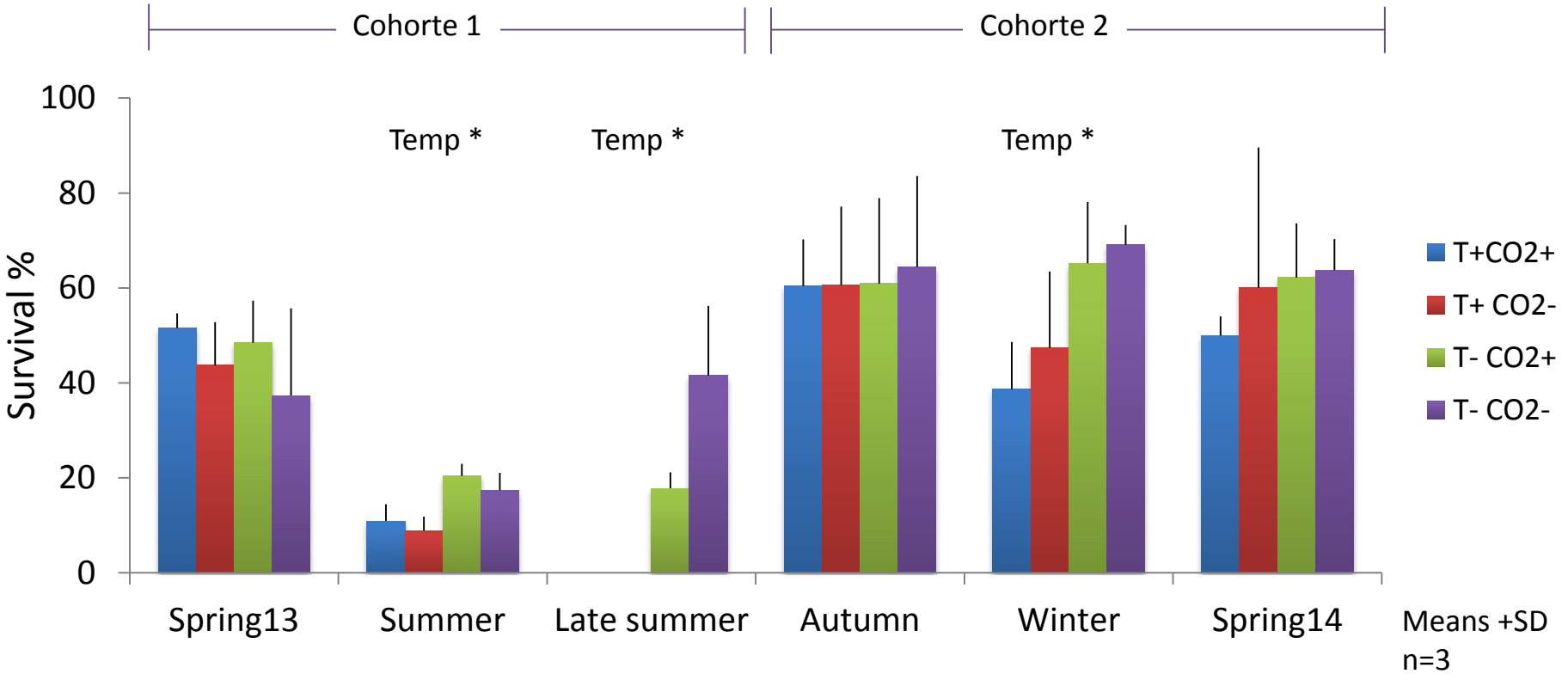
4 treatment levels

High Temperature + pCO_2
High temperature
High pCO_2
Ambient

n = 3



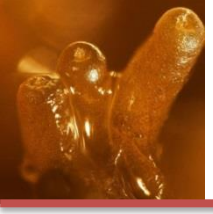
Germlings' survival under climate change



