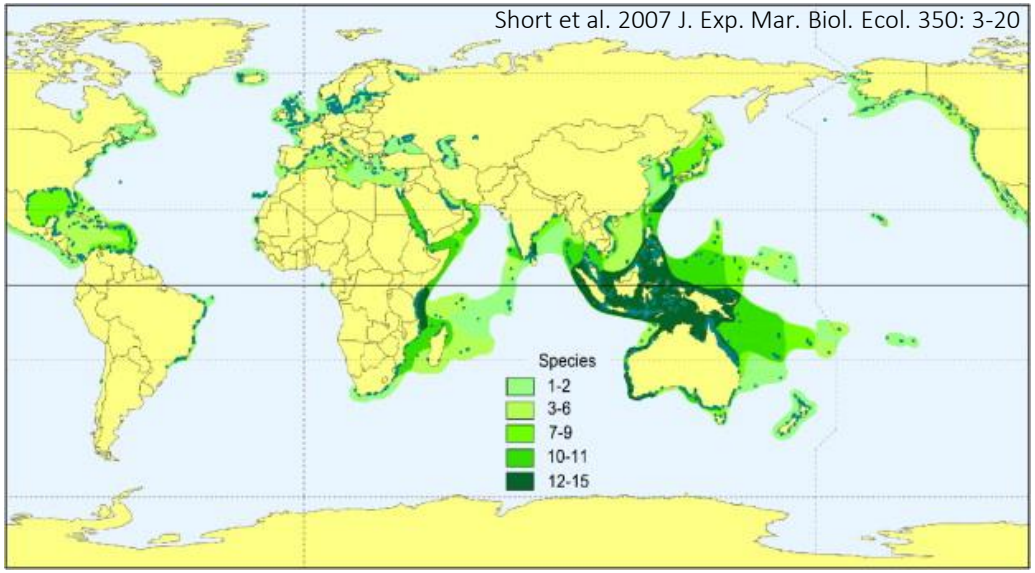
Stable isotope ratios suggest limited trophic importance of seagrasses for invertebrate consumers from Malagasy tropical polyspecific seagrass meadows

Loïc N. MICHEL[1], Haolin WANG[1], Bruno FRÉDÉRICH[2], Thierry LAVITRA[3] & Gilles LEPOINT[1]

[1] Laboratory of Oceanology, University of Liège, Belgium
[2] Laboratory of Functional and Evolutionary Morphology, University of Liège, Belgium
[3] Fisheries and Marine Science Institute, University of Toliara, Madagascar

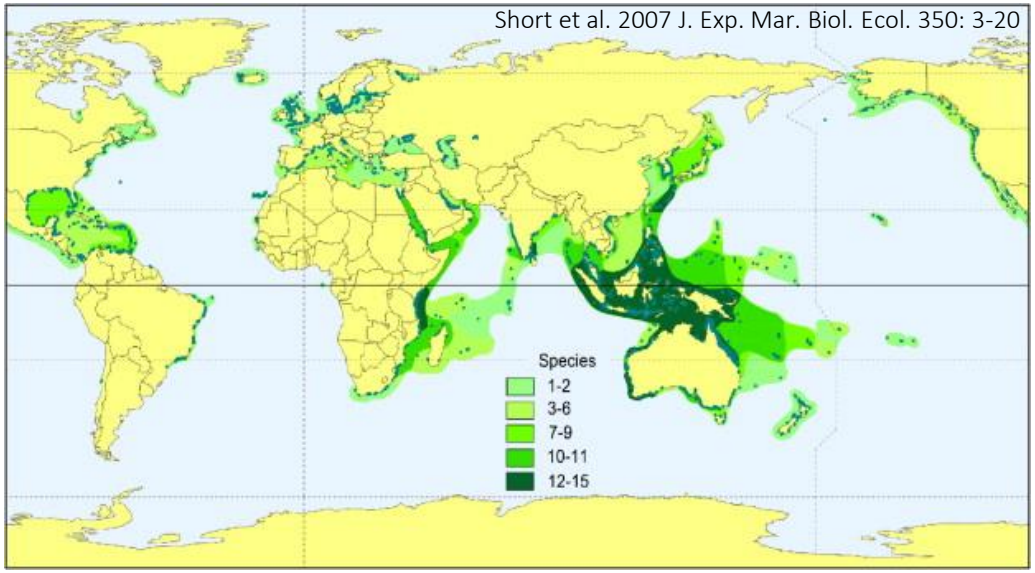
Tropical polyspecific seagrass meadows

- Polyspecific seagrass meadows : ubiquitous features of tropical coastal zones
- Intertidal and subtidal extension



Tropical polyspecific seagrass meadows

- Polyspecific seagrass meadows : ubiquitous features of tropical coastal zones
- Intertidal and subtidal extension

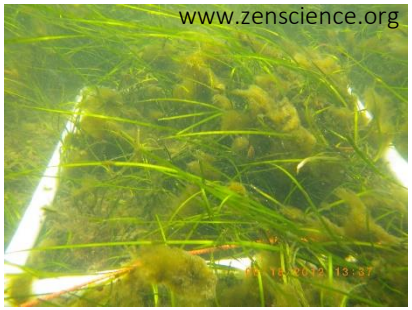


Ecosystem services

- Prevention of shoreline erosion
- Blue carbon sequestration
- Biodiversity hotspots (habitat + trophic resources)
- …

Anthropogenic impacts on tropical meadows

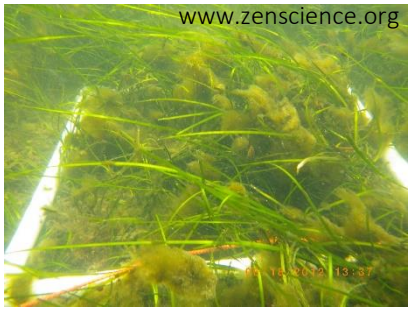
- Functional disruptions
  - Increase of turbidity
  - Eutrophication
  - Overfishing
  - Invertebrate harvesting



Anthropogenic impacts on tropical meadows

- Functional disruptions
  - Increase of turbidity
  - Eutrophication
  - Overfishing
  - Invertebrate harvesting

- Impairment of specific ecosystem functions can be spread along the food web: trophic cascades



Anthropogenic impacts on tropical meadows

- Functional disruptions
  - Increase of turbidity
  - Eutrophication

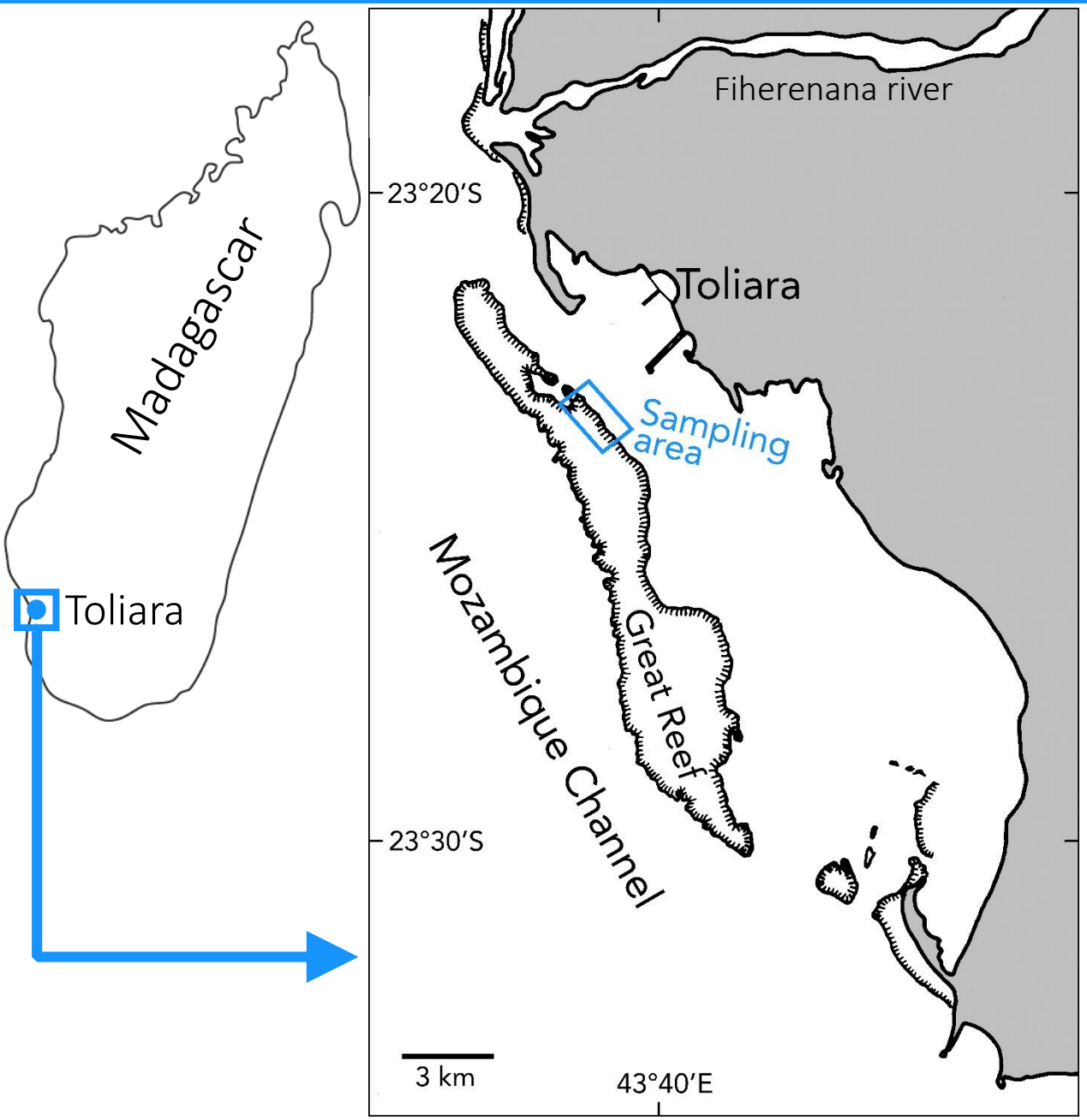
To understand functional responses of meadows to perturbation: knowledge of food web stucture is necessary

↓

Objective: delineate diet of dominant invertebrate consumers in impacted meadows

food web: trophic cascades

Study site : Toliara Great Reef, SW Madagascar



- One of the most extensive barrier reefs of the Western Indian Ocean
- Seagrass meadows cover back-reef and mainland beach
- Since 1970's: important population increase leading to degradation of ecosystems

Sampling

- At low tide (intertidal meadows) or using scuba diving (subtidal meadows)



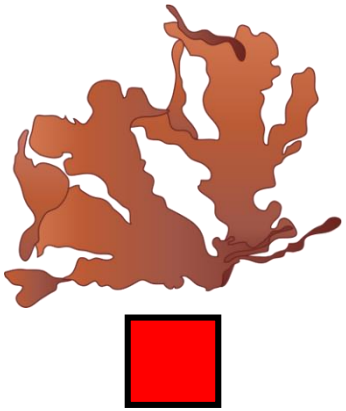
- Dominant invertebrate taxa: hand collection, hand-towed net, light traps
- Potential food items:
  - Seagrasses (7 spp.) + epiphytes
  - Macroalgae (7 spp.)
  - Sediment-associated organic matter (SOM)
  - Suspended particulate organic matter (SPOM)
  - Plankton

