Is sympatric speciation more important in the ocean?

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UROP Online Symposium

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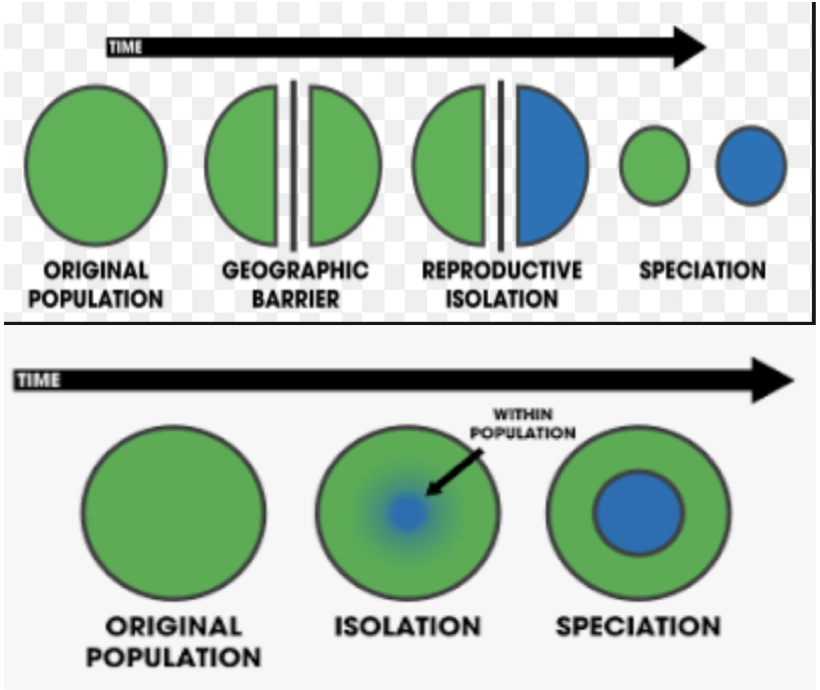
Introduction & Background

- Terrestrial environment: existence of hard barriers, geographical isolation, rich resources, high complexity, etc.
- Marine environment: lack of absolute barriers, dispersal ability of larvae of invertebrates, importance of ocean current, etc.
- ***It’s reasonable to expect more sympatry in the ocean.***

Allopatric vs. Sympatric Speciation

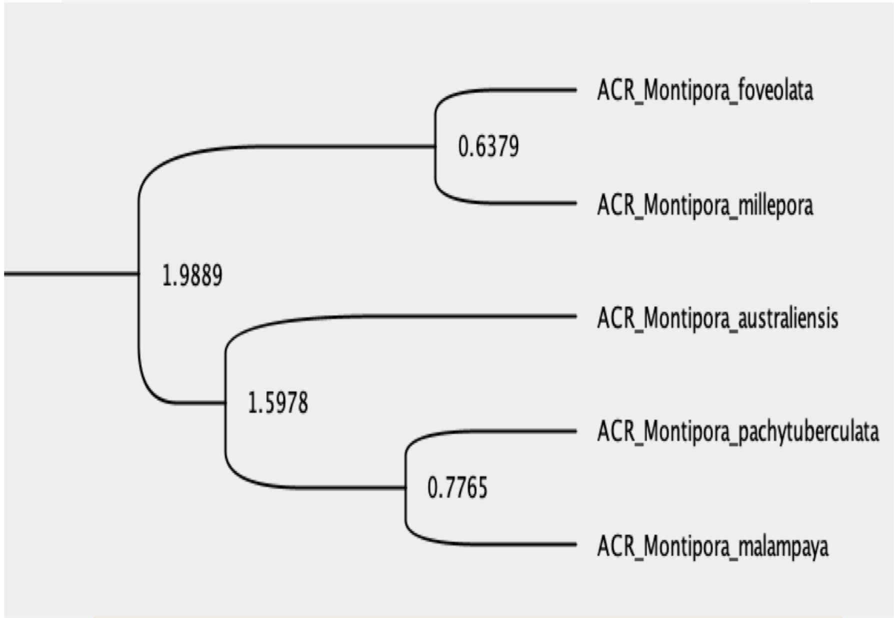
- ***Allopatric Speciation***: speciation that happens when two populations of the same species become isolated from each other due to geographic changes.
- ***Sympatric speciation***: speciation that occurs when two groups of the same species live in the same geographic location. (high range overlap)



Top: allopatric speciation vs. Bottom: sympatric speciation

Phylogenetic data

- Morphological data (e.g. character matrix)
- Genetic information (e.g. DNA sequences)
- **The Principle of Parsimony**: the simplest explanation that can explain the data is to be preferred (i.e. a hypothesis (tree) of relationships that requires the smallest number of character changes is most likely to be correct.)
- Other concepts: ***node age***, ***species pairs***, etc.