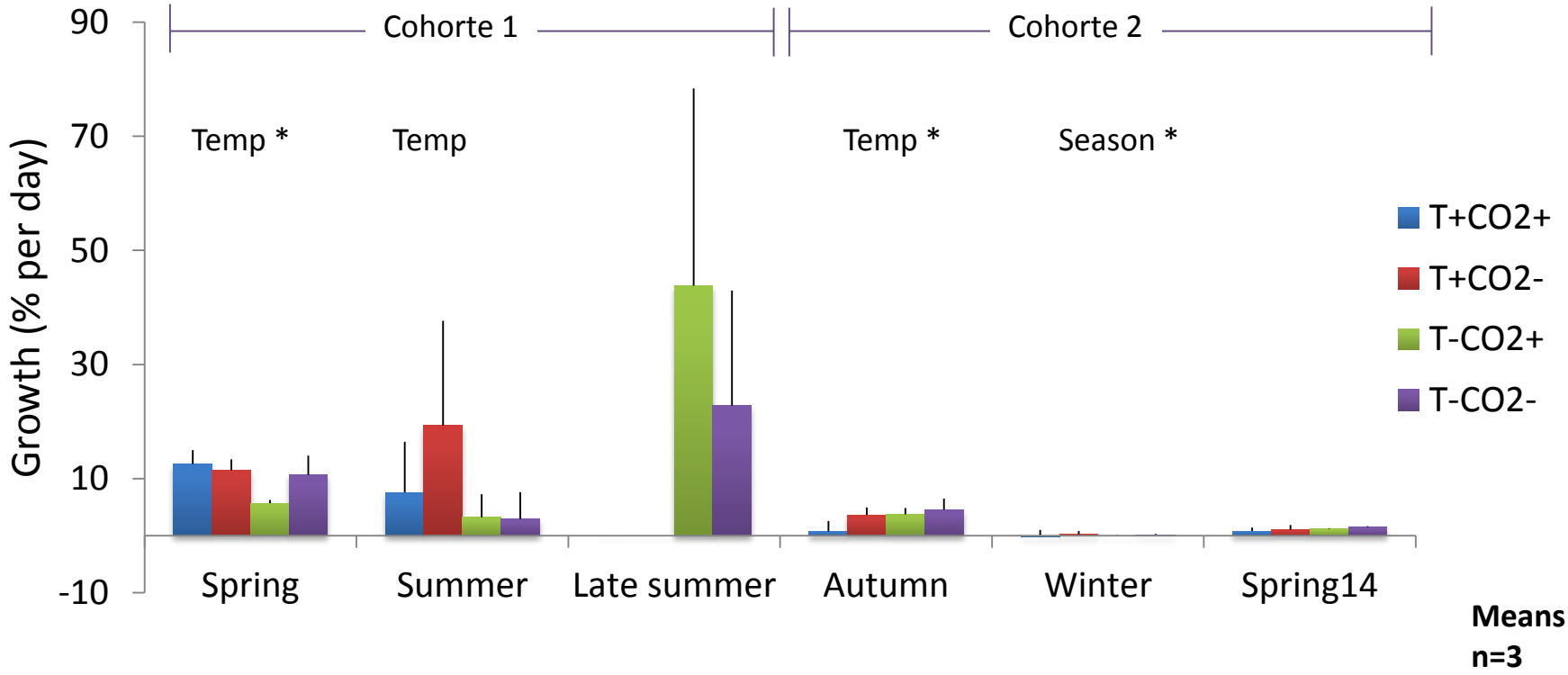
Seasonal variation between spring, summer and late summer (p-value < 0.0001)

Warming causes lower survival from in **summer** (p-value < 0.05)

and also in **winter** (p-value < 0.05)



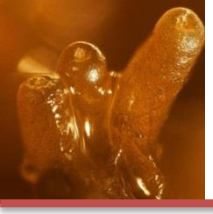
Germlings' growth under climate change



Warming increases growth in spring and in summer (p-value < 0.05)

High pCO_2 increases growth in late summer.

