

Biological responses to environmental changes:

Phenotypic plasticity of the gastropods



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Anthropogenic

Natural

Environmental changes



Biological responses

Species

Community

Physiology, Morphology, behavior

biodiversity, structure

Modern

Past



Testing existing proxy



Developing a new proxy



Reconstructing
Paleoenvironment

1. Availability and reliability of cues
2. Natural vs. anthropogenic changes

Phenotypic plasticity

“ability of one genotype to produce more than one phenotype when exposed to different environments”

Why important?

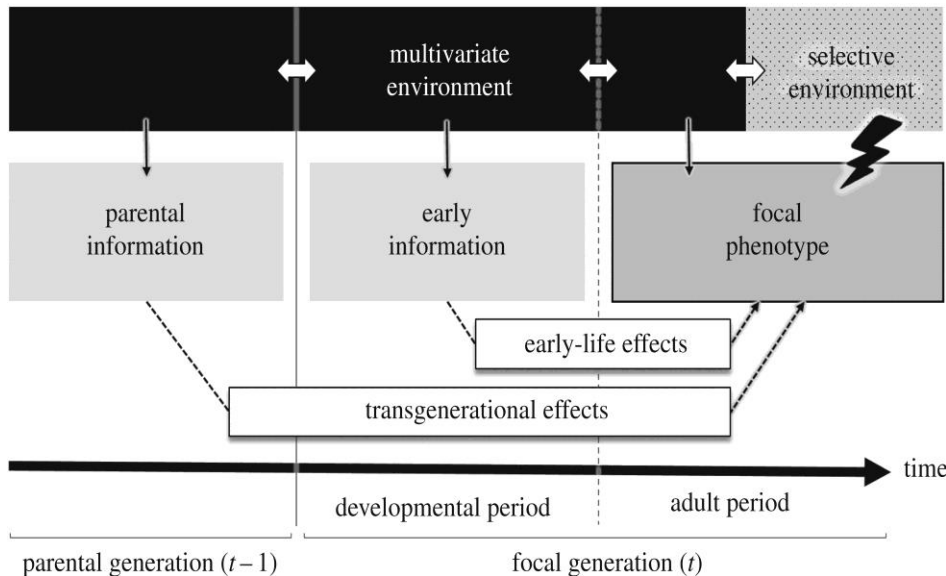
- Response to global change
- For adaptation
- Colonization of new environments, geographical range shifts and the success of invasive species

Availability and reliability of cues

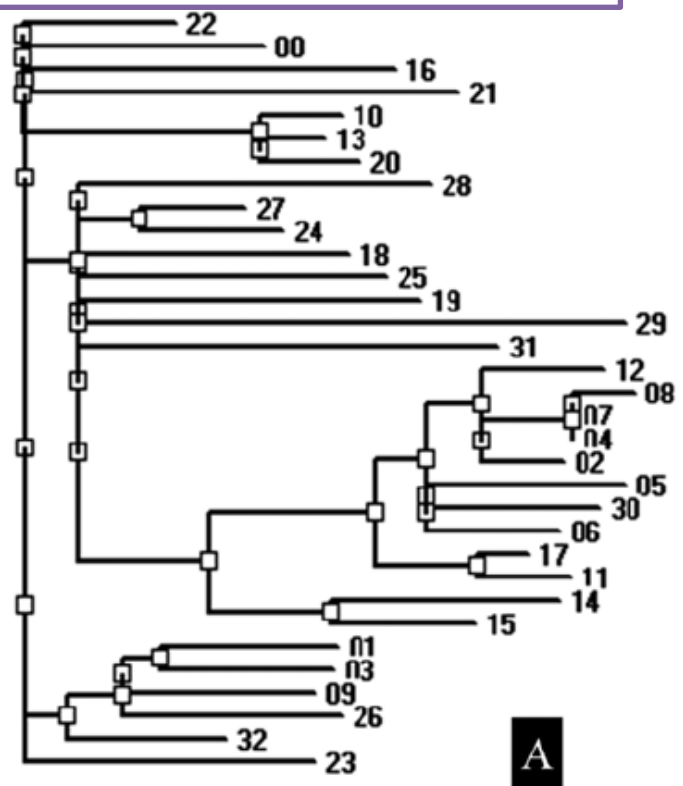
Selective pressures?
Natural vs. anthropogenic?

Which species?

