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EMSc MER

Changes in the benthic subtidal vegetation along the Basque Coast (north Spain) and the probable relationship with climate change

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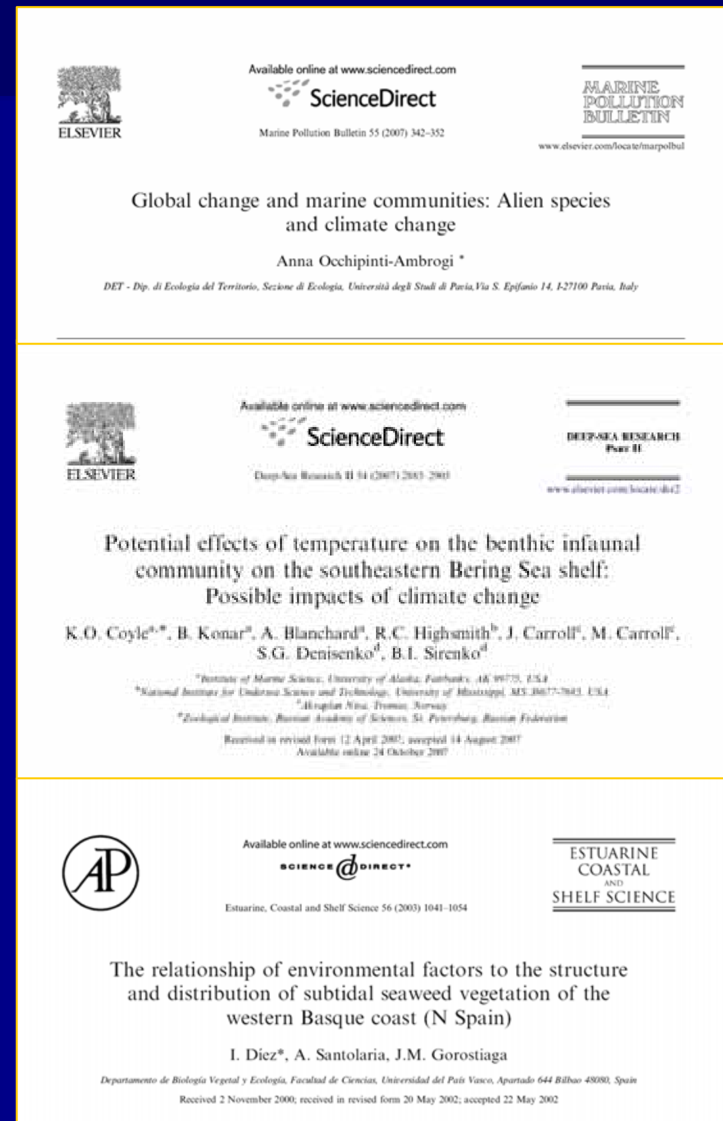
Introduction

- Concern about the effects of global warming and climate change.

- Prediction of biological changes in marine communities and evaluation of effects

- Benthic communities especially relevant for the evaluation of long-term changes in the marine environment

- Algae as indicator species in monitoring programmes



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MARINE POLLUTION BULLETIN
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Global change and marine communities: Alien species and climate change

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DEEP-SEA RESEARCH Part II

Potential effects of temperature on the benthic infaunal community on the southeastern Bering Sea shelf: Possible impacts of climate change

K.O. Coyle[a,*], B. Konar[a], A. Blanchard[a], R.C. Highsmith[b], J. Carroll[c], M. Carroll[c], S.G. Denisenko[d], B.I. Sirenko[d]

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Estuarine, Coastal and Shelf Science 56 (2003) 1041–1054
ESTUARINE COASTAL AND SHELF SCIENCE

The relationship of environmental factors to the structure and distribution of subtidal seaweed vegetation of the western Basque coast (N Spain)

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Received 2 November 2000; received in revised form 20 May 2002; accepted 22 May 2002

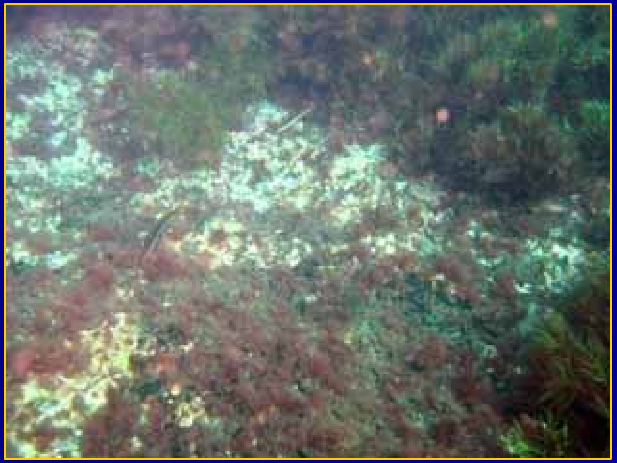
Introduction

- Marine Benthos Research team (UPV) experience in monitoring
- Latest observations revealed changes in the phytobenthic communities with no obvious cause:
  1) An apparent recess of *Gelidium corneum* stands and evident signs of stress

Introduction

2) Proliferation of intertidal species of meridional distribution (*Centroceras clavulatum, Hypnea musciformis, Herposiphonia sp., etc.*)

3) The appearance and expansion of exotic subtidal species like *Antithamnion amphigeneum* and *Peyssonnelia sp*.



4) Reduction of subtidal algal cover.

Introduction

- Increment of temperature reported in the Atlantic waters since the 80's (Hiscock *et al. 2004)* and the Basque Coast (Borja *et al.* 2000)

Vulnerability of the Basque coast to global warming

– Warmer waters

– Flora with a more southern affinity

Objetives

- Quantify changes in subtidal phytobenthic communities for the last 25 years in comparison with a previous study (Limia & Gorostiaga, 1982) undertaken in a stretch of an exposed shore (Kobaron, western Basque coast)

  Focused on:

  - Cover and biomass changes of *Gelidium corneum*,

  - Changes in species composition and relative abundances in the different algal communities

- To formulate hypothesis about possible causes of changes detected and to explore the sensitivity of the benthic marine algae to the changing environmental factors.

Materials and Methods

7 subtidal transects (summer 2007)

Materials and Methods

<u>Relevant Information obtained</u>:

- Percent cover of dominant macrophtes (Braun-Blanquet scale) every 10 m length bands

- Destructive stratified sampling (50 x 40 cm quadrats; dry weight 110º C, 24h) at 6 different depths (2, 3, 6, 9, 10, 11m)

<u>Statistical Analysis</u>

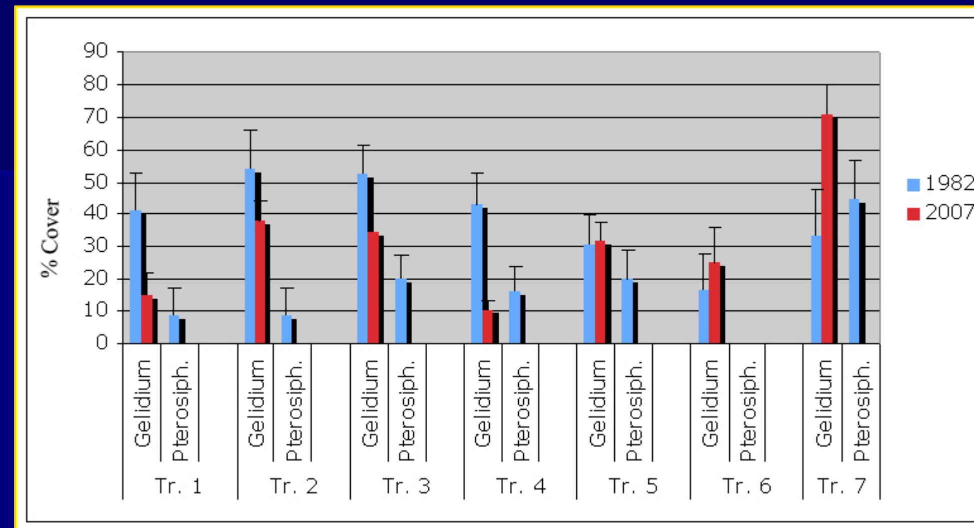
PRIMER-E

Temporal and spatial differences in phytobenthic assemblages were analysed using the PRIMER (Plymouth Routines In Multivariate Ecological Research) software package