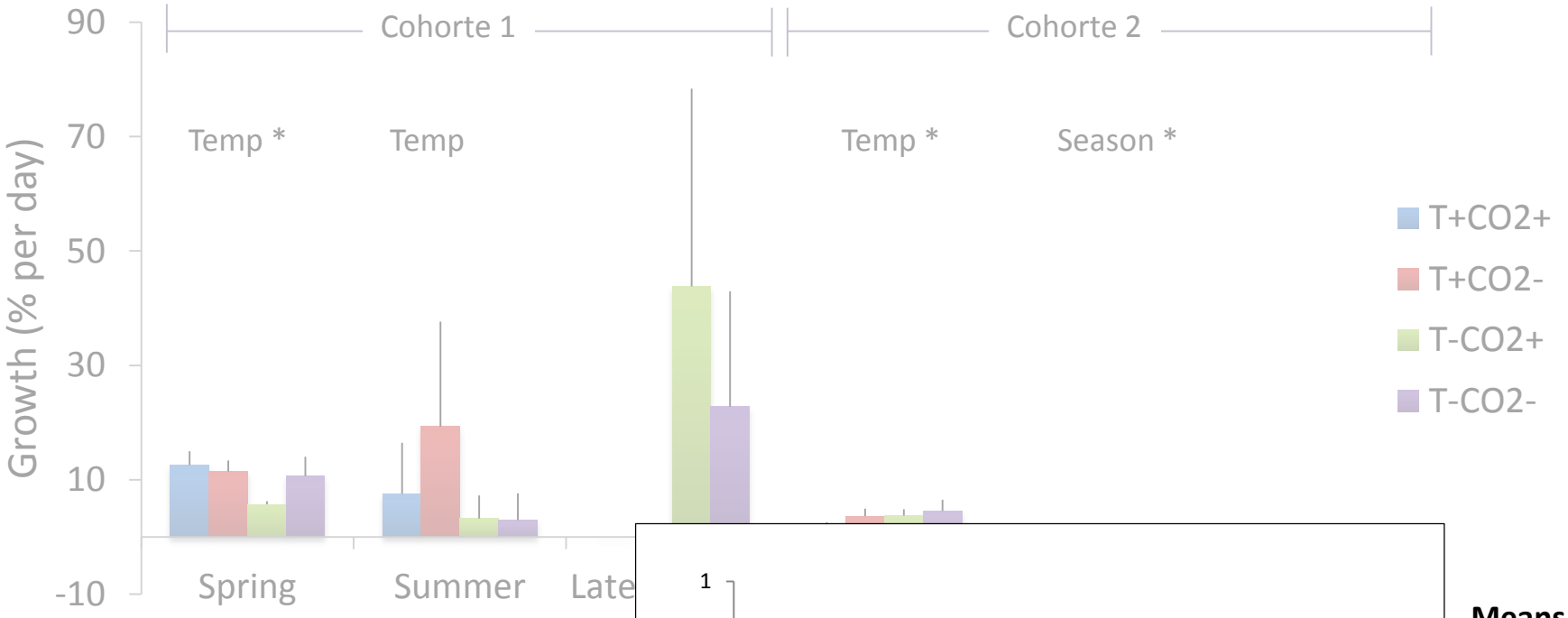
Seasonal variation determines growth in autumn, winter and spring (p-value < 0.05)