Stable isotopes: you are what you eat

Mixing law: an animal's stable isotope composition is a proportional mix of its food items' stable isotope compositions

Stable isotopes: you are what you eat

Mixing law: an animal's stable isotope composition is a proportional mix of its food items' stable isotope composition

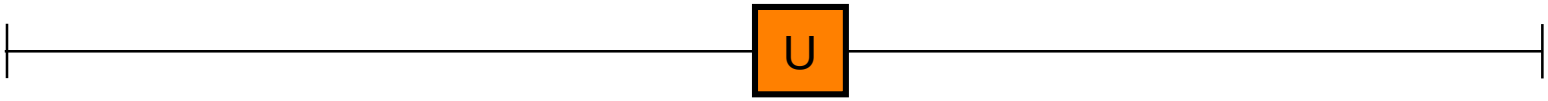


Stable isotopes: you are what you eat

Mixing law: an animal's stable isotope composition is a proportional mix of its food items' stable isotope compositions

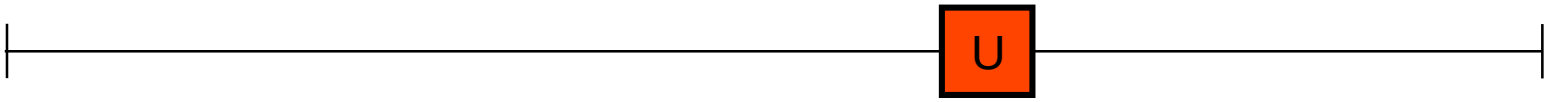
Stable isotopes: you are what you eat

Mixing law: an animal's stable isotope composition is a proportional mix of its food items' stable isotope compositions



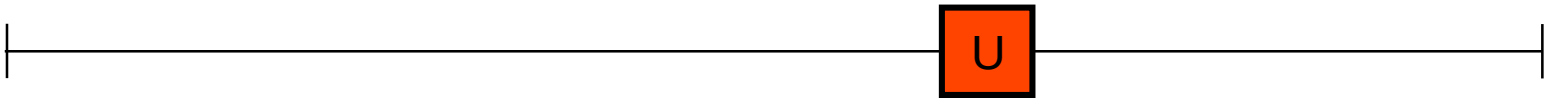
Stable isotopes: you are what you eat

Mixing law: an animal's stable isotope composition is a proportional mix of its food items' stable isotope compositions



Stable isotopes: you are what you eat

Mixing law: an animal's stable isotope composition is a proportional mix of its food items' stable isotope compositions

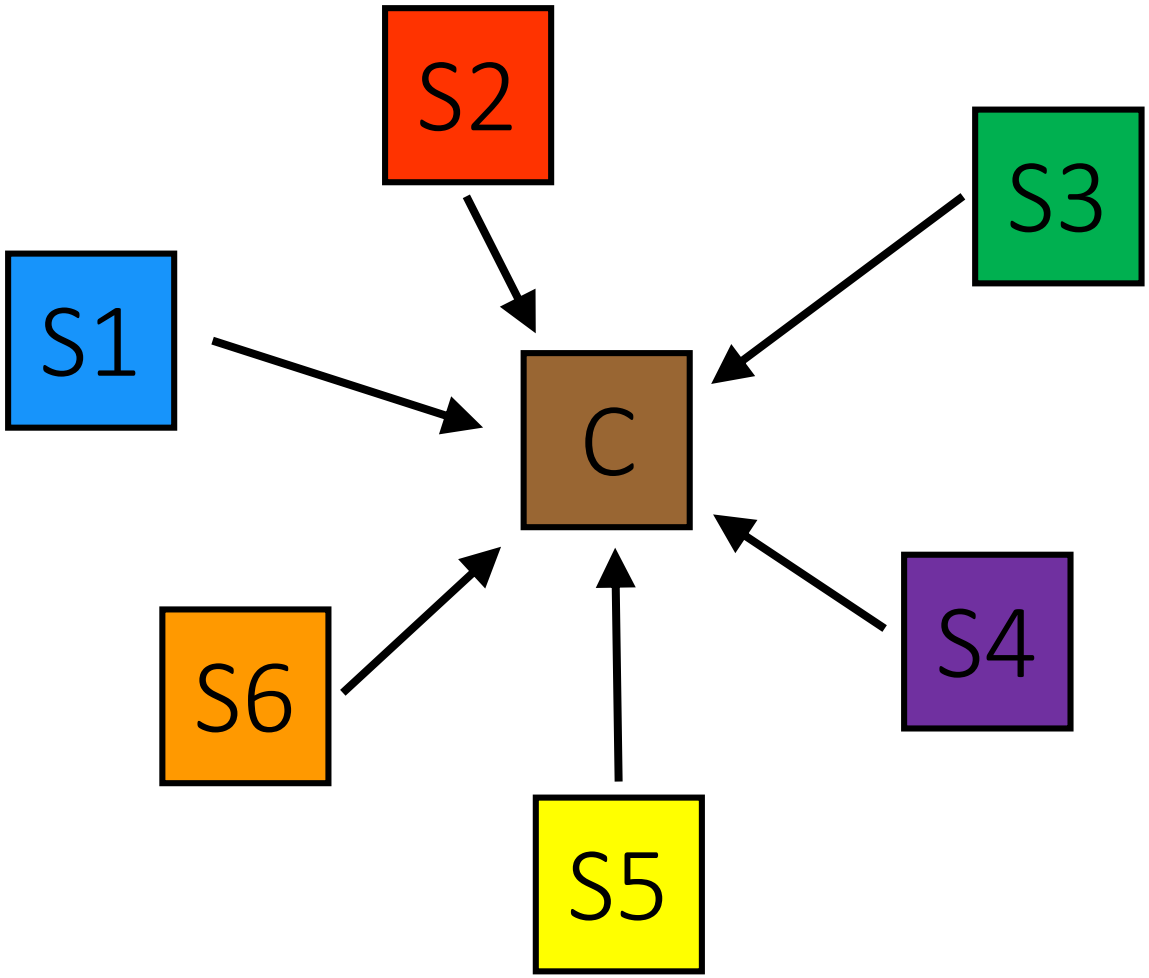


Analysis of stable isotope composition of a consumer and those of its potential food items through mass spectrometry

Estimation of contributions of each item to consumer diet

Stable isotopes: you are what you eat

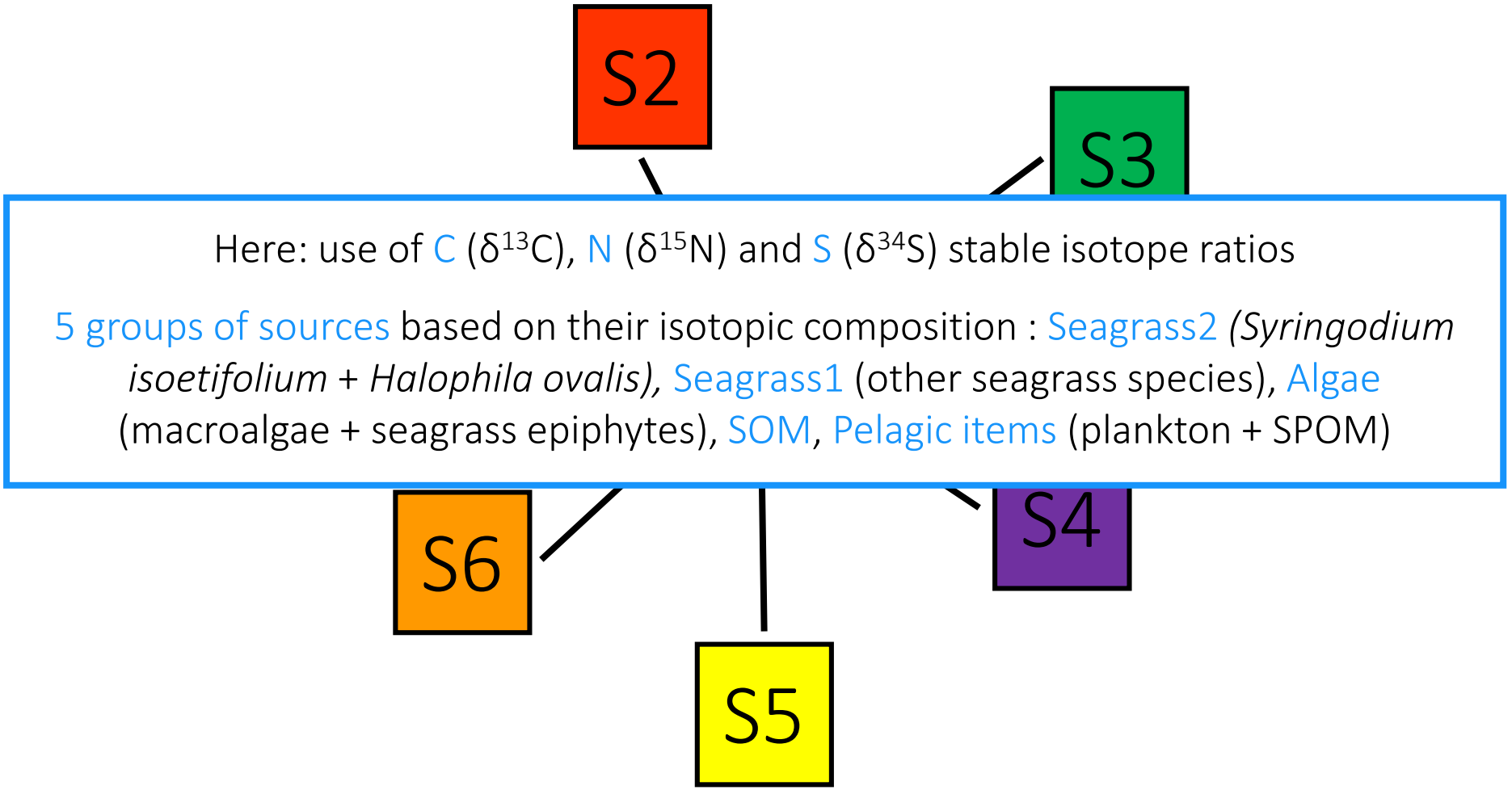
Real-life ecosystems : many potential food items + natural variability of isotopic compositions



Necessity of complex mathematical tools: mixing models (SIAR – Stable Isotope Analysis in R)

Stable isotopes: you are what you eat

Real-life ecosystems : many potential food items + natural variability of isotopic compositions