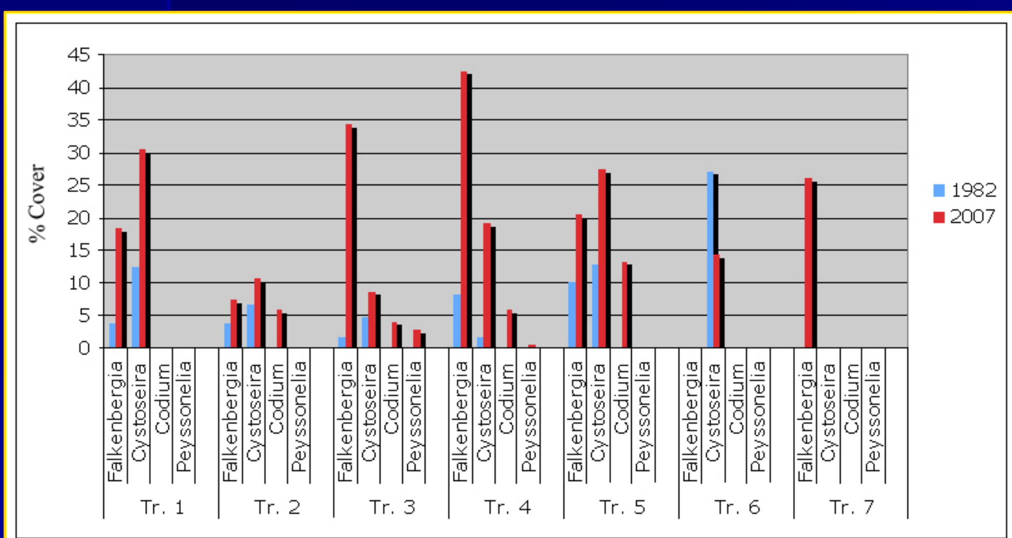
Results: Changes in Cover of community structurating species.

Decrease

Gelidium corneum

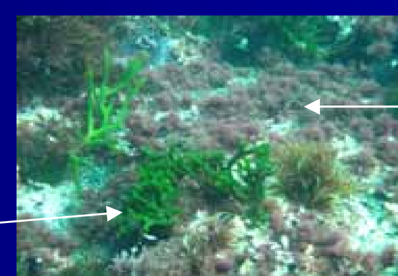


Increase



Cystoseira baccata

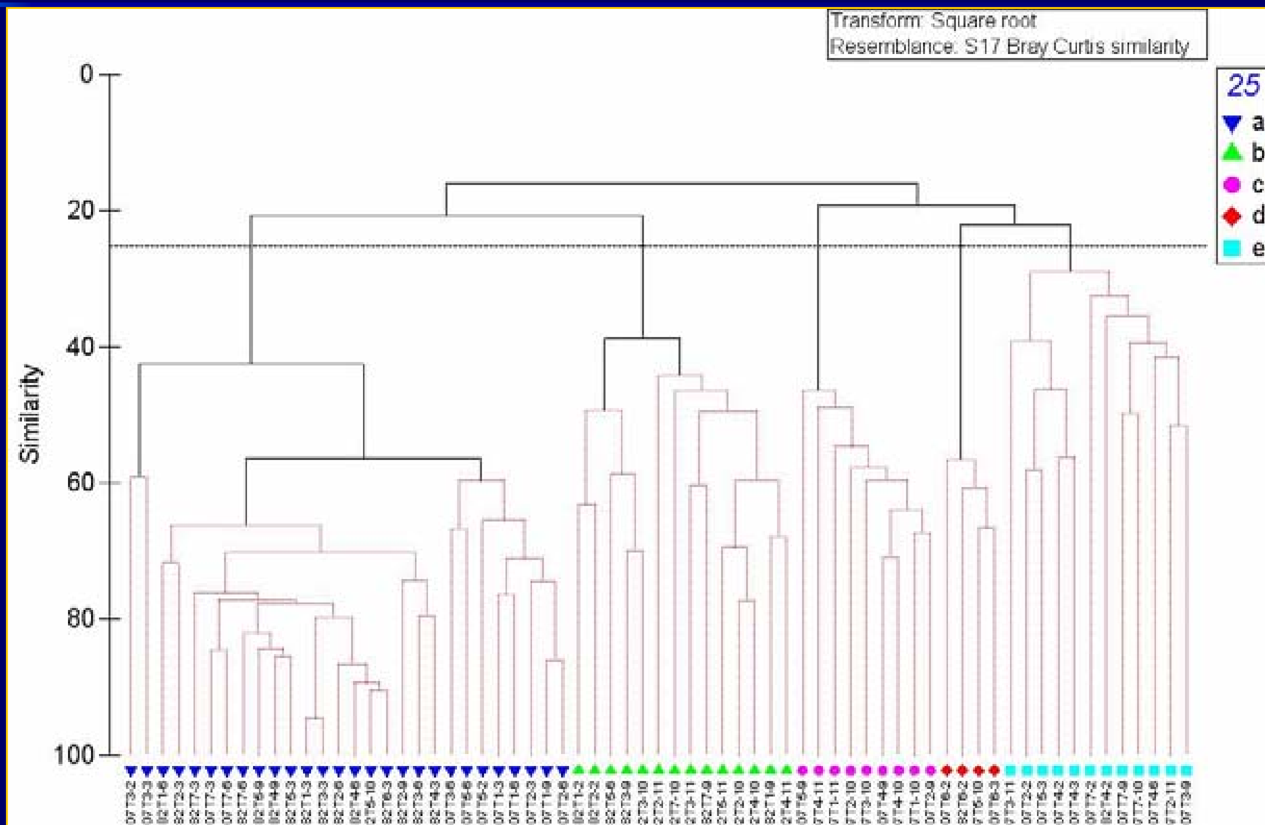
Peyssonelia sp.