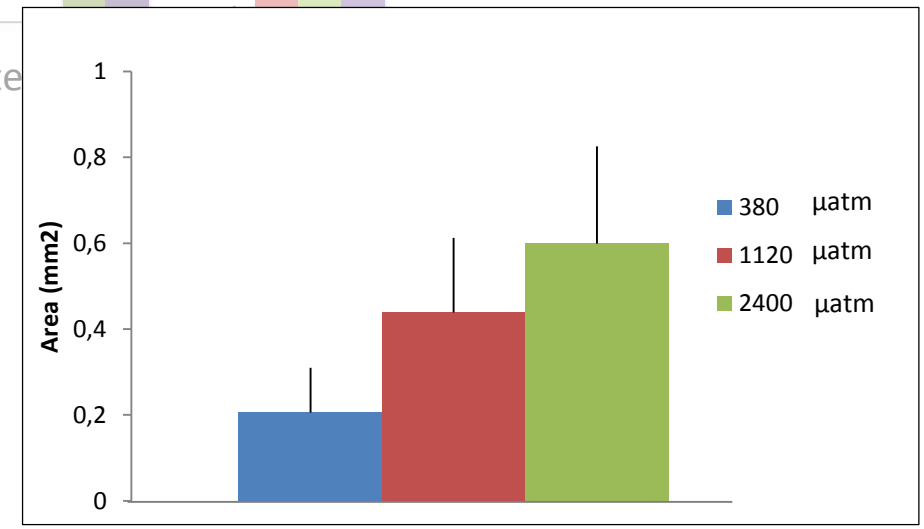


Germlings' growth under climate change

GEOMAR

BIOACID

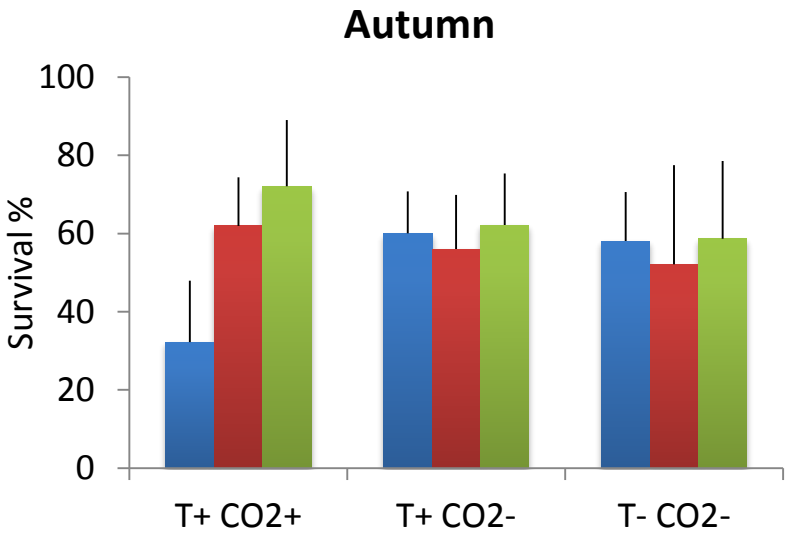


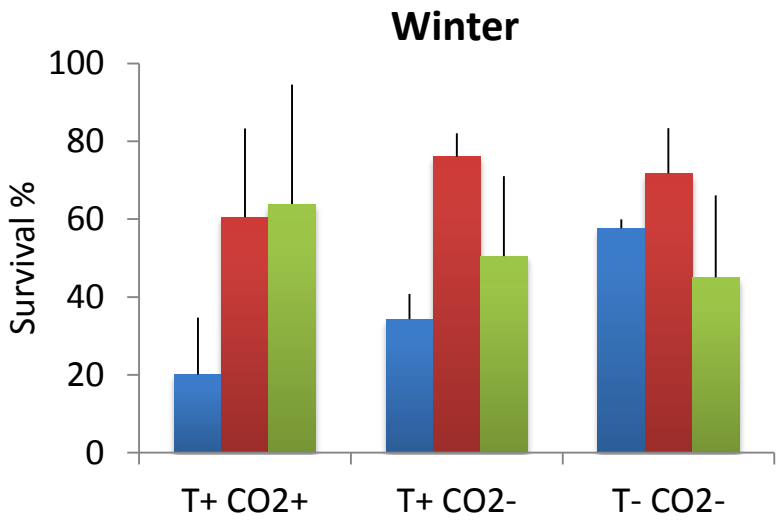


Means +SD
n=3

pCO_2 effect on growth

Diversity level effect on survival





Means +SD
n=3

Survival in the high diversity level > survival low diversity level (p-value < 0.05) at **high temperatures**