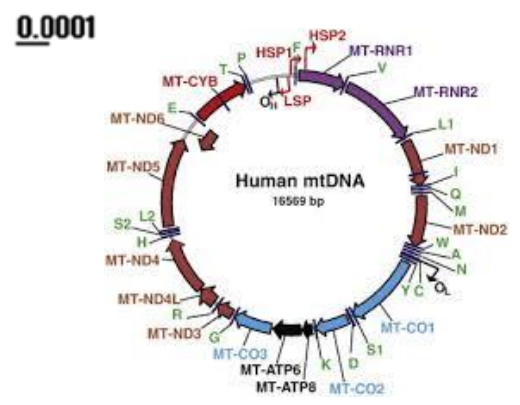
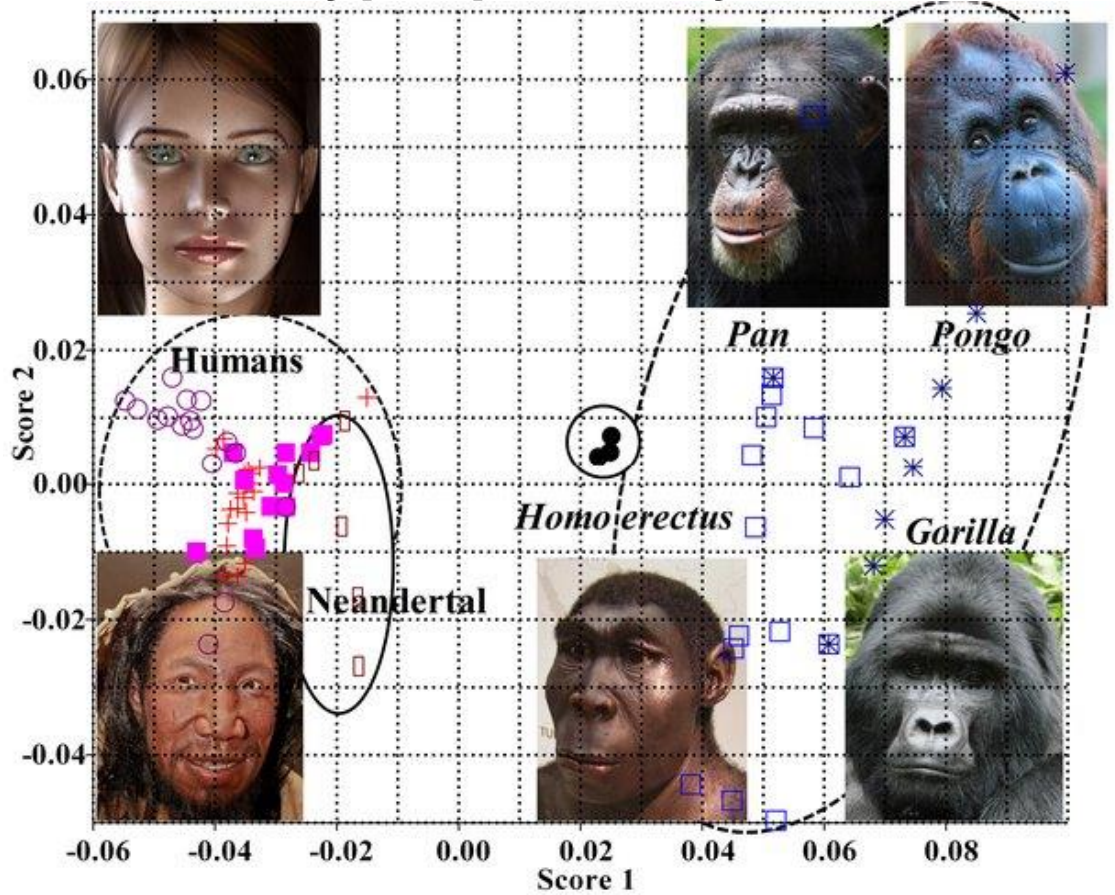
- Species with short generation times (days to months)
- Species with long generation times (years to decades)