Falkenbergia and filamentous algae

Codium decorticatum

Results: Classification



Turf vegetation *C. decorticatum*

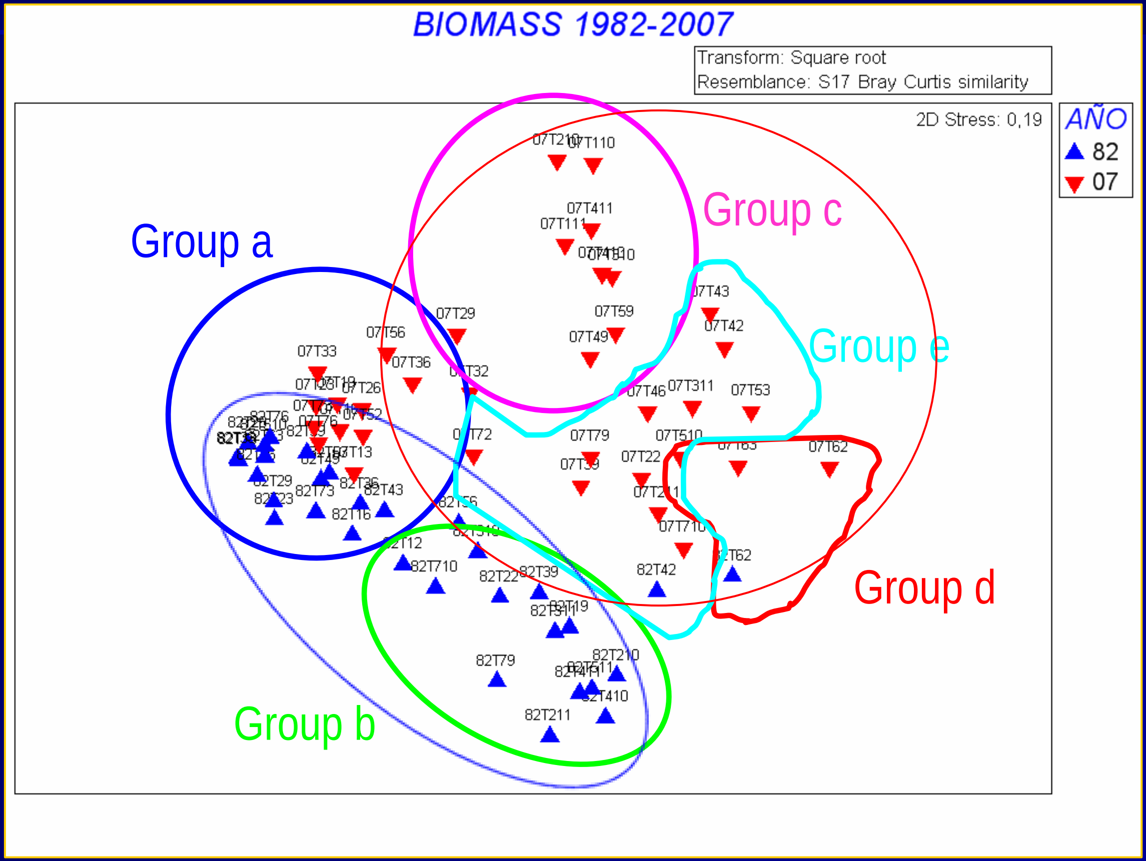
Cystoseira baccata

Pterosiphonia complanata

Halopithys incurva

Gelidium corneum

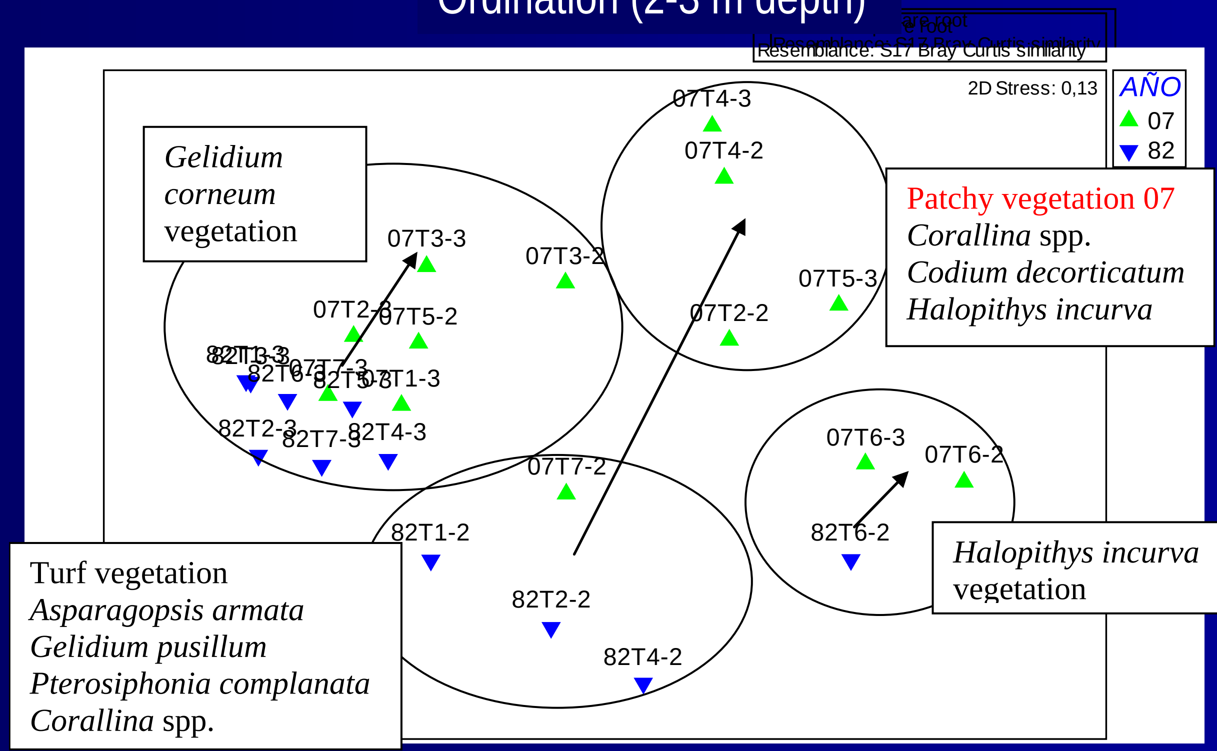
Results: Ordination



2D Non-metric Multi-Dimensional Scaling analysis based on the Bray Curtis similarity index.

Results: Ordenation

Ordination (2-3 m depth)



Vegetation differences between both years were significant (test ANOSIM, R= 0,22 p=0,009)

Results: Structural changes of vegetation at 2-3 m depth

Turf vegetation

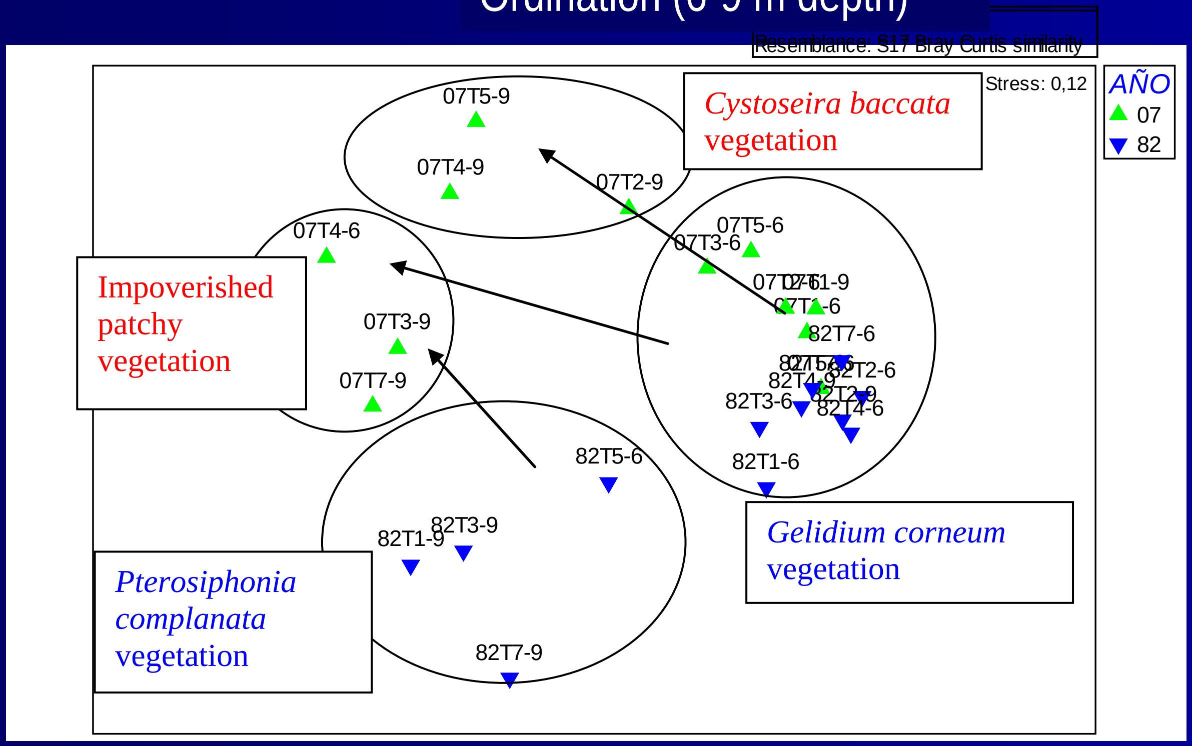
	82 (n=3)	07 (n=5)
Gelidium corneum	13,96±11,53	2,16±1,29
Asparagopsis armata	7,49±2,78	0,19±0,14
Gelidium pusillum	5,27±3,74	-
Gelidium spinosum	3,26±1,58	0,50±0,43
Pterosiphonia complanata	2,43±1,49	0,19±0,08
Corallina officinalis	1,82±0,98	4,90±2,11
Halopithys incurva	0,01±0,01	4,46±3,17
Codium decorticatum	-	23,13±13,36
Corallina elongata	-	0,78±0,36