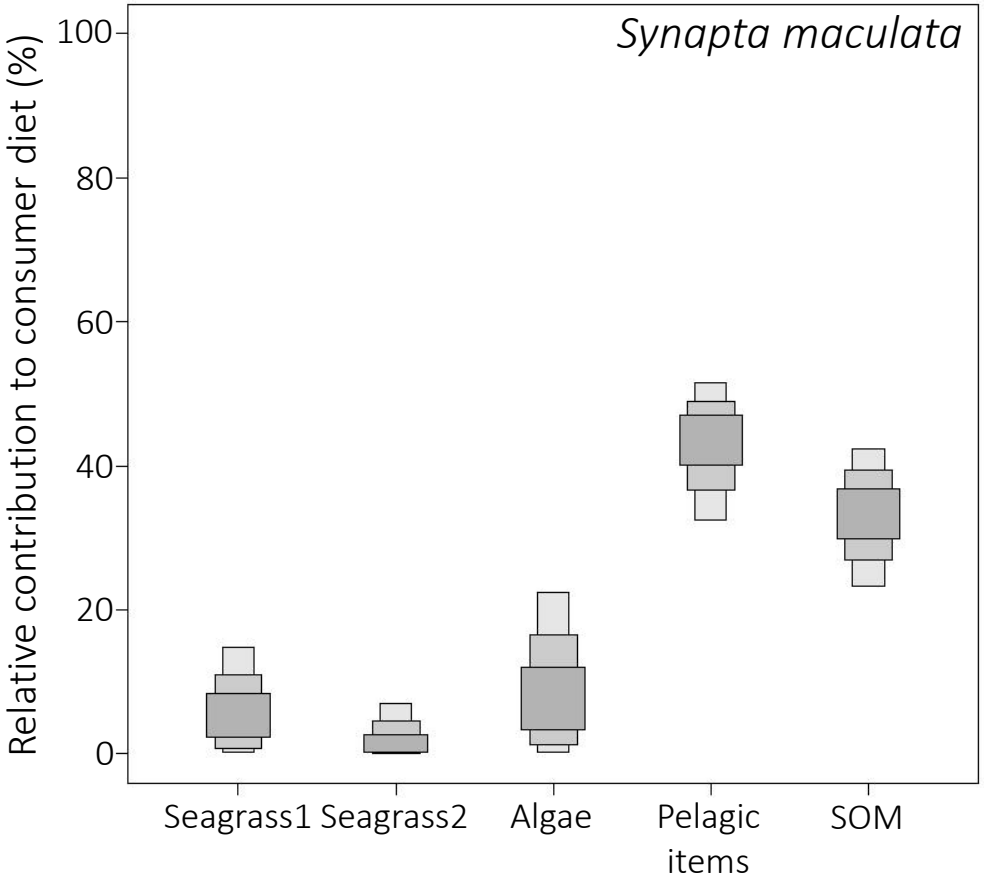
Here: use of C ($\delta^{13}C$), N ($\delta^{15}N$) and S ($\delta^{34}S$) stable isotope ratios

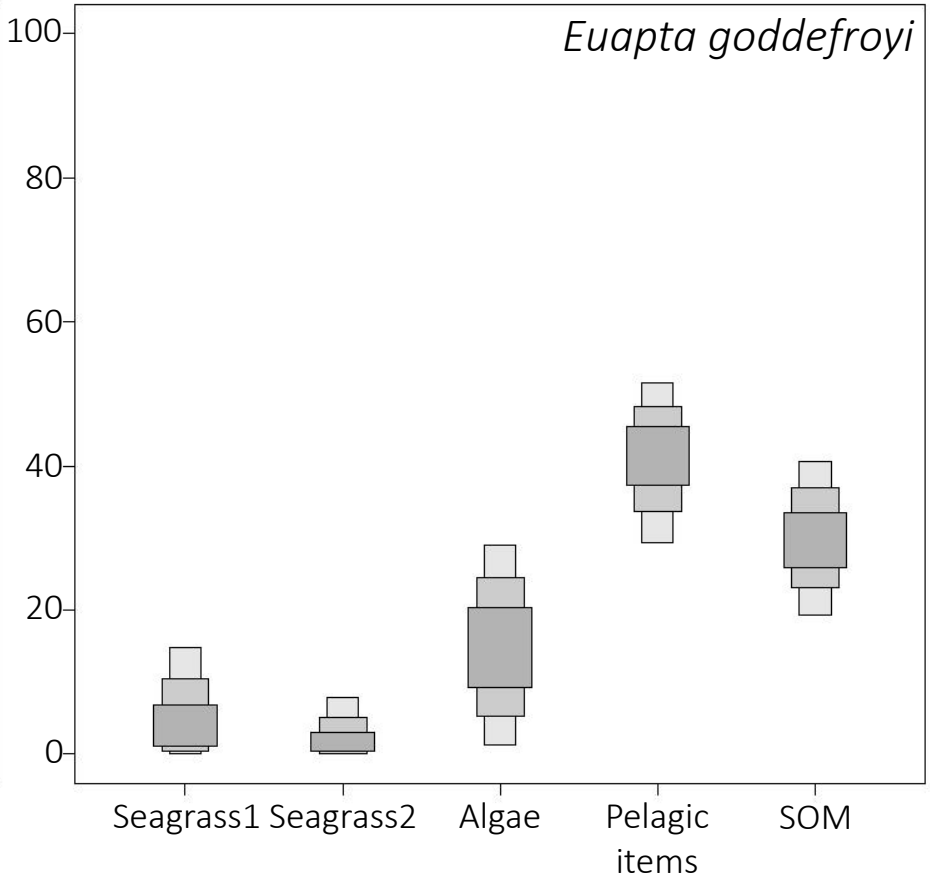
5 groups of sources based on their isotopic composition : Seagrass2 *(Syringodium isoetifolium + Halophila ovalis),* Seagrass1 (other seagrass species), Algae (macroalgae + seagrass epiphytes), SOM, Pelagic items (plankton + SPOM)

Necessity of complex mathematical tools: mixing models (SIAR – Stable Isotope Analysis in R)