Increased survival for a group of many families indicated **facilitation** processes among different genotypes

Sibling groups' co-tolerance to multiple stressors

Resistance towards **multiple stressors** depends:

Relationship co-tolerance

Stress induced community tolerance

antagonistic interaction between the two abiotic factors

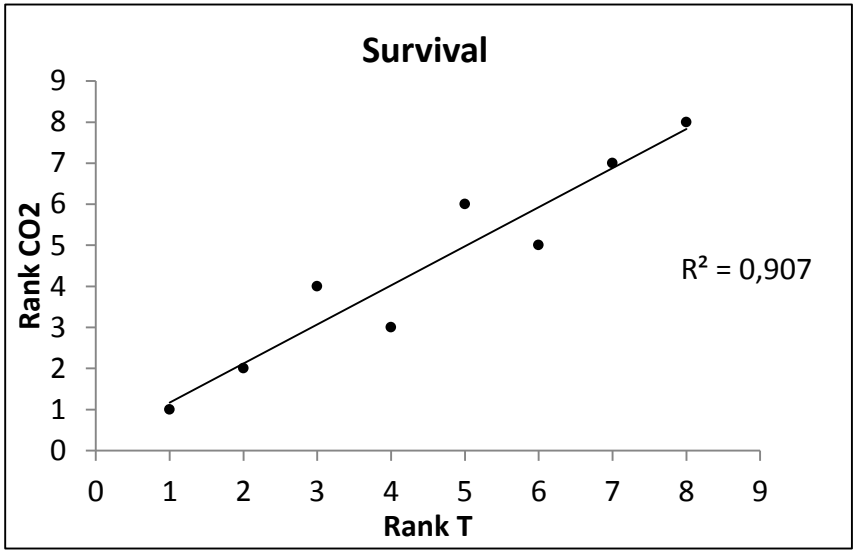
Vinebrook et al. (2004)

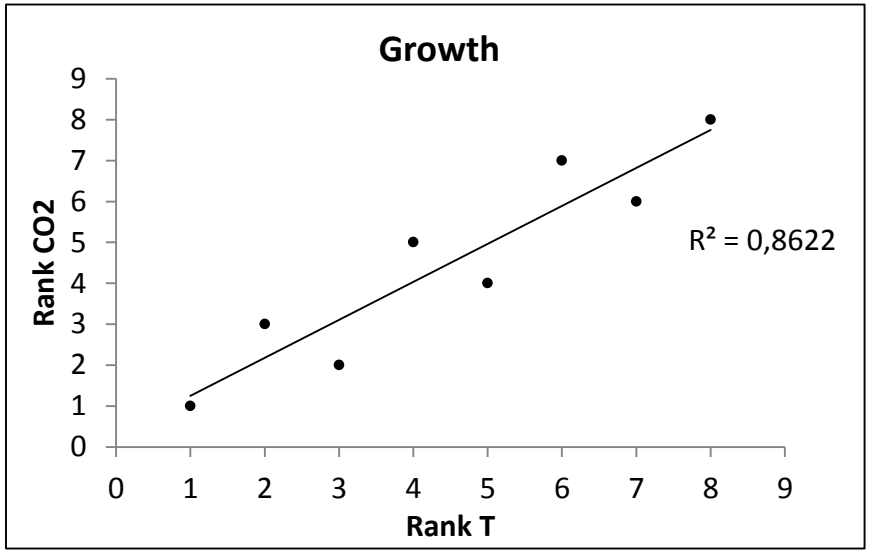
Sibling groups were ranked for tolerance to temperature and pCO_2