Gelidium corneum vegetation

	82 (n=7)	07 (n=6)
Gelidium corneum	189,36±33,89	70,03±22,02
Pterosiphonia complanata	0,77±0,41	0,09±0,07
Asparagopsis armata	0,22±0,20	0,68±0,41
Corallina officinalis	0,27±0,27	0,64±0,59
Dictyopteris polypodioides	0,37±0,27	-
Gelidium pusillum	0,19±0,13	-
Gelidium spinosum	0,05±0,04	0,02±0,02
Codium decorticatum	-	17,75±11,63
Corallina elongata	-	2,25±2,17
Callithamnion tetragonum	-	0,21±0,07
Acrosorium ciliolatum	-	0,12±0,09

Results: Ordenation

Ordination (6-9 m depth)



Vegetation differences between both years were significant (test ANOSIM, R= 0,23 p=0,01)

Results: Structural changes of vegetation at 6-9 m depth

Gelidium corneum bed (82)
converted in

A cleared *Gelidium corneum* bed (07)

	82 (n=8)	07 (n=6)
Gelidium corneum	157,09±21,48	83,11±16,83
Dictyopteris polypodioides	1,84±1,34	-
Pterosiphonia complanata	1,12±0,84	0,05±0,03
Asparagopsis armata	0,34±0,32	0,19±0,14
Dictyota dichotoma	0,43±0,42	2,02±0,67
Plocamium cartilagineum	0,66±0,31	1,70±0,75
Rhodymenia pseudopalmata	0,03±0,02	0,40±0,18
Cystoseira baccata	-	9,44±6,82
Callithamnion tetragonum	-	0,30±0,17
Acrosorium ciliolatum	-	0,20±0,06
Codium decorticatum	-	0,12±0,12

A *Cystoseira baccata* bed (07)

	82 (n=8)	07 (n=3)
Gelidium corneum	157,09±21,48	5,87±5,43
Dictyopteris polypodioides	1,84±1,34	0,03±0,03
Asparagopsis armata	0,34±0,32	0,05±0,02
Cystoseira baccata	-	43,67±8,96
Halopithys incurva	-	3,38±3,38
Jania rubens	-	1,27±1,13
Phyllophora crispa	-	1,01±0,55
Acrosorium ciliolatum	-	0,49±0,12
Codium decorticatum	-	0,38±0,38

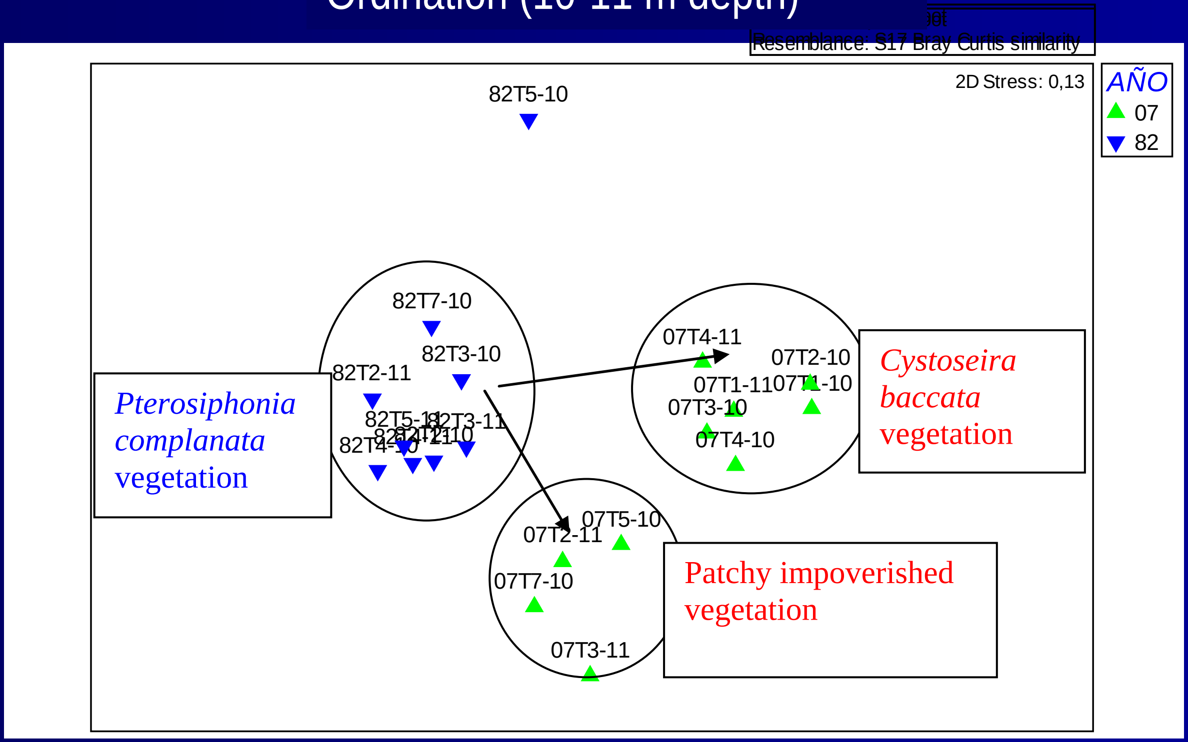
P. complanata bed (82)
converted in

A patchy impoverished vegetation

	82 (n=4)	07 (n=3)
Pterosiphonia complanata	6,02±2,88	0,32±0,13
Gelidium corneum	5,70±3,87	1,42±0,42
Asparagopsis armata	3,38±1,71	1,10±0,44
Calliblepharis ciliata	2,76±2,76	-
Dictyopteris polypodioides	1,25±0,46	-
Heterosiphonia plumosa	0,90±0,51	0,12±0,12
Cryptopleura ramosa	0,48±0,25	0,01±0,003
Sphondylothamnion multifidum	0,38±0,33	-
Corallina officinalis	0,03±0,02	0,57±0,28
Cladophora pellucida	-	0,23±0,17
Codium decorticatum	-	0,25±0,20
Phyllophora crispa	-	0,46±0,27

Results: Ordenation

Ordination (10-11 m depth)



Vegetation differences between both years were highly significant (test ANOSIM, R= 0,63 p=0,001)

Results: Structural changes at 10-11 m vegetation

Pterosiphonia complanata bed (82)
converted in

A Cystoseira baccata bed (07)