Results: Holothuroidea

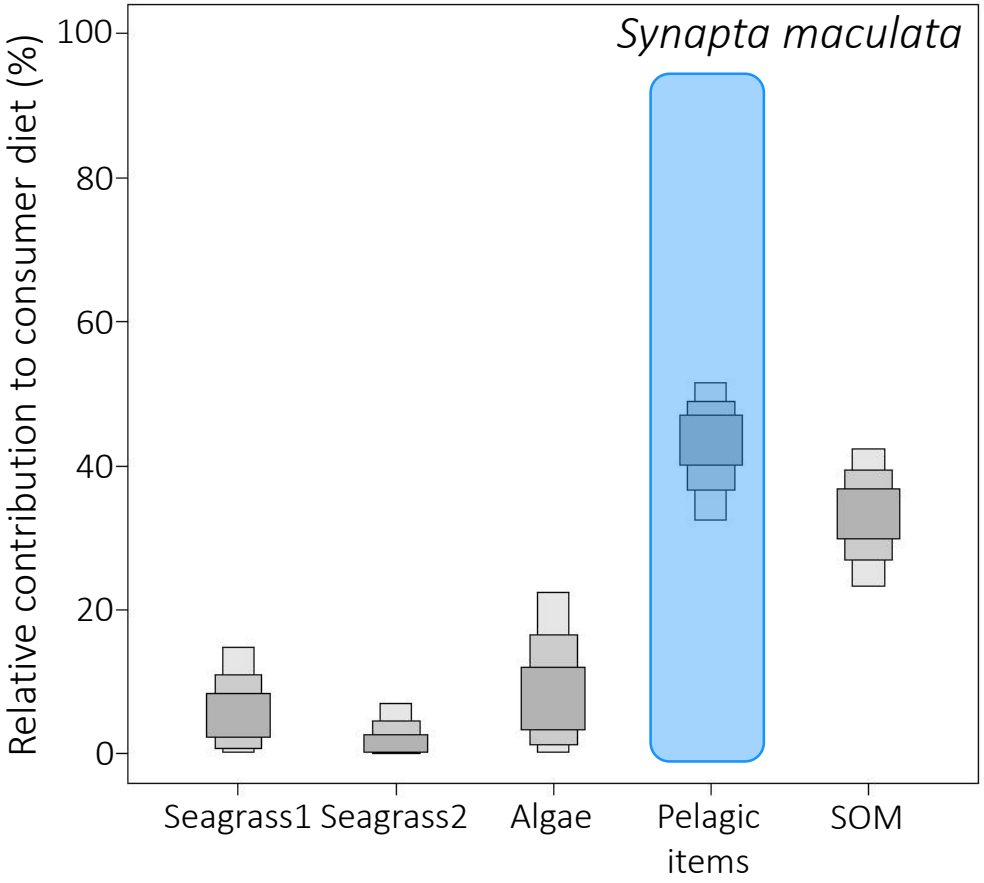
Images: Wikipedia commons

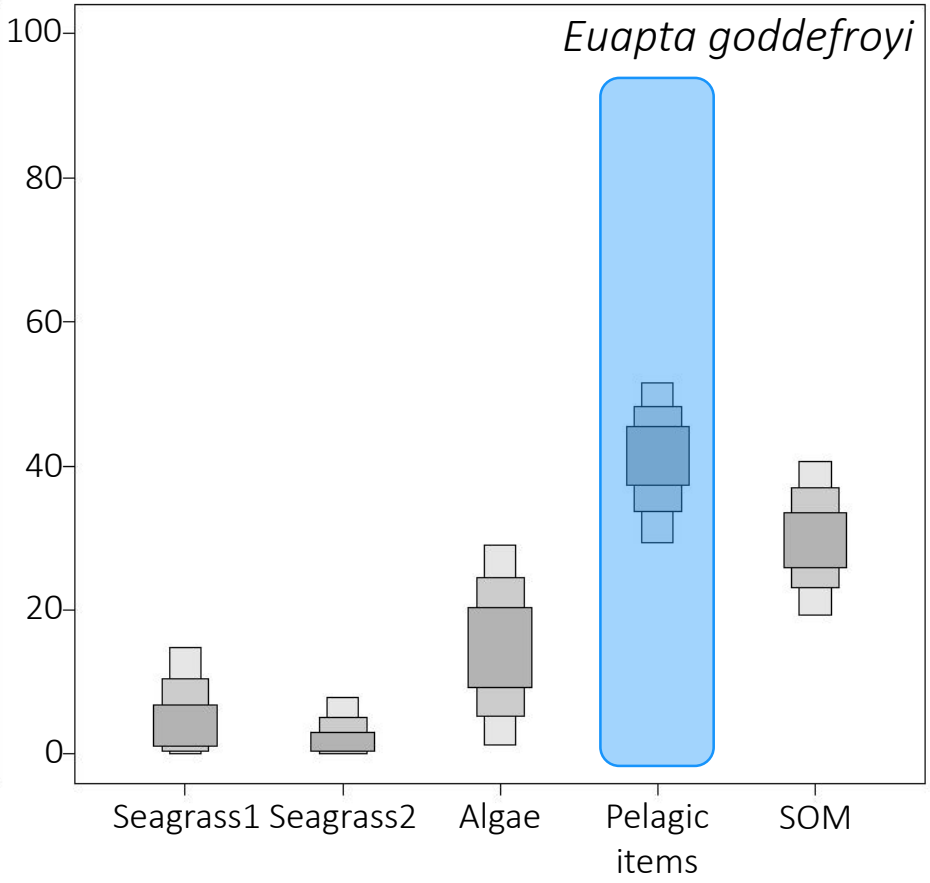




Results: Holothuroidea

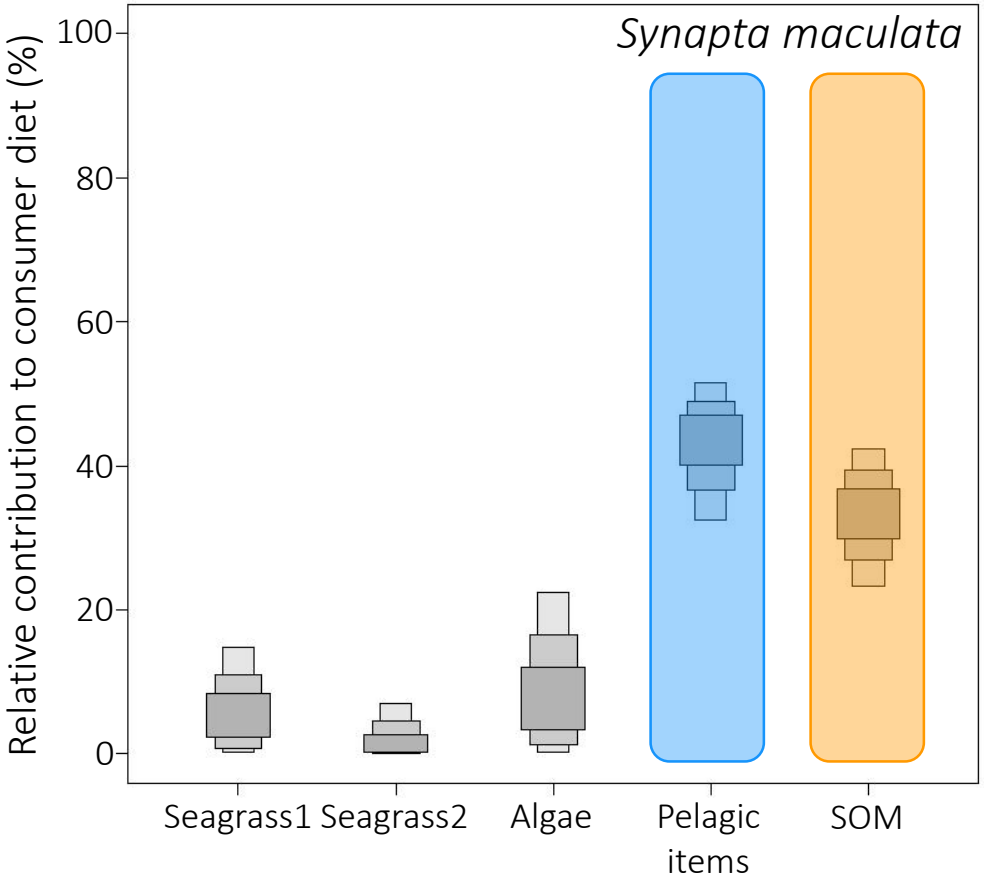
Images: Wikipedia commons

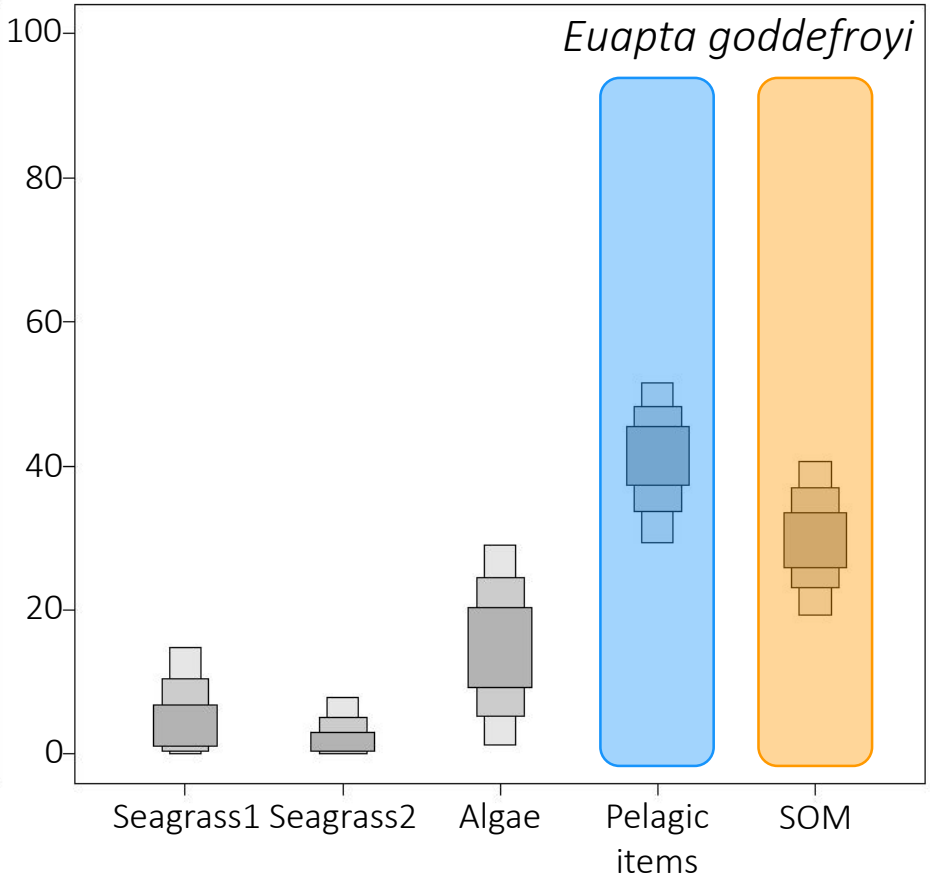




Results: Holothuroidea