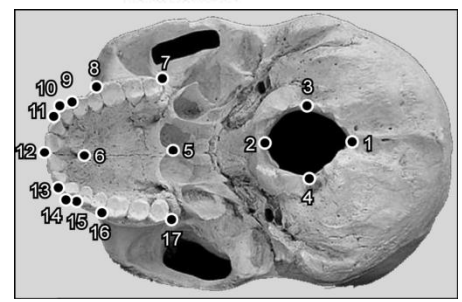
Molecules vs. morphologies



Phenotypic plasticity of humans

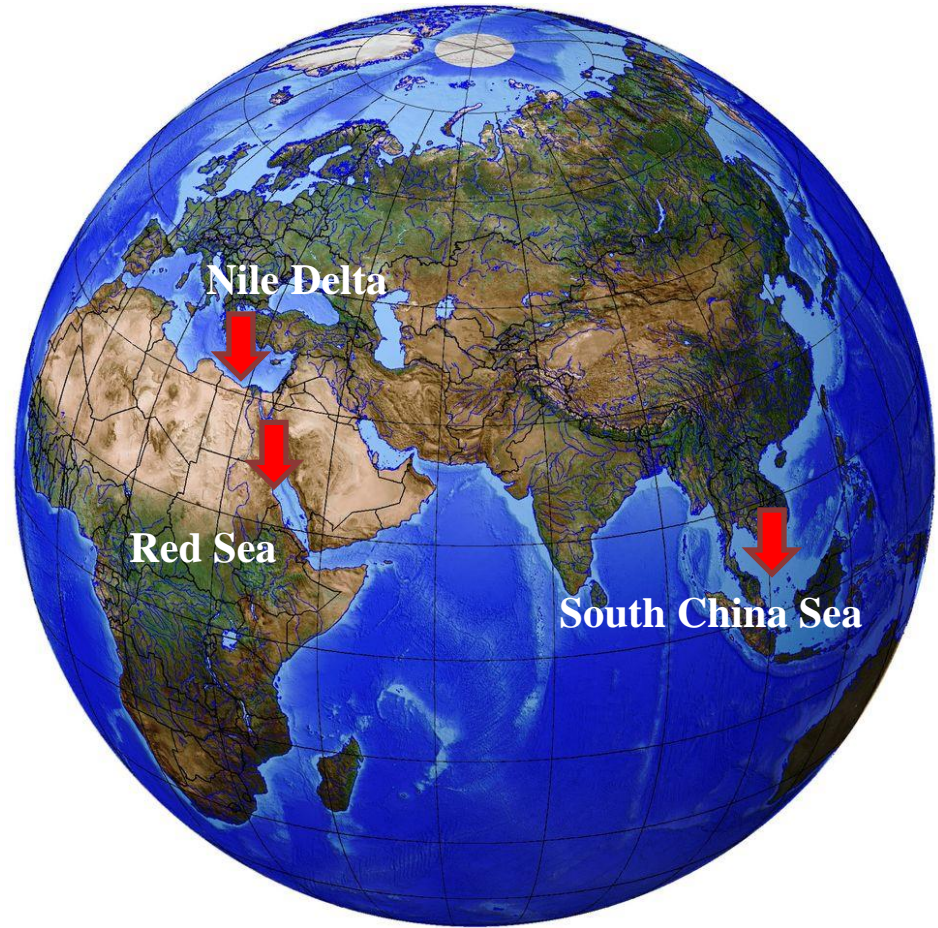


Genotype vs. phenotype





Phenotypic plasticity of the gastropods

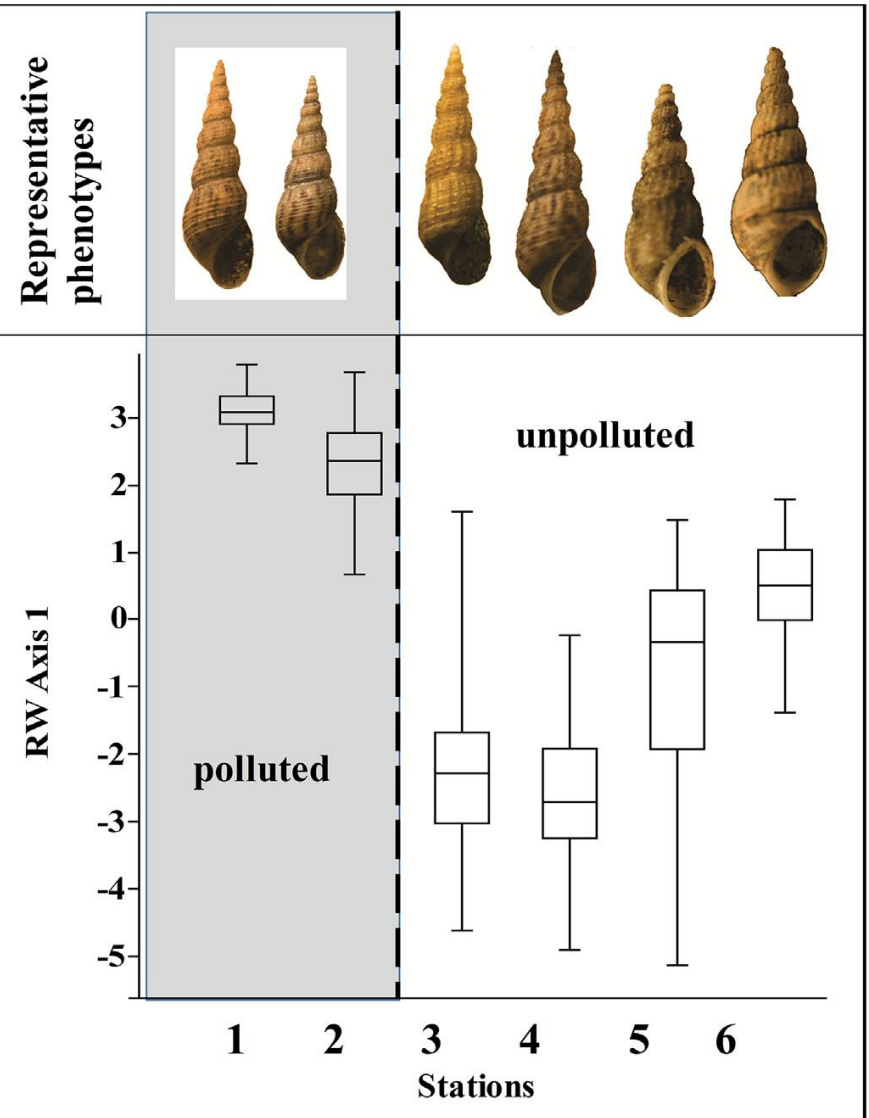
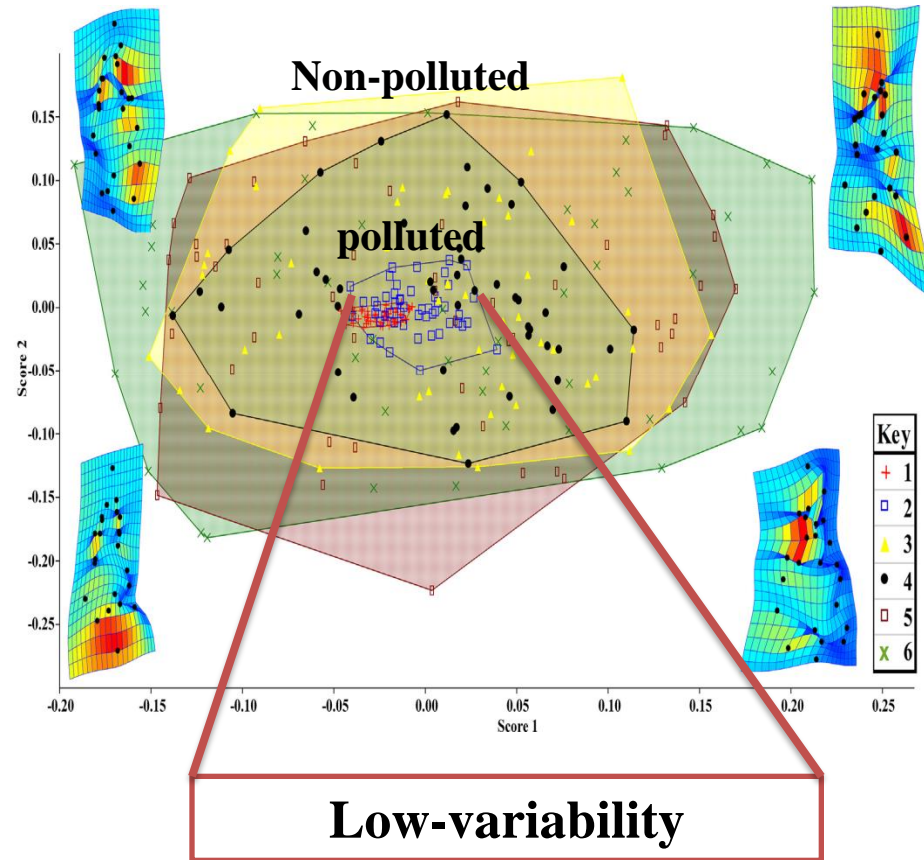