Tolerances to temperature and pCO_2 were correlated

Sibling groups' co-tolerance to multiple stressors

Spring 2013





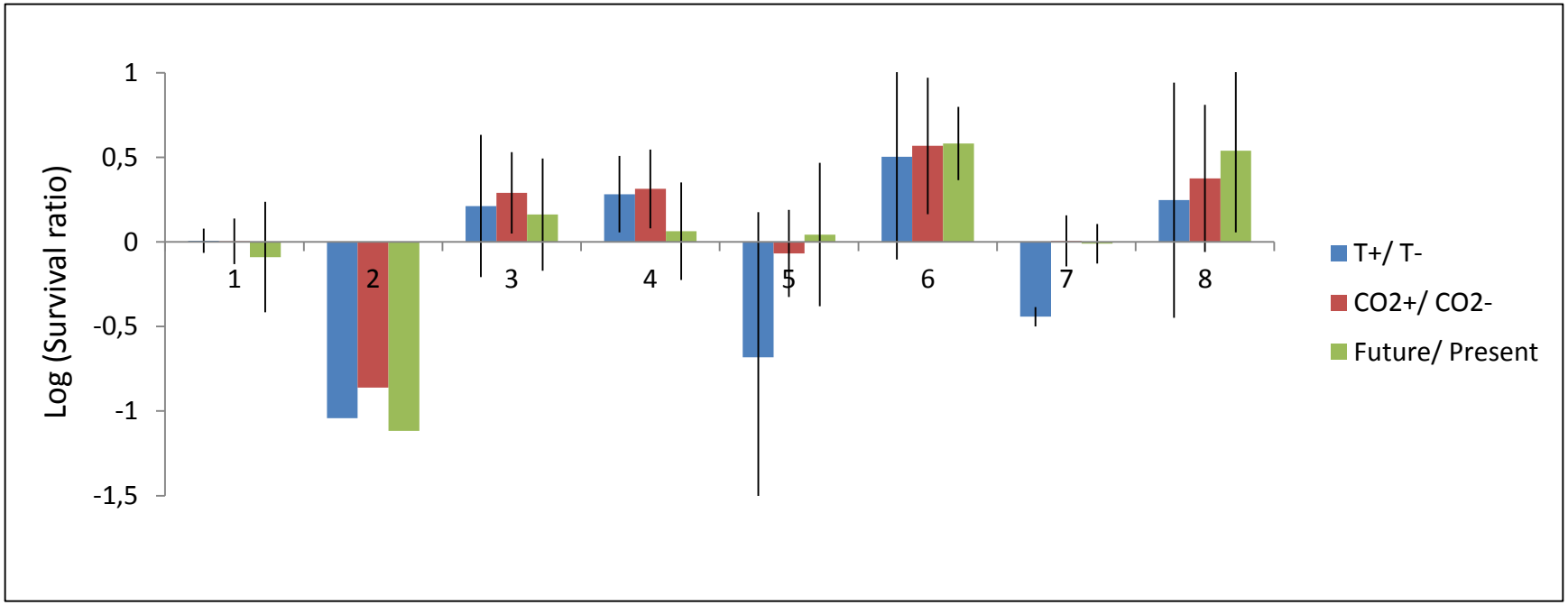
Positive sibling group co-tolerance for sibling groups with regard on survival and growth