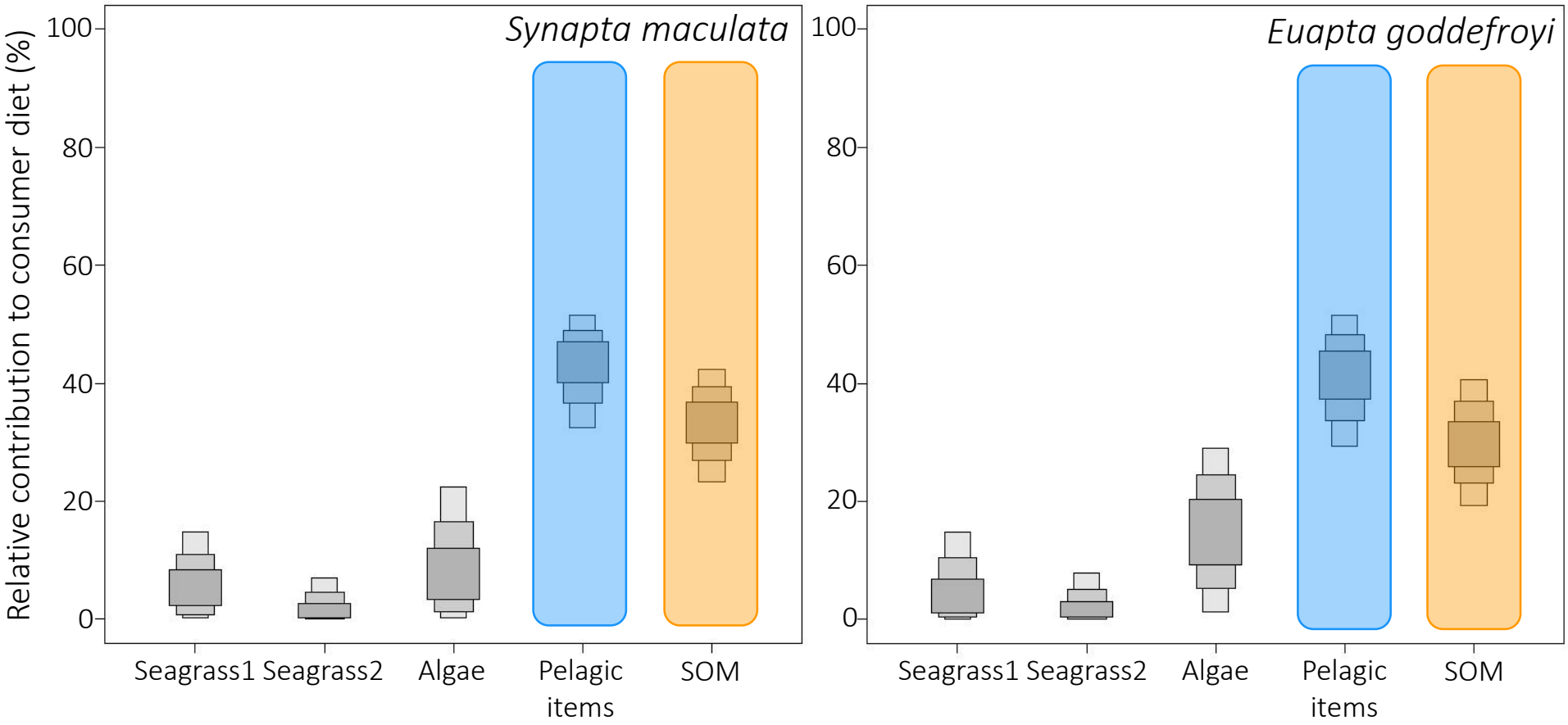
Images: Wikipedia commons





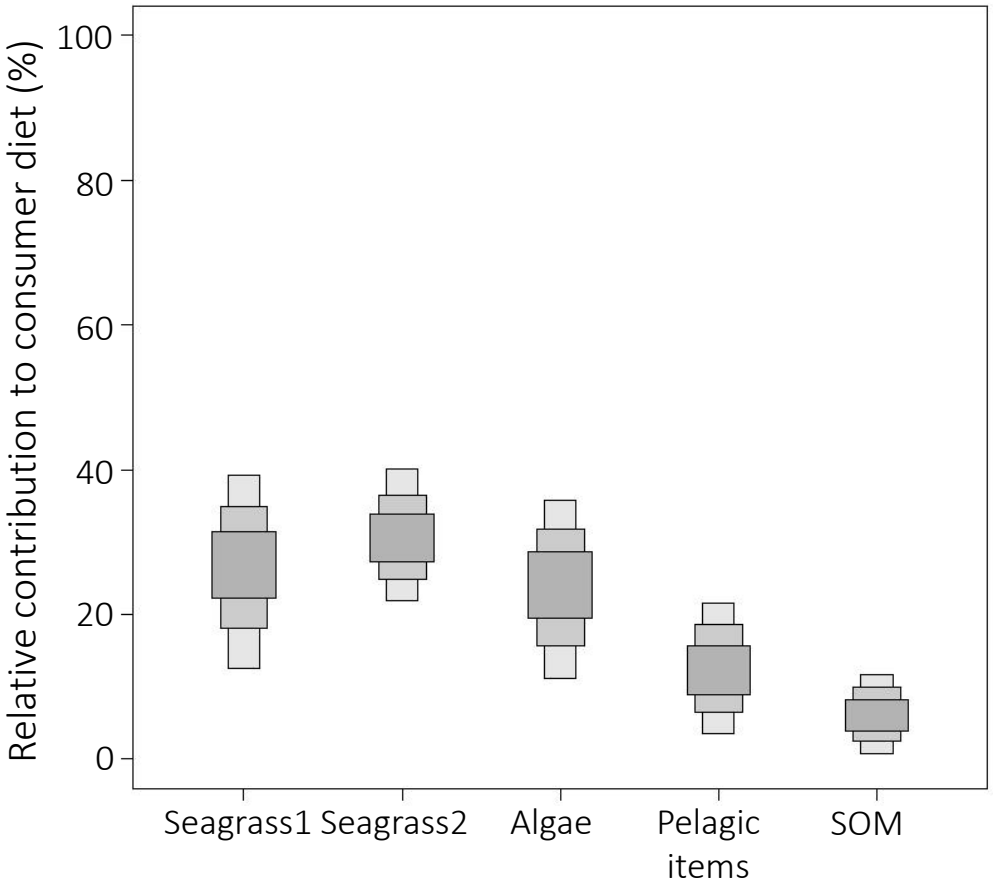
Results: Holothuroidea

Images: Wikipedia commons



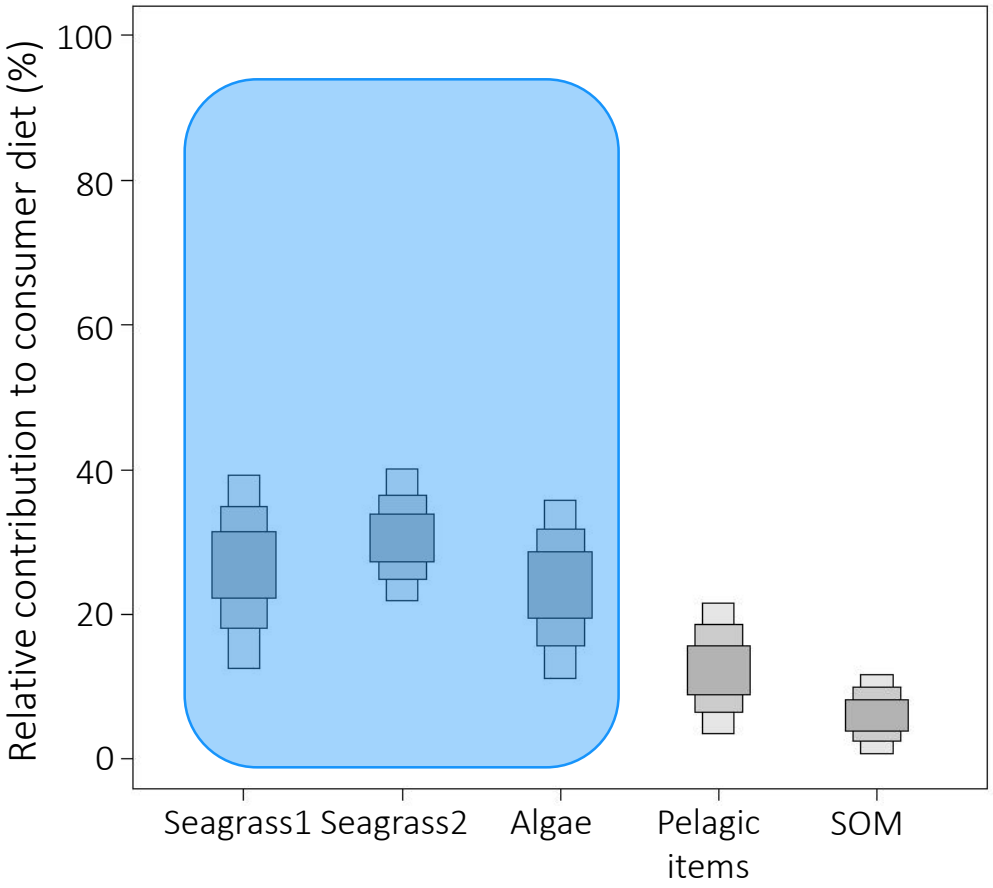
- Both species are suspension/deposit-feeders
- Important diet similarity