Study sites

Nile Delta

Melanoides tuberculata

A pollution-induced stabilizing-selection

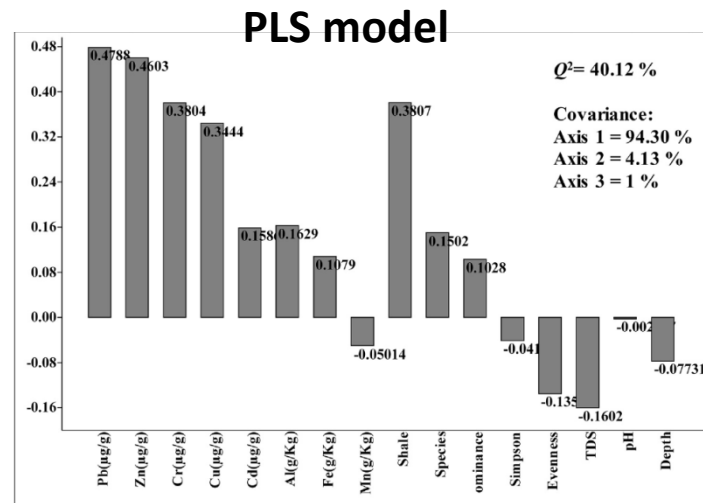


Nile Delta



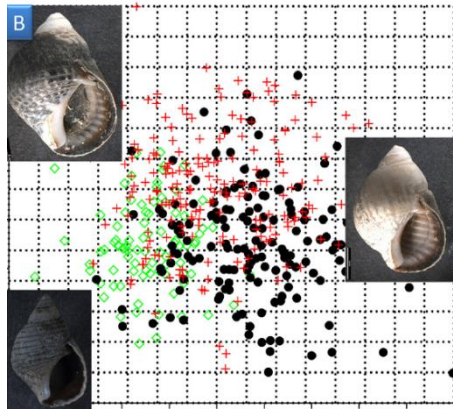
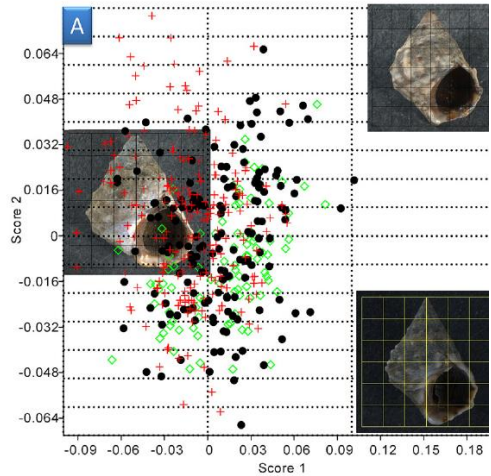
source of pollution
Bahr El-Baqar Drain

VIPs (Variable Importance for projection)



Red Sea

Phenotypic differentiation of the Red Sea gastropods in response to the environmental deterioration:



Relative warp (RW)

Ecotype (A)

higher shell & smaller aperture.