Stress-induced community tolerance

Antagonistic interaction between the factors temperature and pCO_2

Antagonistic interaction: Temperature and pCO_2

Log effect ratio: Survival in Spring



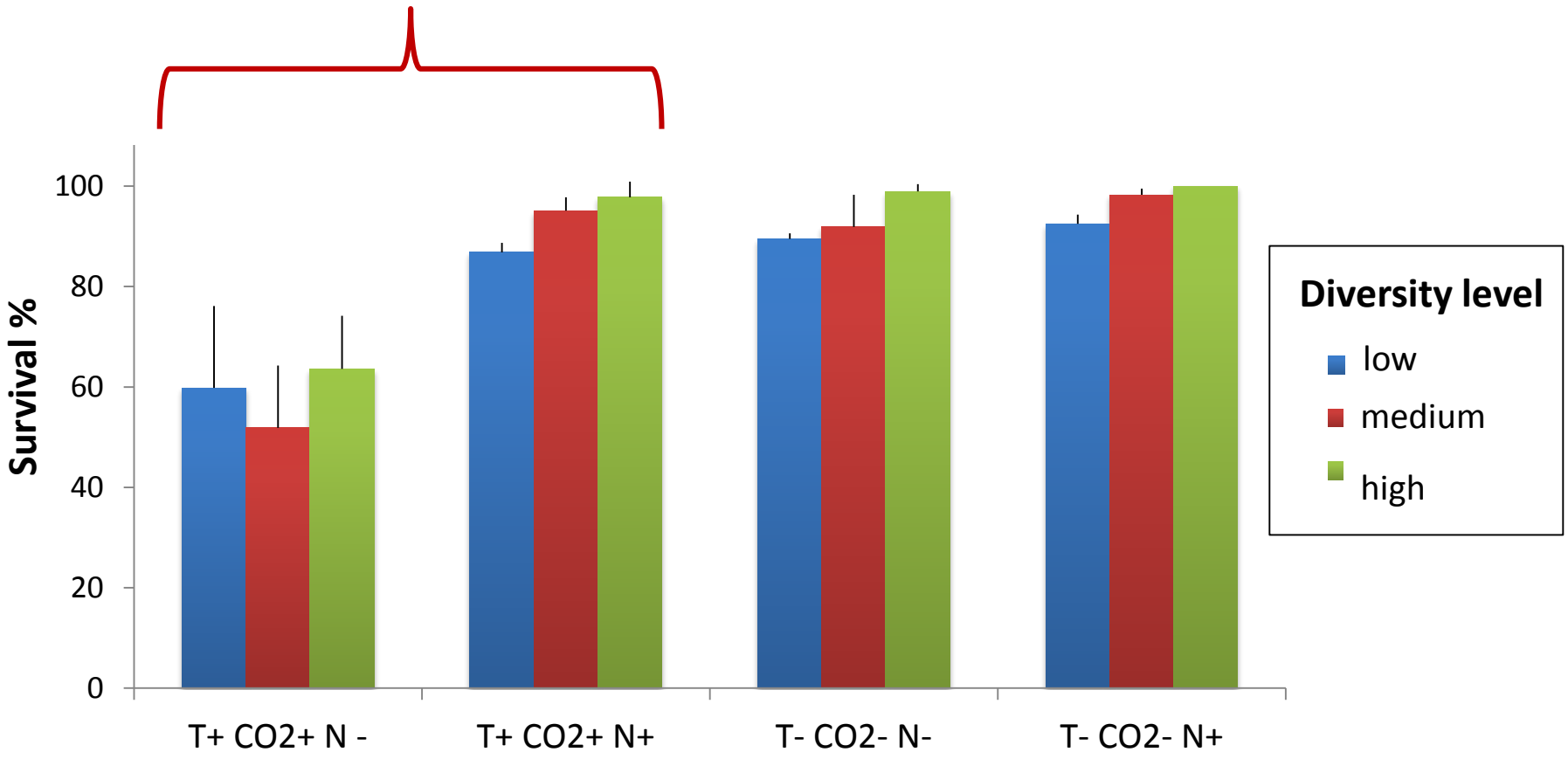
$$log\ effect\ ratio = log\ \frac{Survival\ (T+)}{Survival\ (T-)}$$

Survival differences after **eutrophication**

GEOMAR

BIOACID

Nutrients **Survival during heat wave** (p-value < 0,05)



Means +SD
n=3

Conclusions

- **Warming** has stronger effects on germlings' performance than high pCO_2
- **Warming** enhances **growth** during until summer, but **reduces survival** in late summer
- **Seasonal variation** determines climate change effects on growth and survival
- **Higher diversity level** show higher survival than low diversity level
- The **positive co-tolerance relationship** to warming and acidification lead to an **antagonistic** interaction
- **Eutrophication** mitigates mortality during a heat wave in summer

Muchas gracias por su attencion!