Results: Echinoidea



Tripneustes gratilla

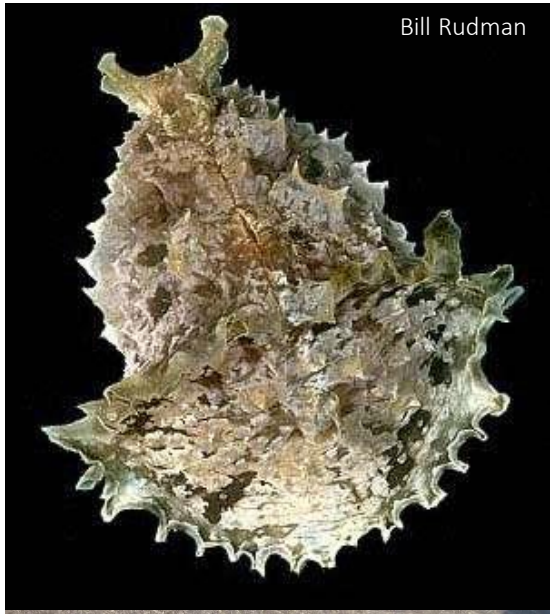
Results: Echinoidea



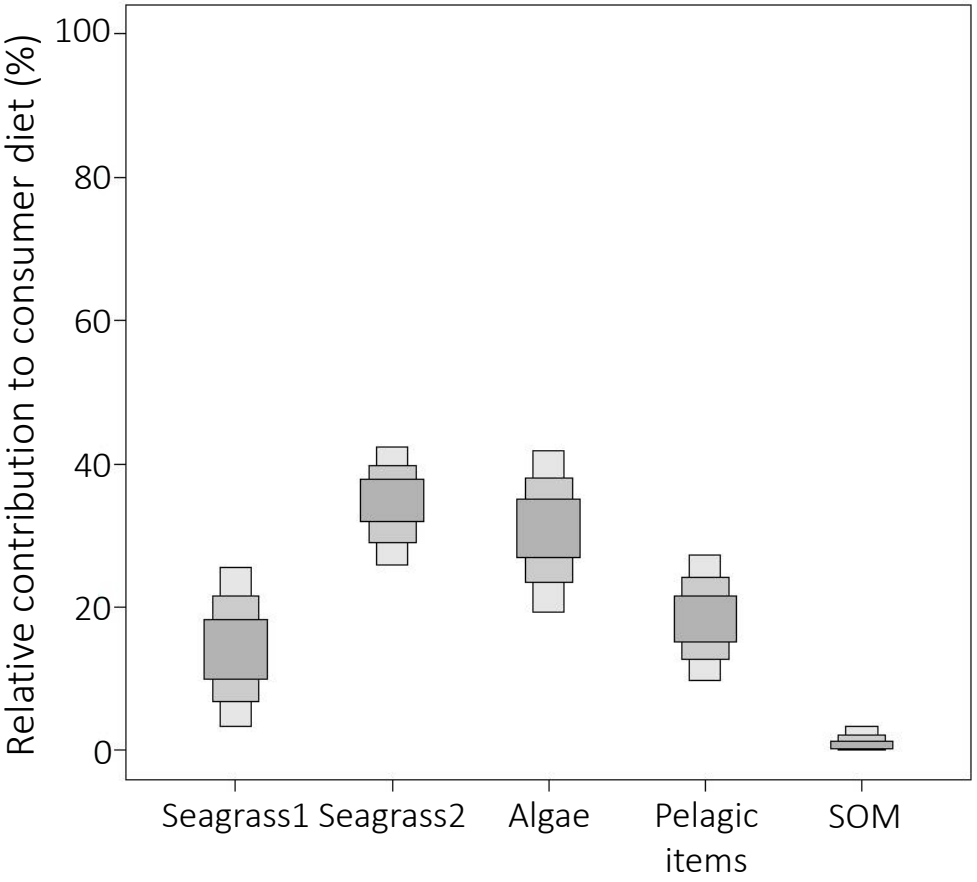
Tripneustes gratilla

- Generalist grazer feeding on seagrass and macroalgae in similar proportions

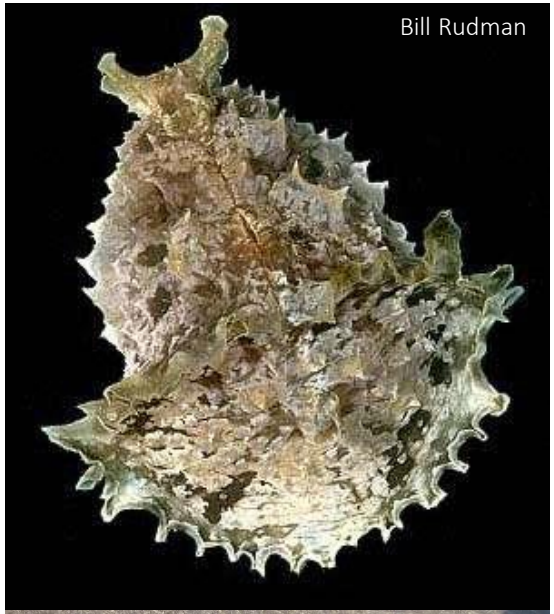
Results: Gastropoda



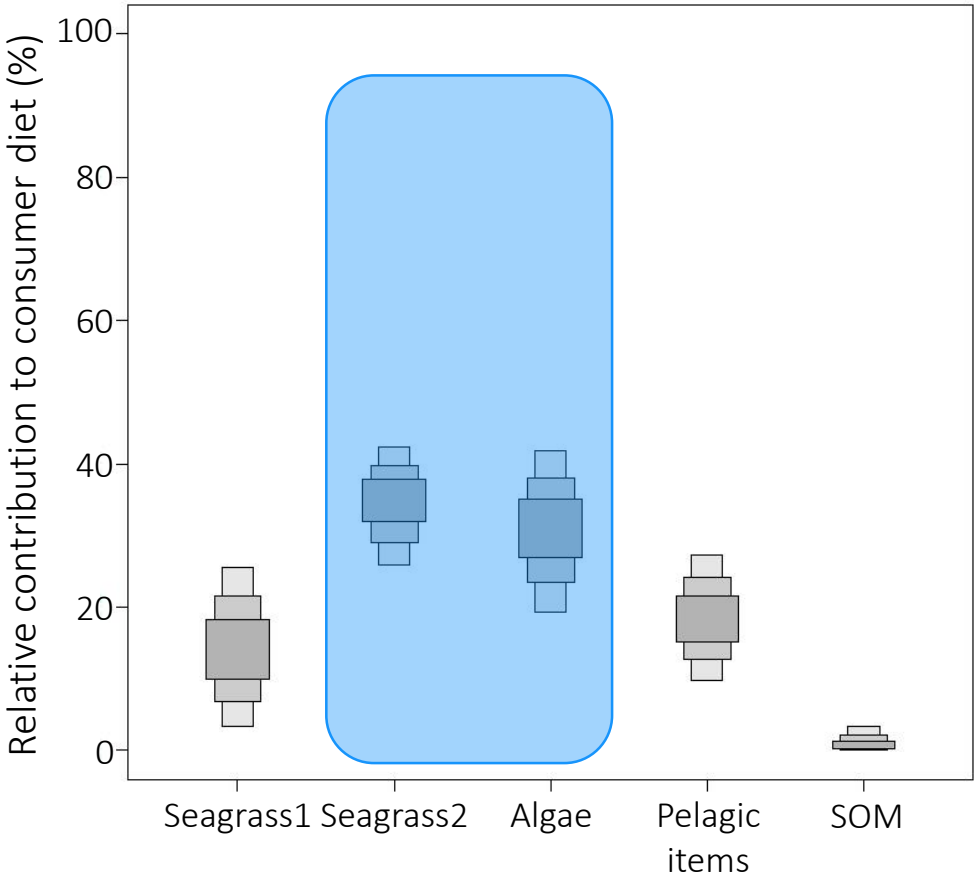
Dolabella auricularia



Results: Gastropoda



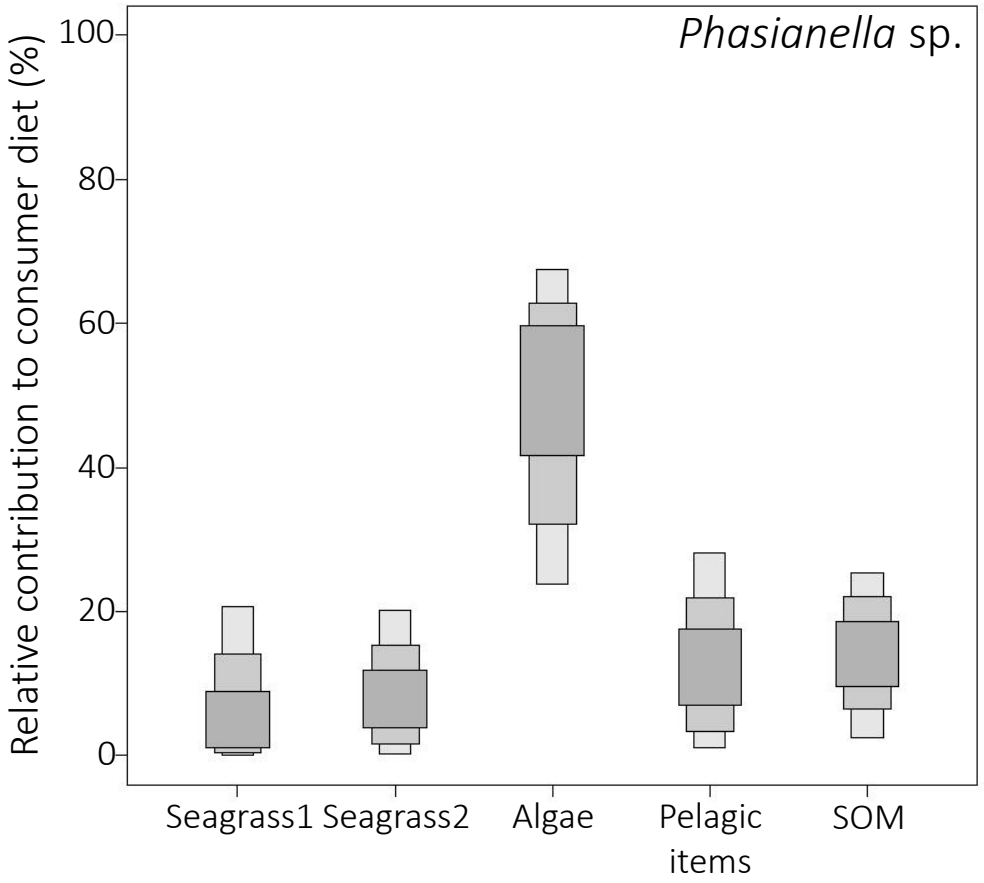
Dolabella auricularia

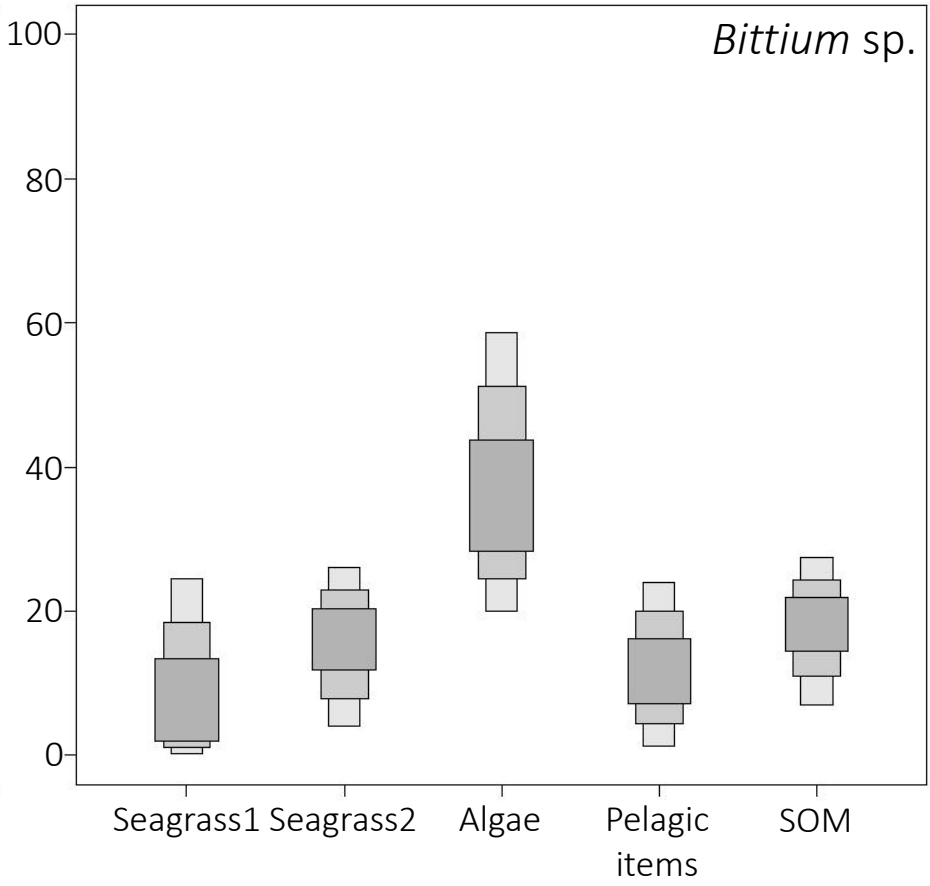


- Grazer feeding on macroalgae and seagrasses
- Preferential consumption of *Syringodium isoetifolium* and/or *Halophila ovalis*: better palatability of leaves?