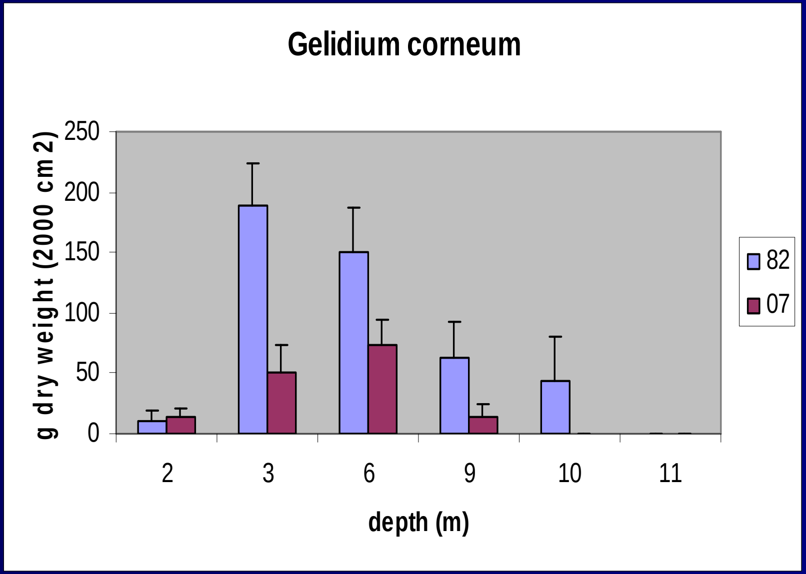
	82 (n=8)	07 (n=6)
Pterosiphonia complanata	12,83±3,21	0,44±0,3
Dictyopteris polypodioides	4,94±2,51	0,07±0,36
Calliblepharis ciliata	4,89±1,86	0,10±0,08
Gelidium corneum	3,67±2,34	0,12±0,05
Heterosiphonia plumosa	3,06±1,35	0,04±0,02
Asparagopsis armata	2,52±0,97	0,09±0,04
Pterosiphonia pennata	0,46±0,14	0,05±0,04
Halopteris filicina	0,31±0,19	0,03±0,02
Gymnogongrus crenulatus	0,25±0,15	-
Sphondylothamnion multifidum	0,22±0,09	-
Acrosorium ciliolatum	0,12±0,09	0,62±0,24
Cystoseira baccata	-	78,61±23,23
Phyllophora crispa	-	3,69±2,32

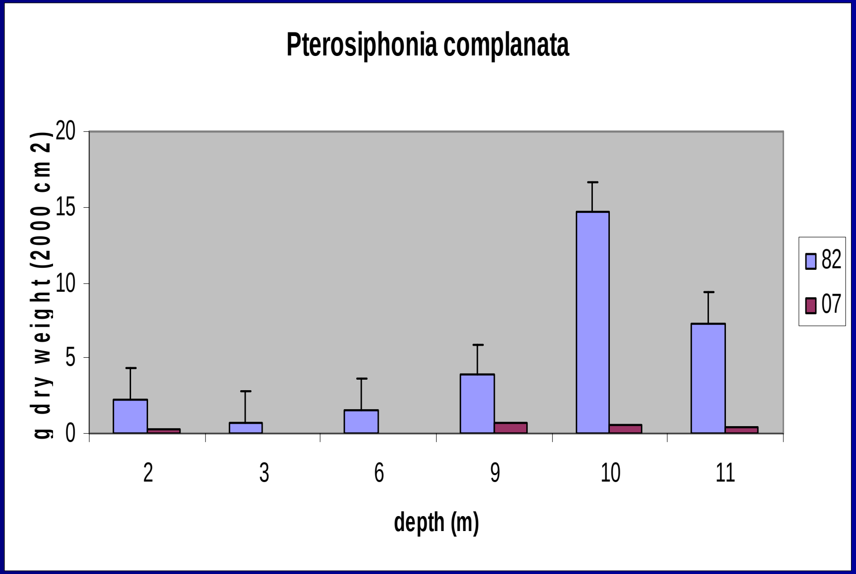
An impoverished patchy vegetation (07)

	82	07
Pterosiphonia complanata	12,83±3,21	0,61±0,20
Dictyopteris polypodioides	4,94±2,51	-
Calliblepharis ciliata	4,89±1,86	-
Gelidium corneum	3,66±2,34	0,12±0,04
Heterosiphonia plumosa	3,06±1,35	0,04±0,04
Asparagopsis armata	2,52±0,98	0,87±0,18
Pterosiphonia pennata	0,46±0,14	0,16±0,09
Gymnogongrus crenulatus	0,25±0,15	-
Sphondylothamnion multifidum	0,22±0,09	0,004±0,004
Plocamium cartilagineum	0,68±0,42	0,24±0,22
Dictyota dichotoma	0,40±0,29	0,23±0,20
Cryptopleura ramosa	0,38±0,13	0,17±0,15
Halopithys incurva	0,23±0,15	11,31±11,23
Acrosorium ciliolatum	0,12±0,09	0,37±0,20
Corallina officinalis	0,001±0,002	1,81±1,69
Codium decorticatum	-	2,75±2,74
Peyssonnelia sp	-	1,85±1,85
Cladophora pellucida	-	0,16±0,14

Results and discussion: Biomass changes in structurating species

Results show significant changes in the subtidal marine vegetation in the study area during the last 25 years.





Hipotheses:

Harvest effect?

Interannual natural variation?

Pollution effect?

Grazing effect?

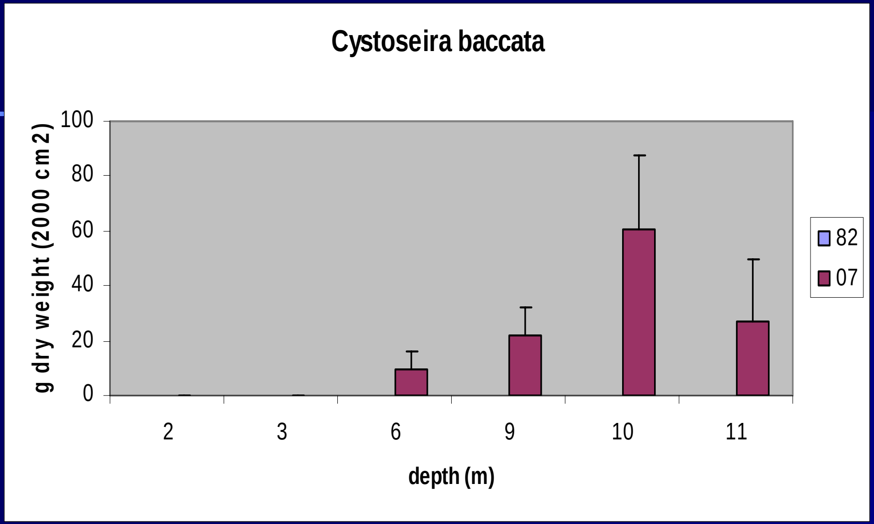
Sand effect?

Natural nutrient variation?

Light and Tª variation?