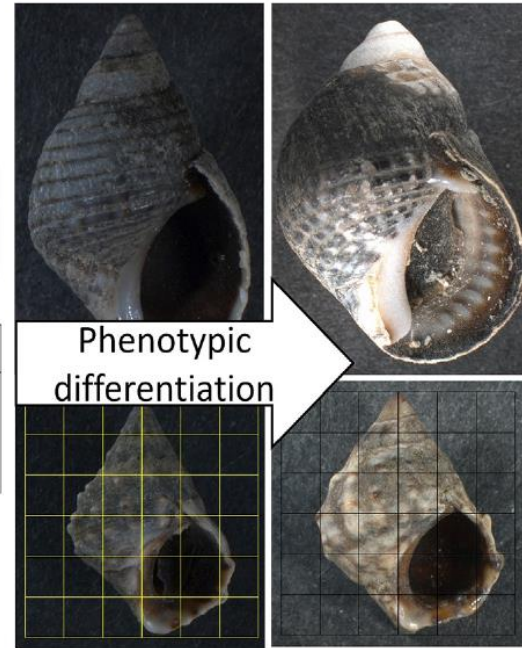
Pb	Zn	Th	Ba
1.17	1.4	1.2	2.6

Index of Pollution < 3

A pollution-induced disruptive-selection

Um Gheig Lead-Zinc Mine

Echinolittorina subnodosa



Ecotype (B)

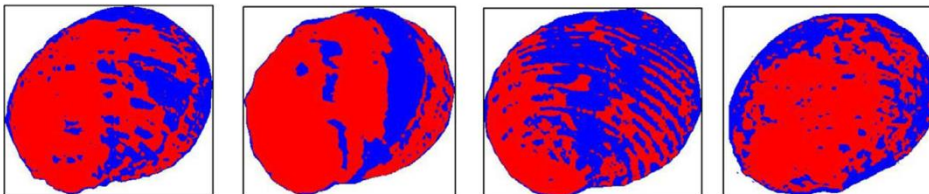
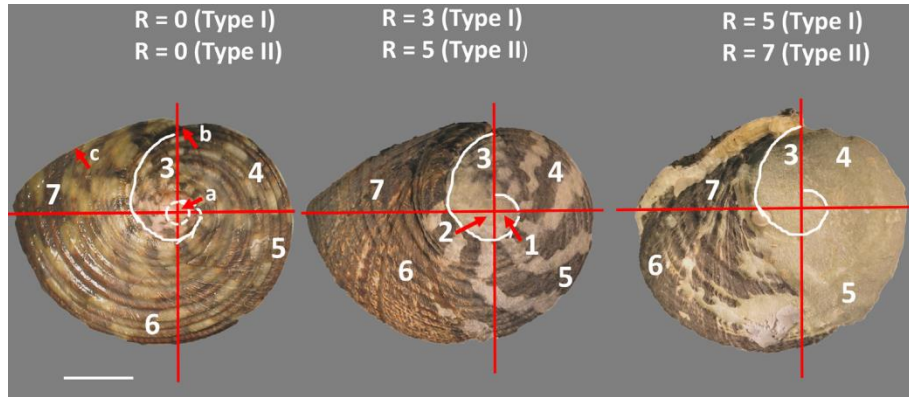
rounded shell & bigger aperture

Pb	Zn	Th	Ba
62.9	2.9	3.8	6.8

Index of Pollution > 3

Planaxis sulcatus

South China Sea Coast of Brunei

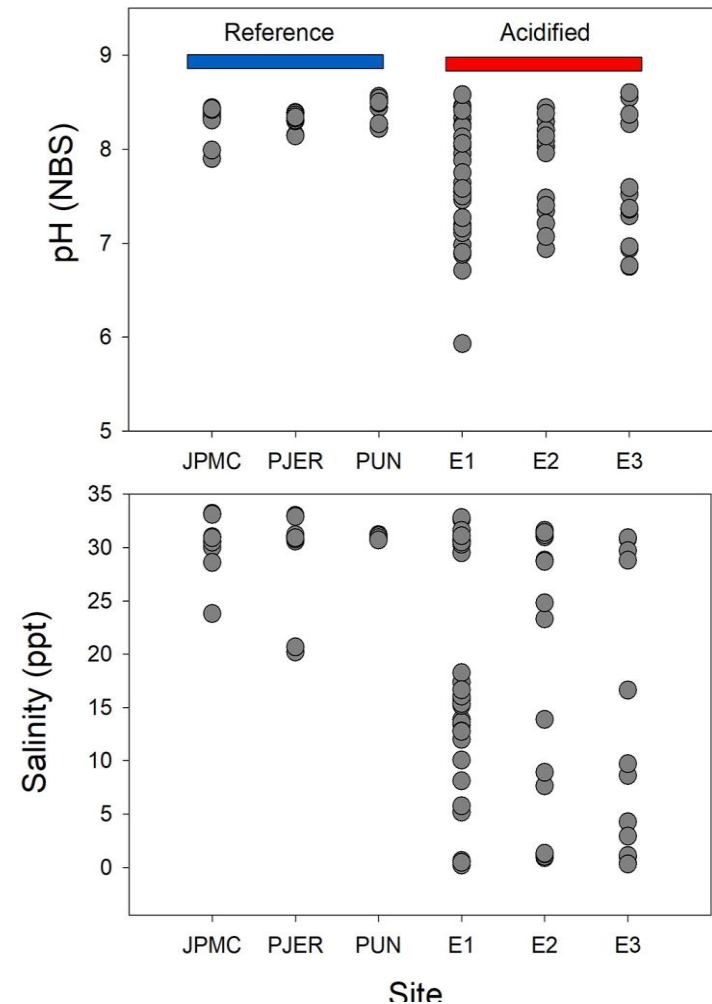


Red Pixels (R) = 45877	Red Pixels (R) = 39818	Red Pixels (R) = 27851	Red Pixels (R) = 33078
Blue Pixels (B) = 21364	Blue Pixels (B) = 14413	Blue Pixels (B) = 30608	Blue Pixels (B) = 15582
Shell erosion % = 68.23%	Shell erosion % = 73.42%	Shell erosion % = 47.64%	Shell erosion % = 67.98%