Results: Gastropoda

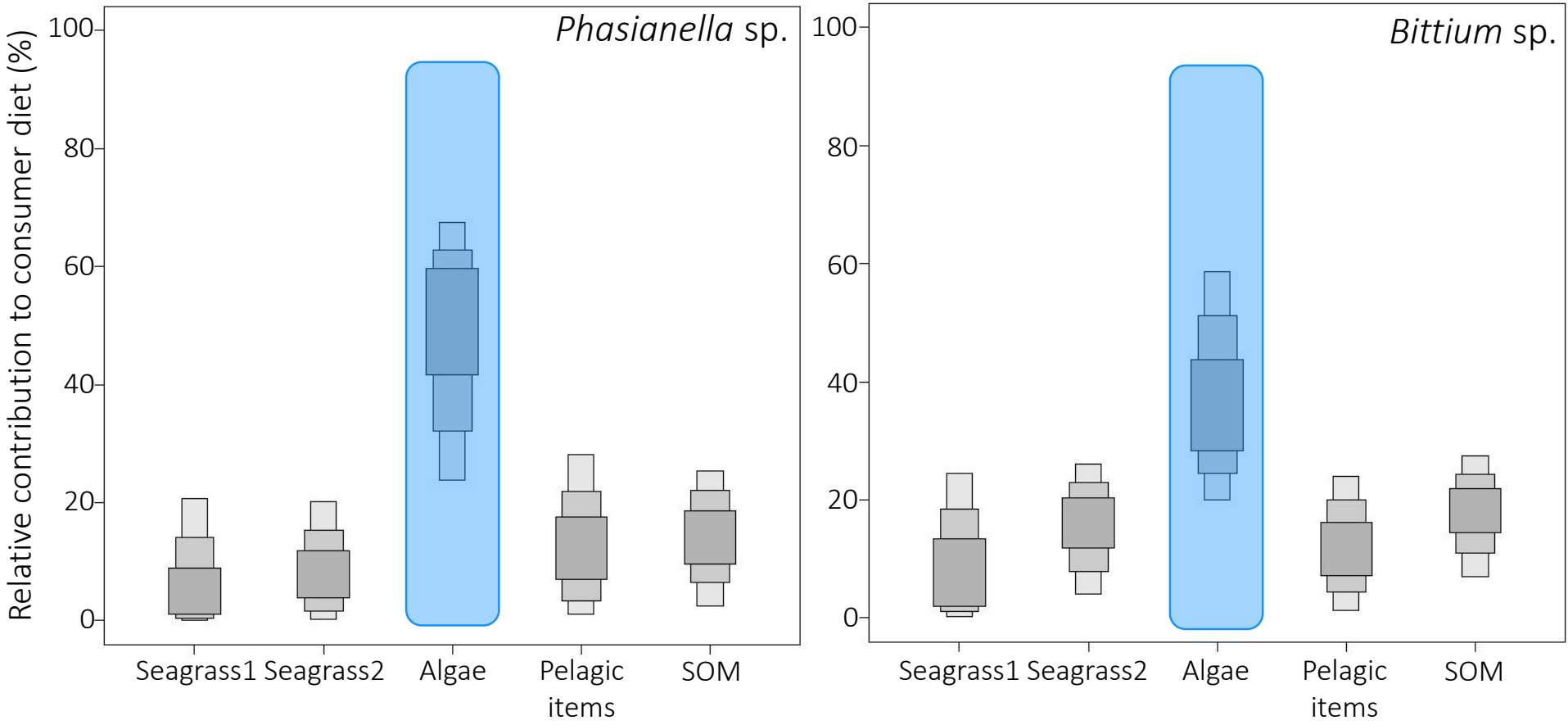
Images: www.gastropods.com





Results: Gastropoda

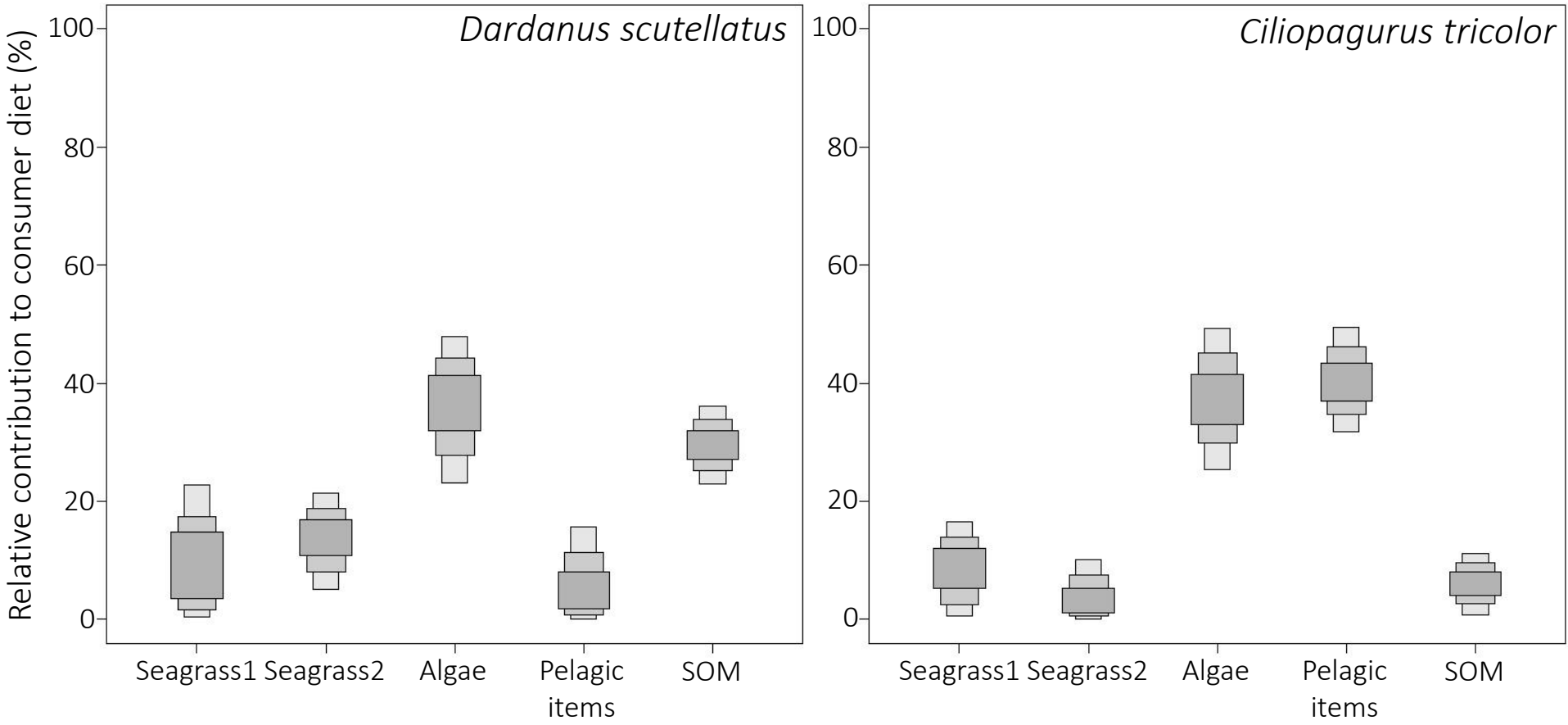
Images: www.gastropods.com



- Both species mostly rely on macroalgae and/or seagrass epiphytes
- Similar feeding habits

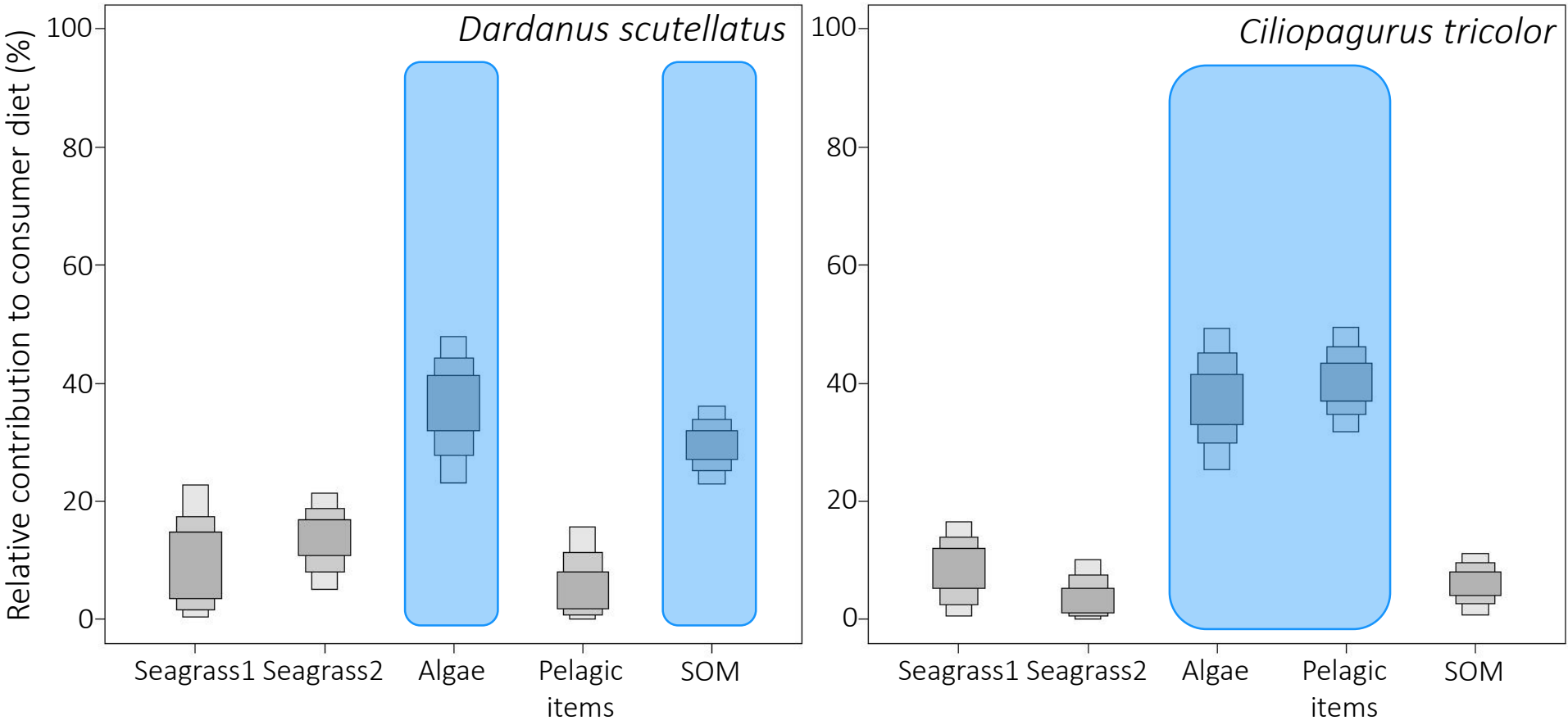
Results: Paguroidea

Images: decapoda.free.fr



Results: Paguroidea

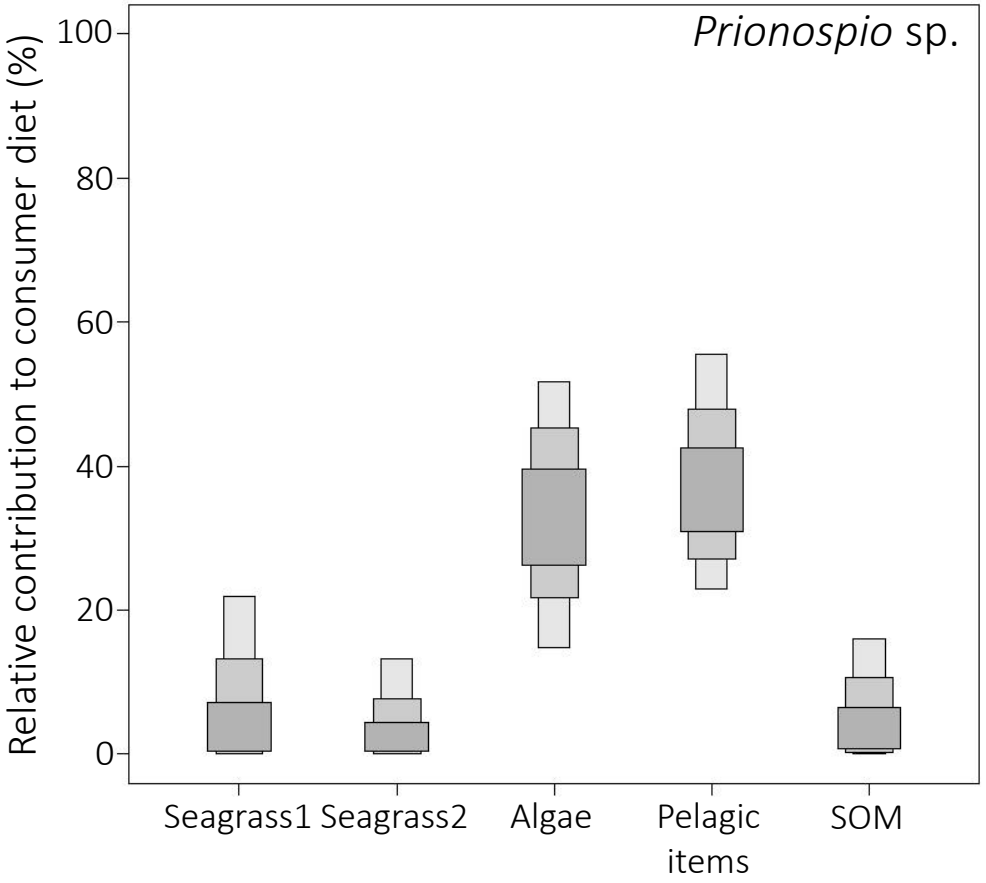
Images: decapoda.free.fr

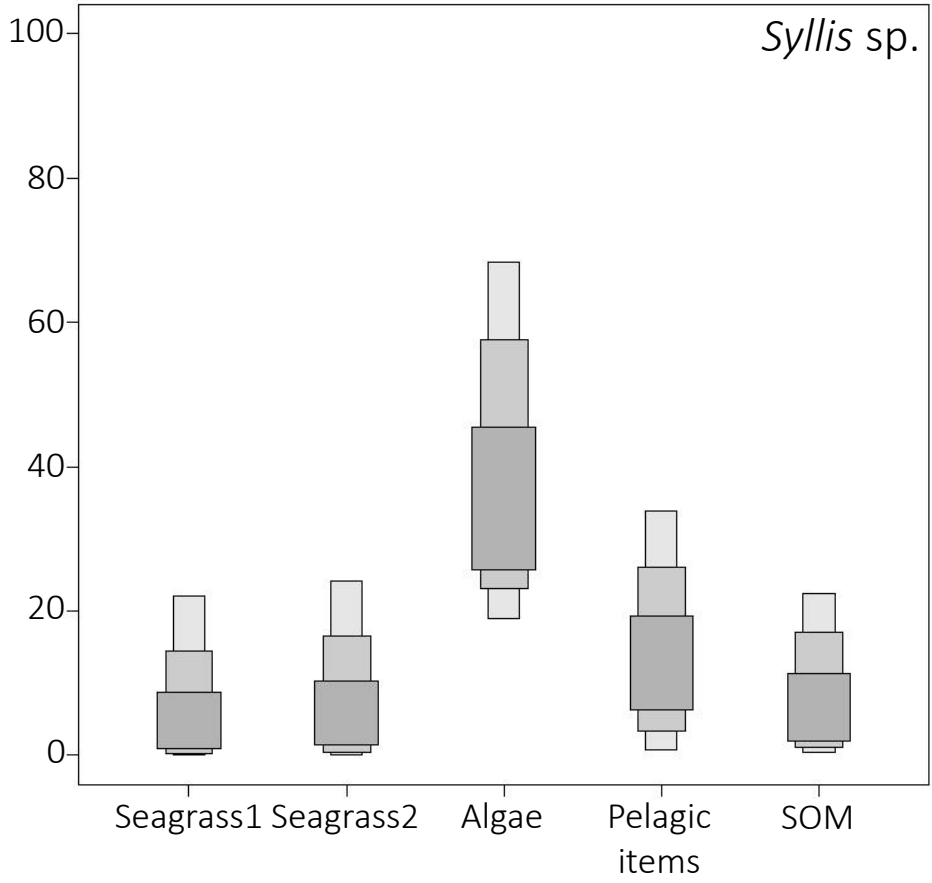


- Important differences in resource use between the two species: both heavily rely on macroalgae, but *C. tricolor* consumes pelagic food items while *D. scutellatus* forages on sediment-associated organic matter