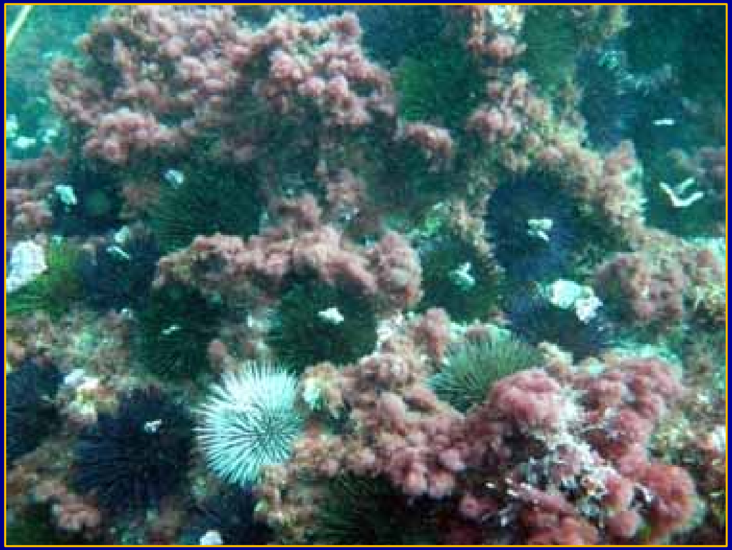
Water motion variation?

Results and discussion: Biomass changes in structurating species



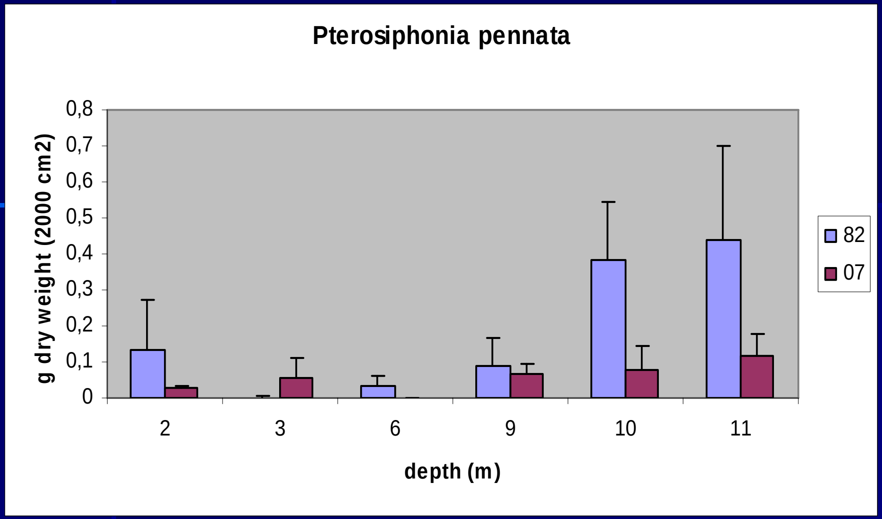
Not pollution degradation

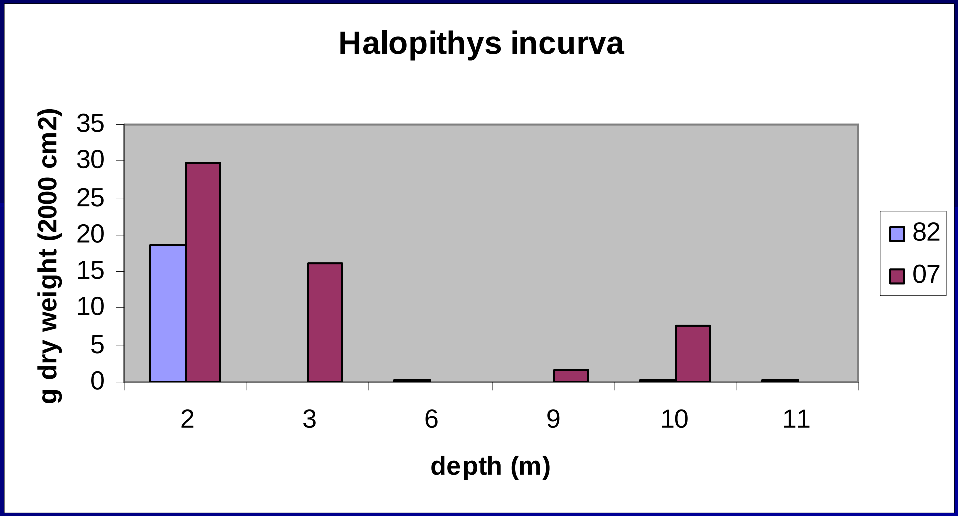
Cystoseira



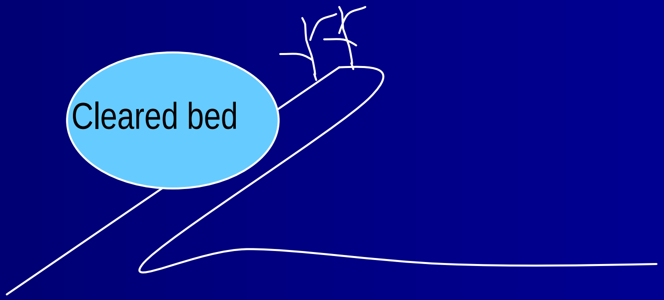
Sea urchins mainly distributed at shallow waters

Results and discussion: Biomass changes in structurating species





Sand effect?



Results and discussion: Biomass changes in structurating species

Not a local disturbance → Same symptoms at two localities with *G. corneum* beds (15 and 40 km away from the study area)

Natural nutrient variation?

Light and Tª variation?

Water motion variation?

→ Climatic anomalies?

Results and discussion: Biomass changes in structurating species

Results and discussion: Biomass changes in structurating species

Not a local disturbance → Same symptoms at two localities with *G. corneum* beds (15 and 40 km away from the study area)

Natural nutrient variation? →

Light and Tª variation? → Climatic anomalies?

Water motion variation? →

Results and dicussion: rejection of the hypothesis

Climatic anomalies at the Basque coast (not yet compiled information)

But ………….

Sunny dried summers and mild winters

↓

Response of benthic marine algae

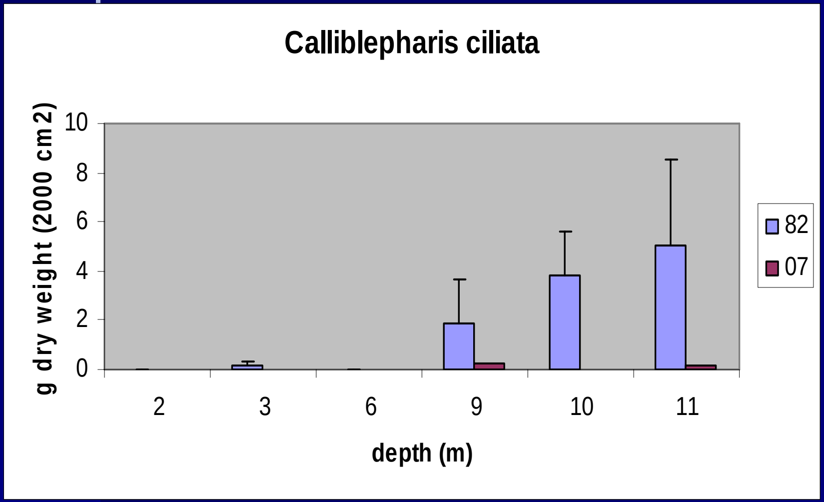
1) Ho= same abundance of southern species between both years