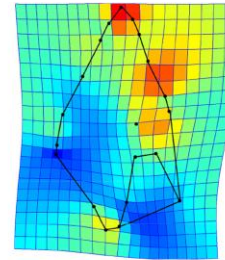
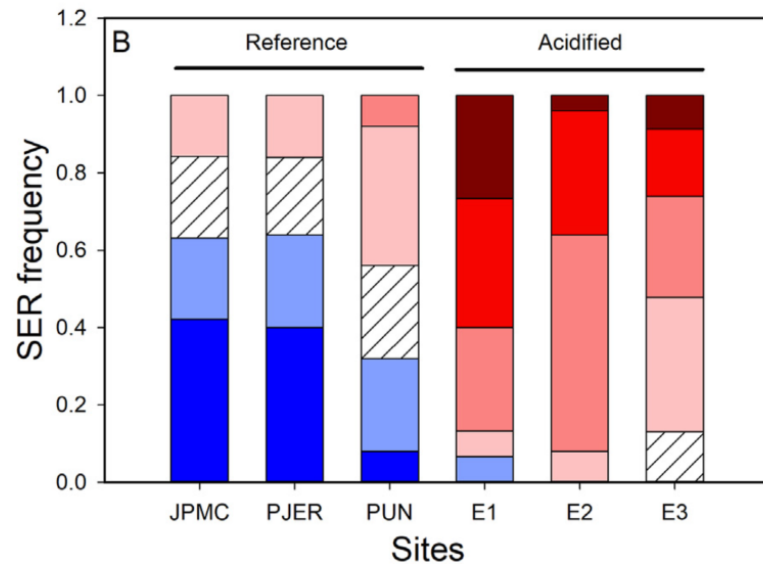
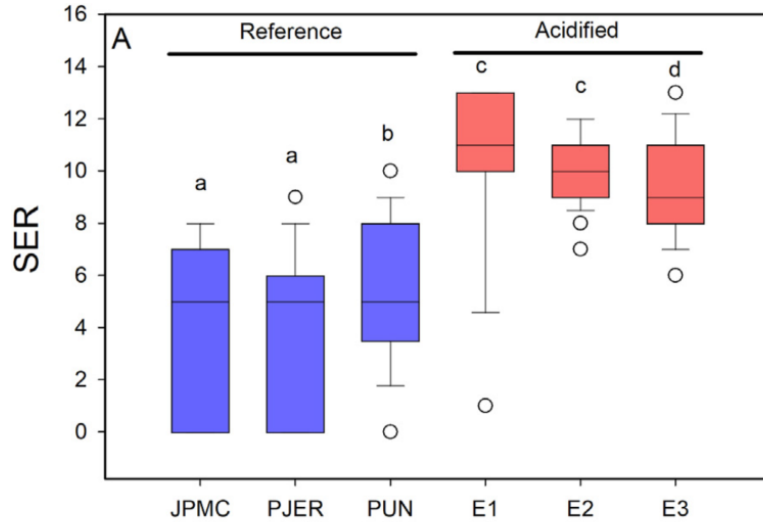
Nerita chamaeleon

Shell Erosion Ranking SER

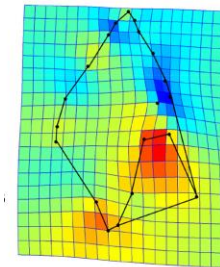
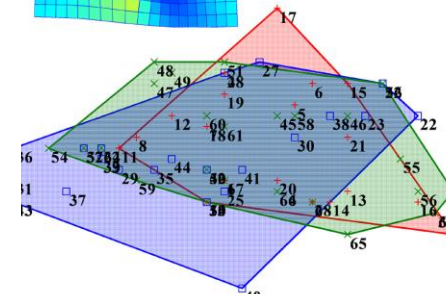
Coastal sediments are rich pyrite (FeS₂)