Results: Polychaeta

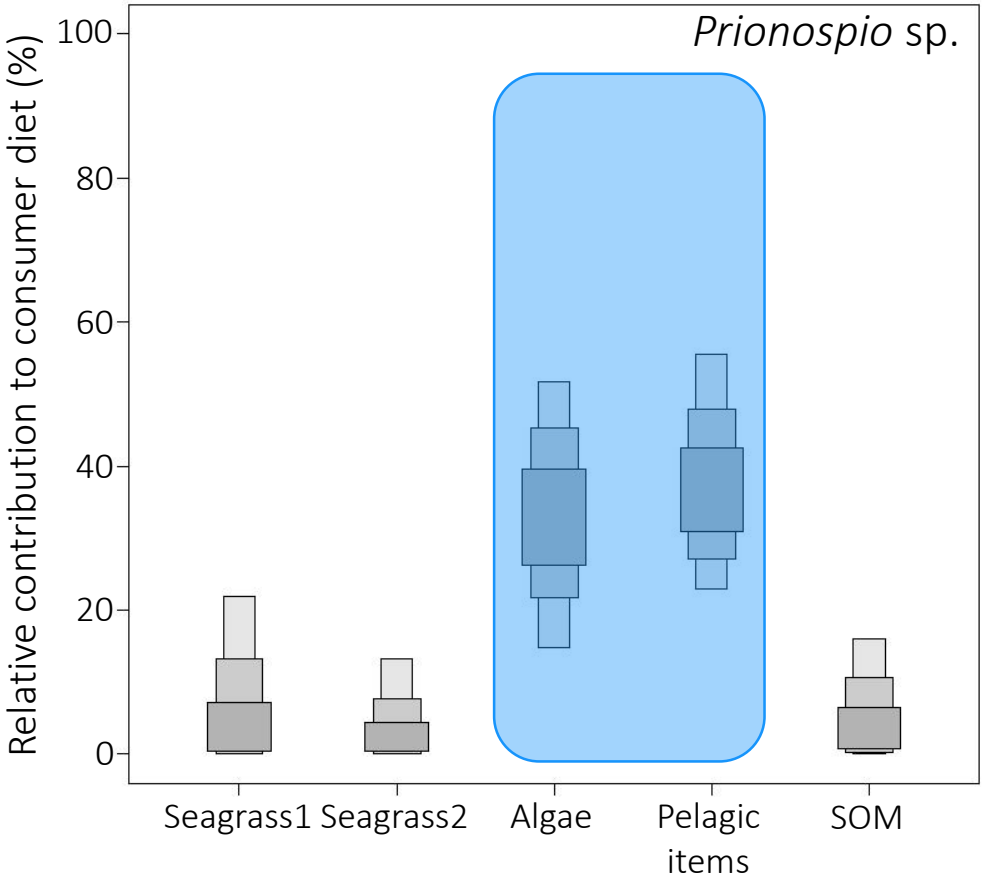
Images: www.marinespecies.org

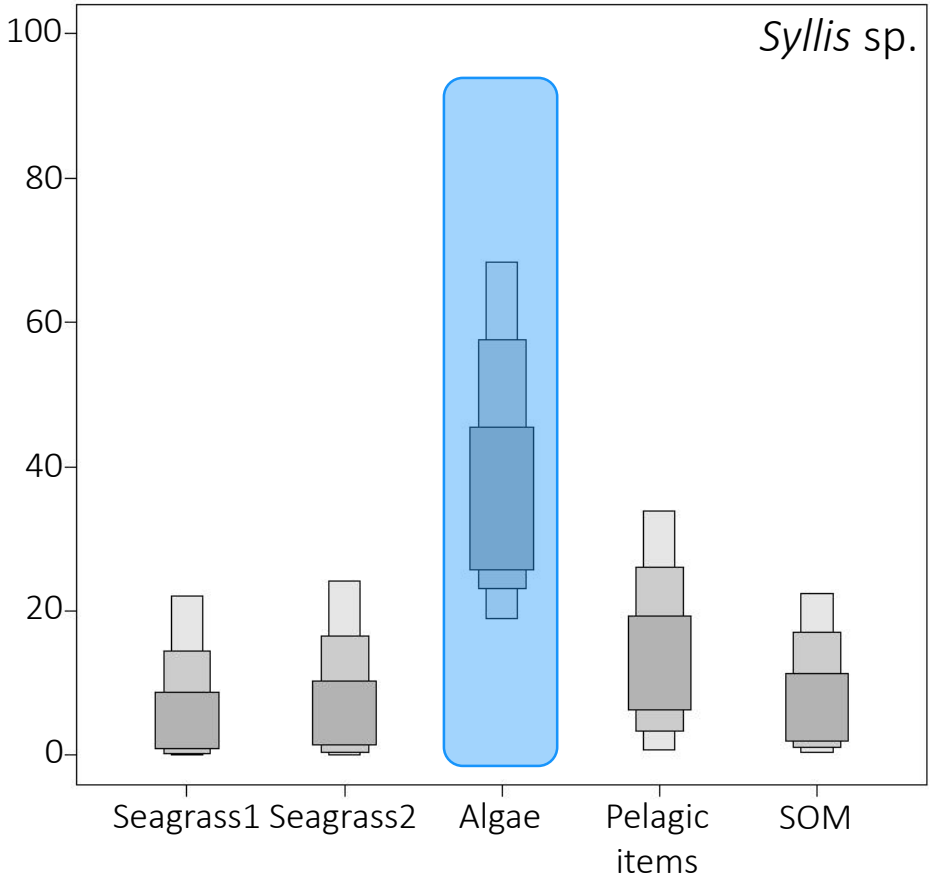




Results: Polychaeta

Images: www.marinespecies.org





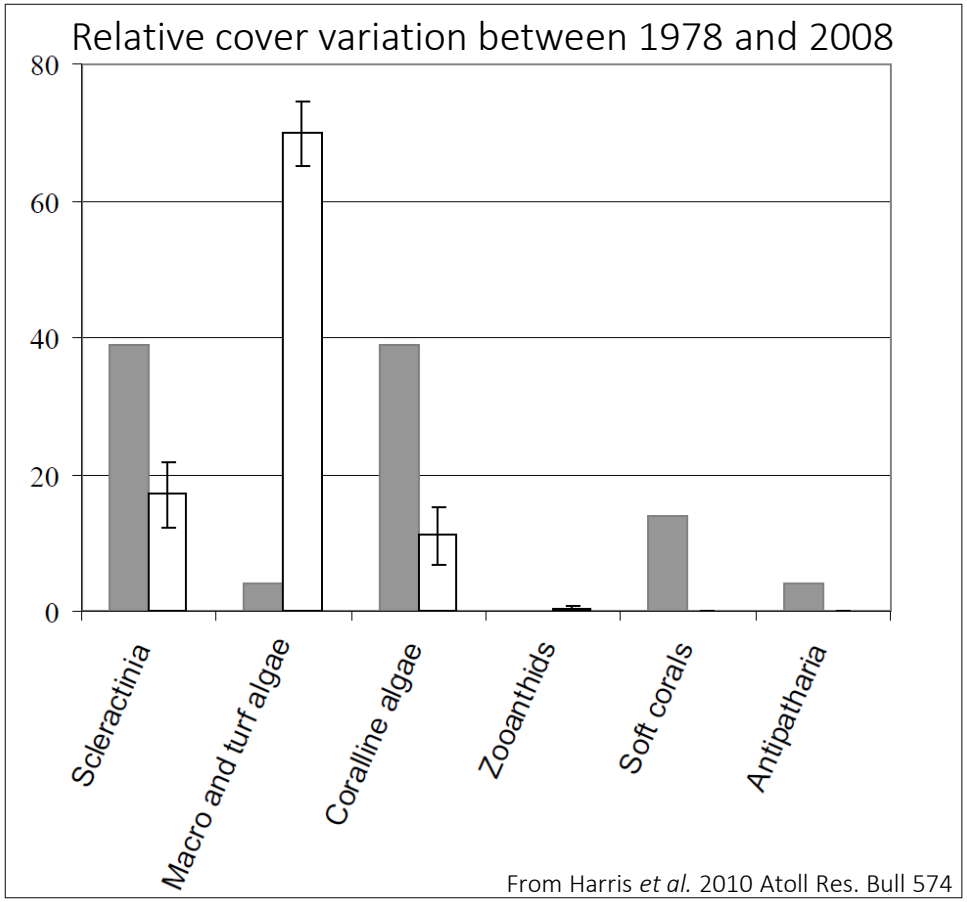
- *Syllis* sp.: grazer relying mostly on macroalgae and/or seagrass epiphytes
- *Prionospio* sp.: grazer / suspension feeder

Main findings

- Only two of of the dominant invertebrate taxa feed predominantly on seagrass tissues: Trophic use of seagrasses in beds of the Toliara great Reef seems lower than in other comparable locations (*e.g.* Vonk *et al.*, 2008)
- Most studied taxa heavily rely on macroalgae and/or seagrass epiphytes: linked with high resource availability?

Main findings

- Only two of of the dominant invertebrate taxa feed predominantly on seagrass tissues: Trophic use of seagrasses in beds of the Toliara great Reef seems lower than in other comparable locations (*e.g.* Vonk *et al.*, 2008)
- Most studied taxa heavily rely on macroalgae and/or seagrass epiphytes: linked with high resource availability?



Great Reef of Toliara underwent phase shift over the past 40 years

Important epiphytic cover (influence of increased nutrient load?)

Main findings

- Trophic diversity among species bearing taxonomical and/or morphological resemblance widely varied from one group to another




≈ ≈ ≠ ≠




➔ Caution when regrouping invertebrates in higher taxa, functional guilds, etc.


Thanks for
your attention!