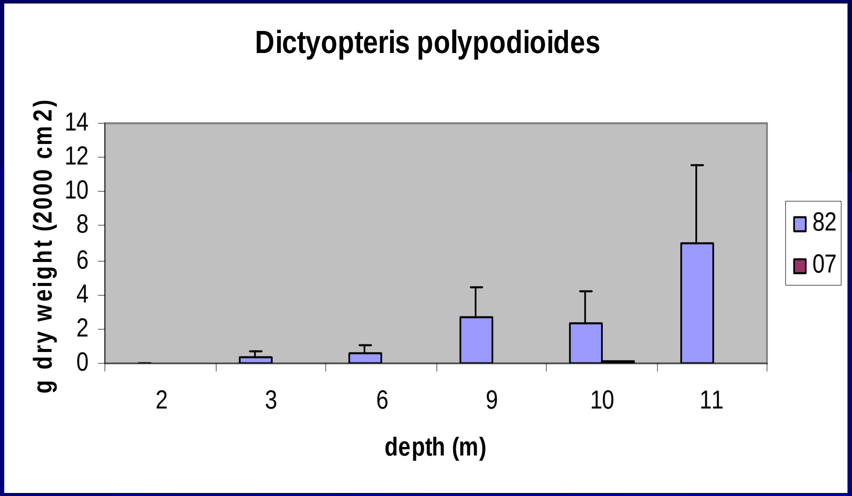
Hypothesis

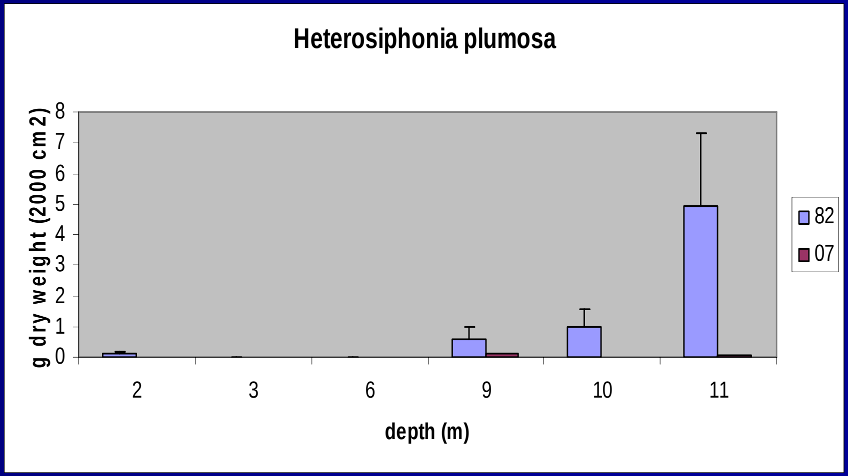
2) Ho= same abundance of northern species between both years