Differences in pH were reflected in size, shape and erosion



Non-polluted



polluted



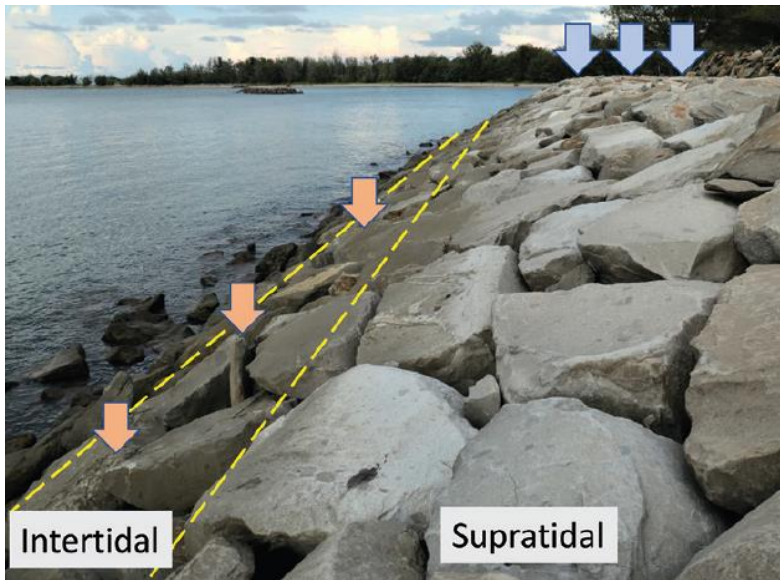
10 mm

Planaxis sulcatus

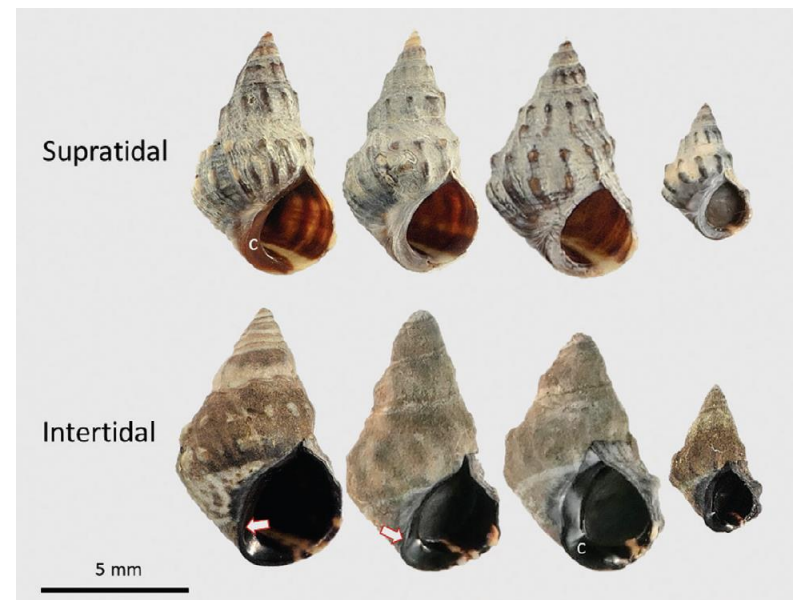
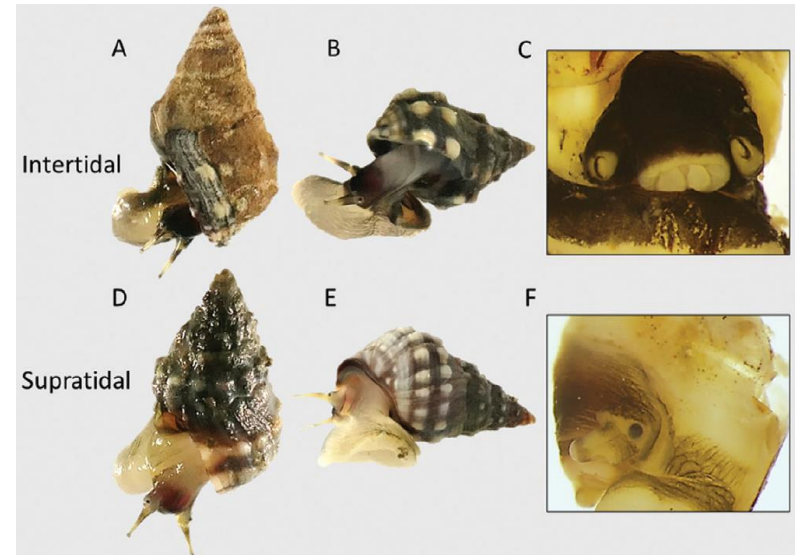
South China Sea
Coast of Brunei

South China Sea Coast of Brunei

Supratidal existence drives phenotypic divergence, but not speciation, in tropical rocky-shore snails



Echinolittorina malaccana

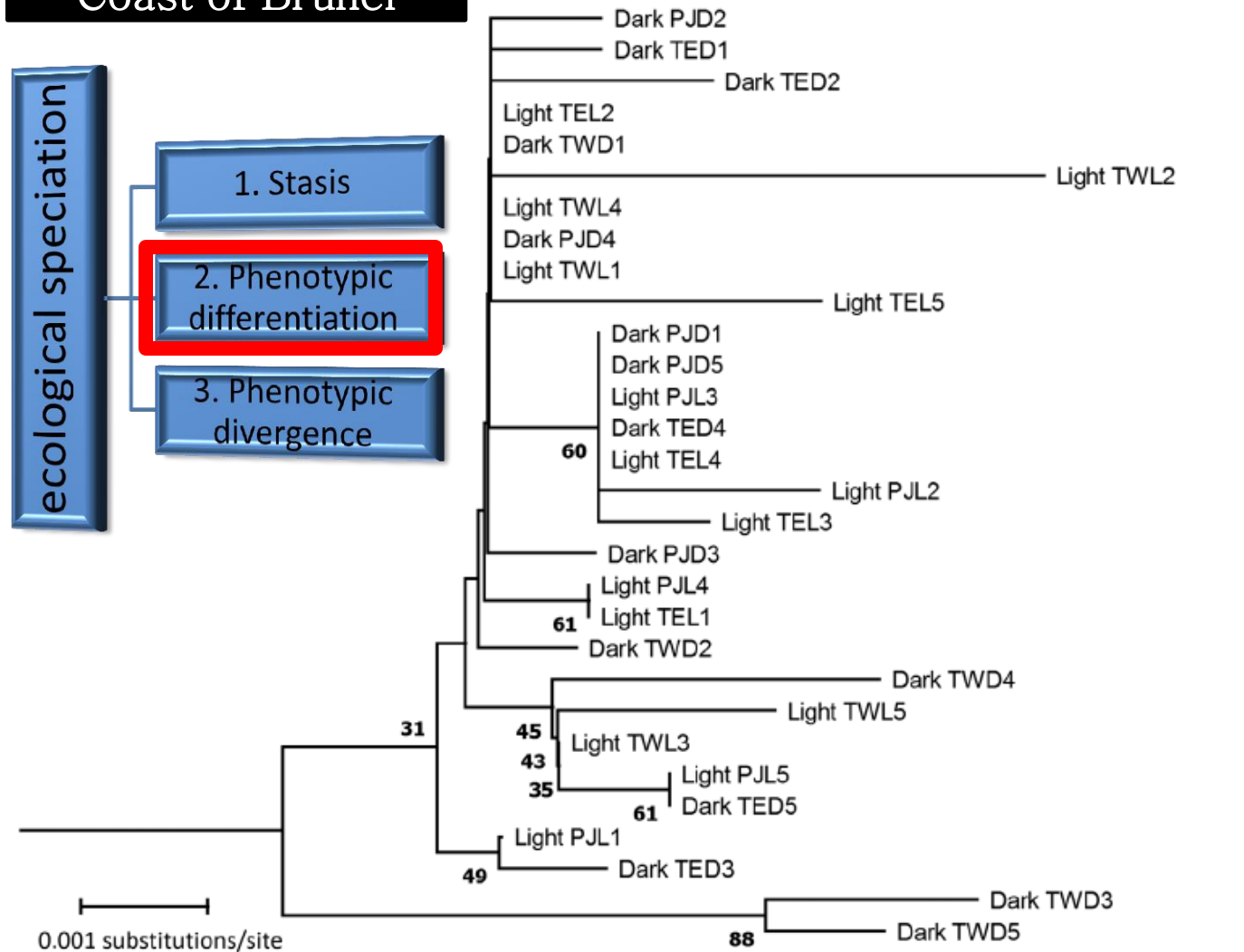
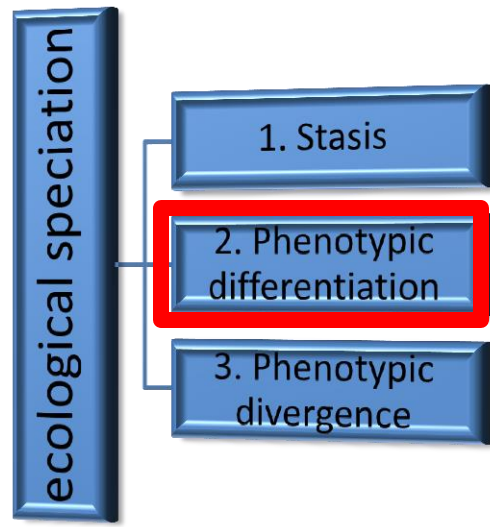
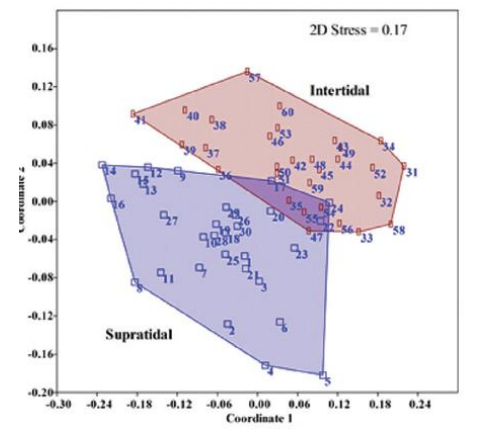
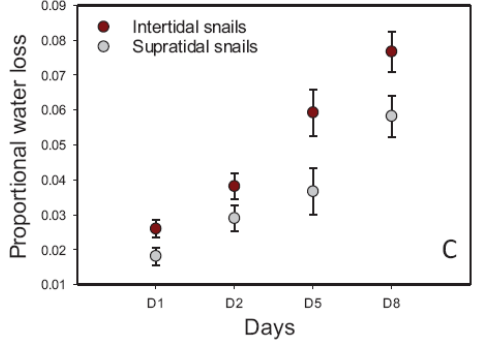
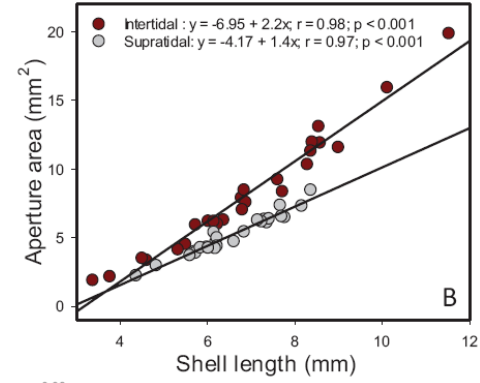


Morphology

South China Sea Coast of Brunei

mtDNA

cytochrome oxidase subunit I (COI)



Conclusion

Morphologies represent biological responses better than genomes

Phenotypic plasticity is a reliable indicator of environmental changes

Disruptive-selection was initiated in *Echinolittorina* and *Planaxis*. While, stabilizing-selection was seen in the freshwater *Melanooides*

The phenotypic divergence stage has not yet accomplished

These changes are induced by both natural and anthropogenic changes!

As humans are the driver of the phenotypic changes, they may shift the evolution and/or the extinction rates





**Thank
You!!!**



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