Results and dicussion: rejection of the hypothesis

Northern affinity species decreasing

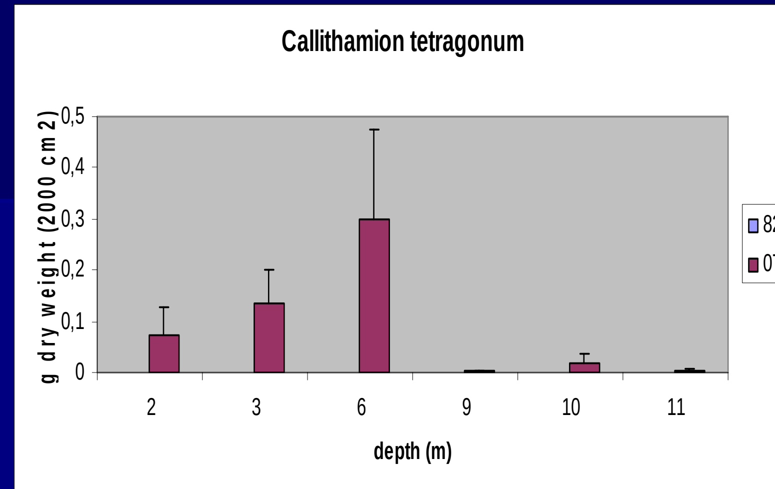


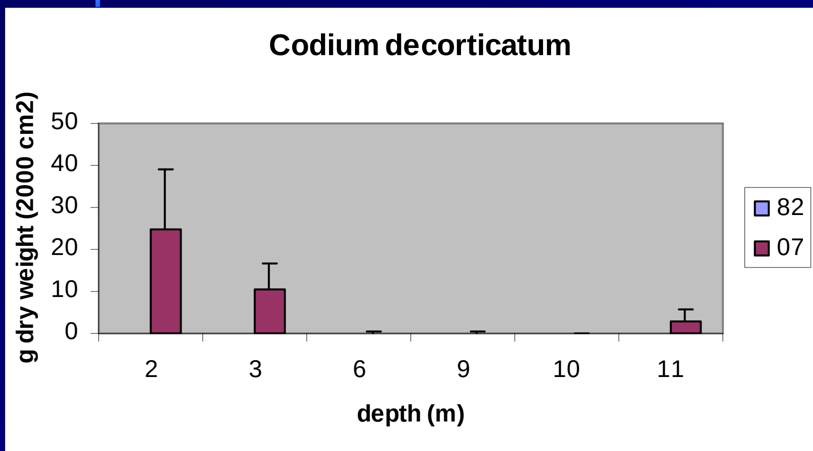


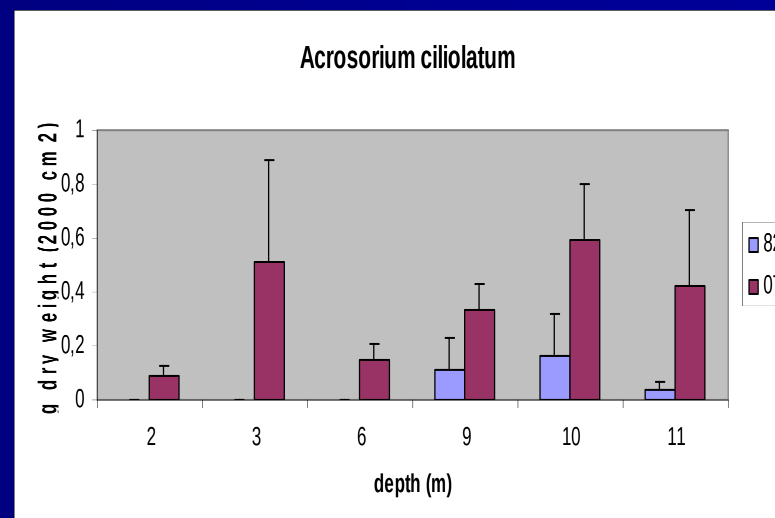


Results and dicussion: rejection of the hypothesis

Increasing of southern affinity species

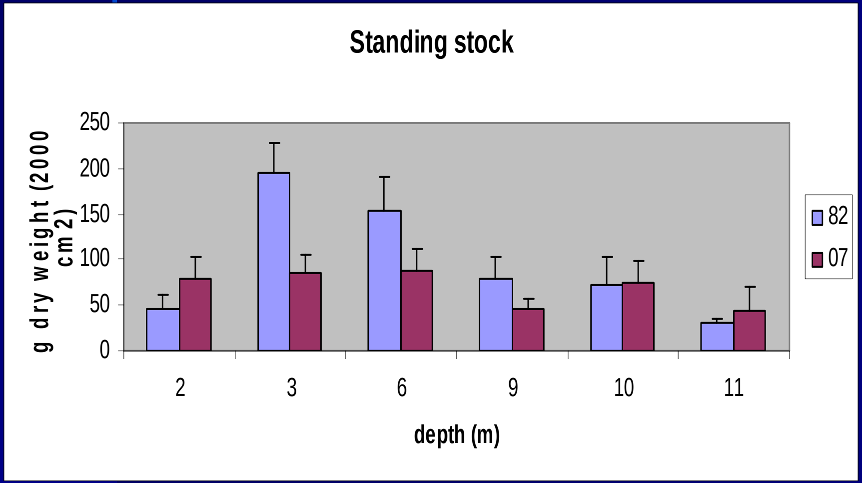




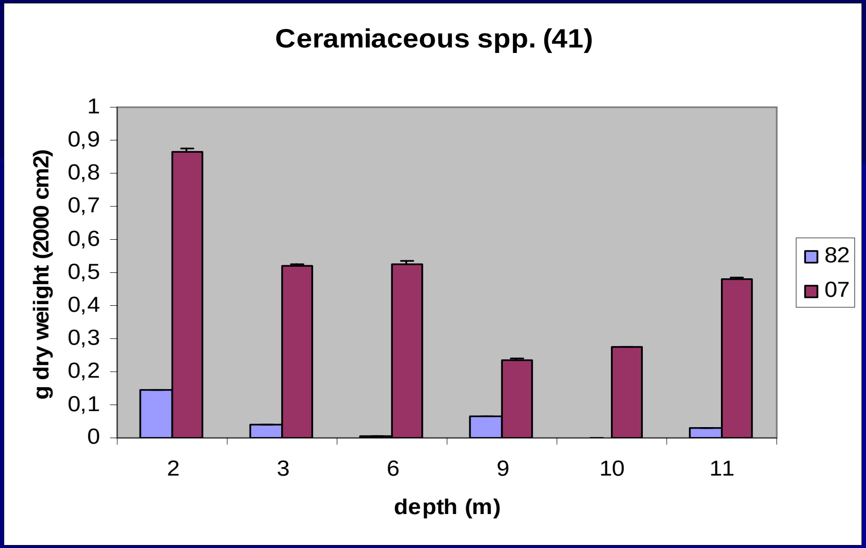


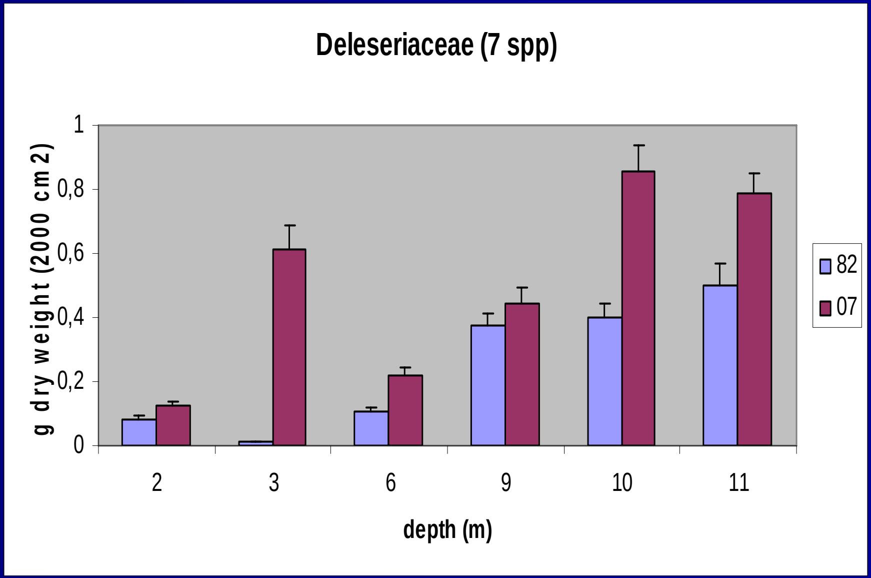
Results and discussion: other symptoms

Temporal standing stock reduction (- 28%)



Epiphytes increase (ceramicaceous and delesseriaceous algae)





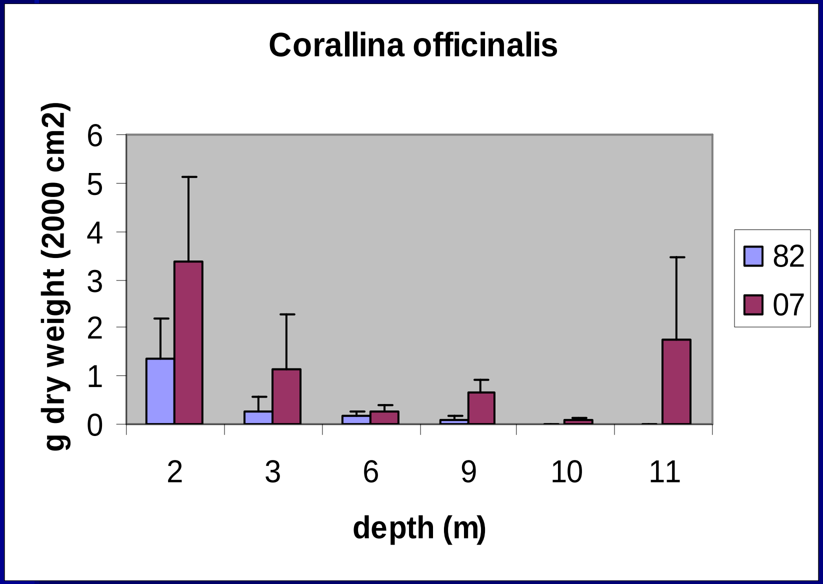
Increase of irradiance (sunny days, clear waters):
Fronds of *G. corneum*, suffer photo-oxidative stress and perhaps a higher consumption of phycobiliproteins

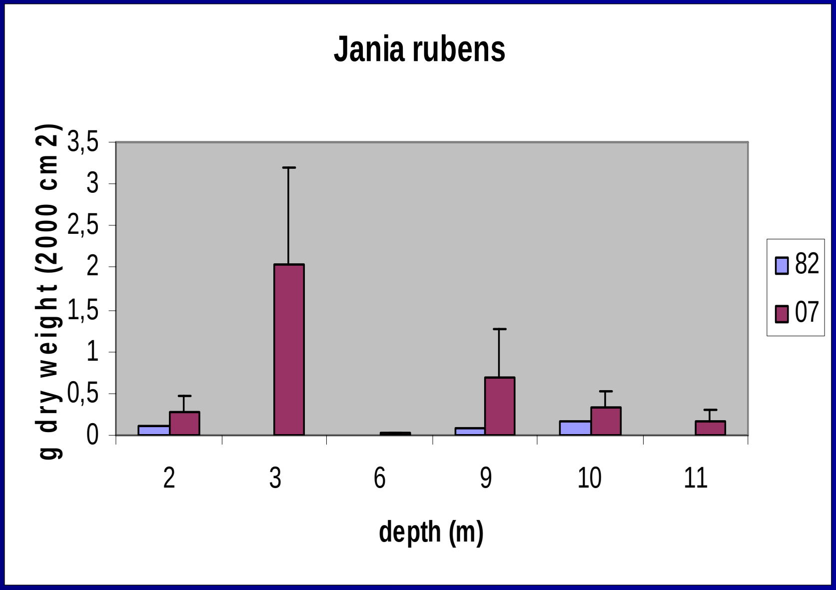
Results and discussion: other symtoms

¿More calcification? (Light and Tª increasing):

Increasing of the photophylous *Corallina* and *Jania* .

Bleaching of the sciaphylous *Mesophyllum lichenoides.*





Conclusions

- Significant changes in species abundance and distribution can be associated to the particular environmental conditions of the last two decades.
- Light, water´s transparency and Tª increases could be the main responsible of the recorded changes (changes in nutrient availability and water motion must be also explored).
- Phytobenthic communities could be used as a sensitive tool to detect changes in the environment associated with climate change.

Further research

- Evaluate the subtidal vegetation changes occurred along the Basque coast since 1991 (Gorostiaga *et al*., 1996; Díez *et al*., 2003).
- Correlate meteorological variables (Temperature, irradiance, precipitation rate, swell, etc) with the changes detected.
- Physiological changes experienced by *Gelidium corneum* and other indicator species to determine tolerating ranges to environmental factors.

Bioindicators

THANK YOU!