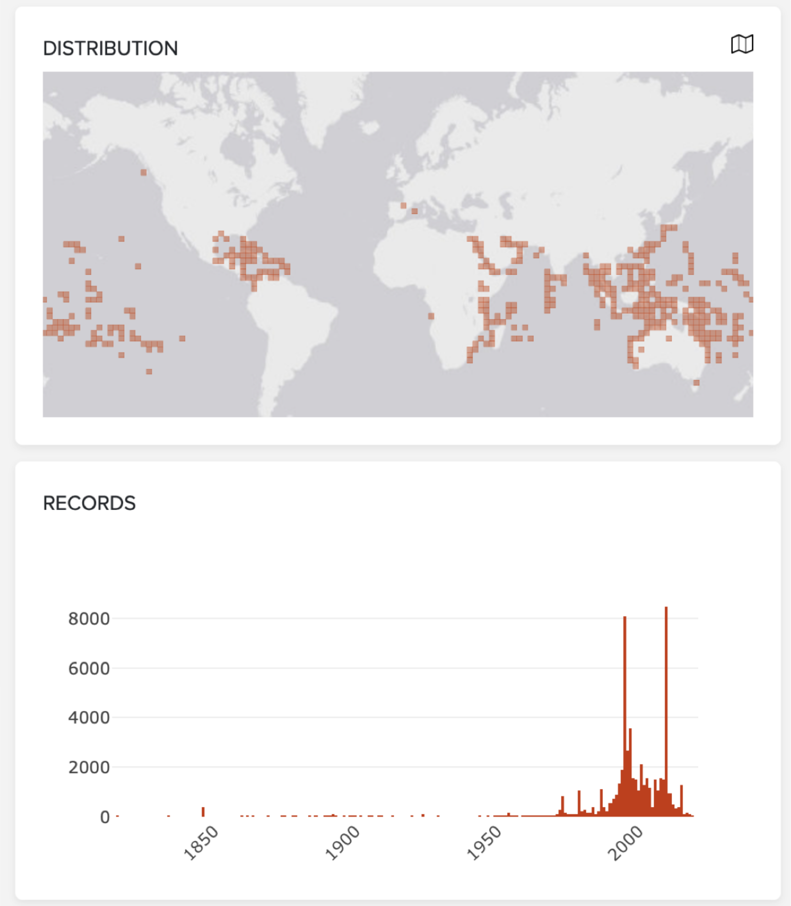


Example of Evolutionary tree for Corals. The numbers above represent the age of the node in the tree..

Other data?

- **Biogeographic data**
- Help identify range overlap of sister species pairs
- OBIS (Ocean Biodiversity Information System) provides distribution and occurrences data for most known species.
- R library: obistools, georange

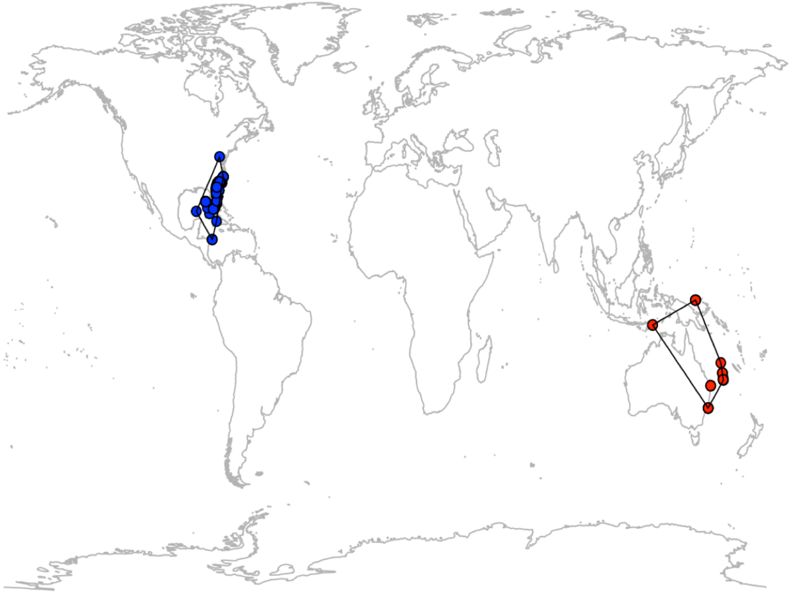
Example: Genus Acropora in OBIS



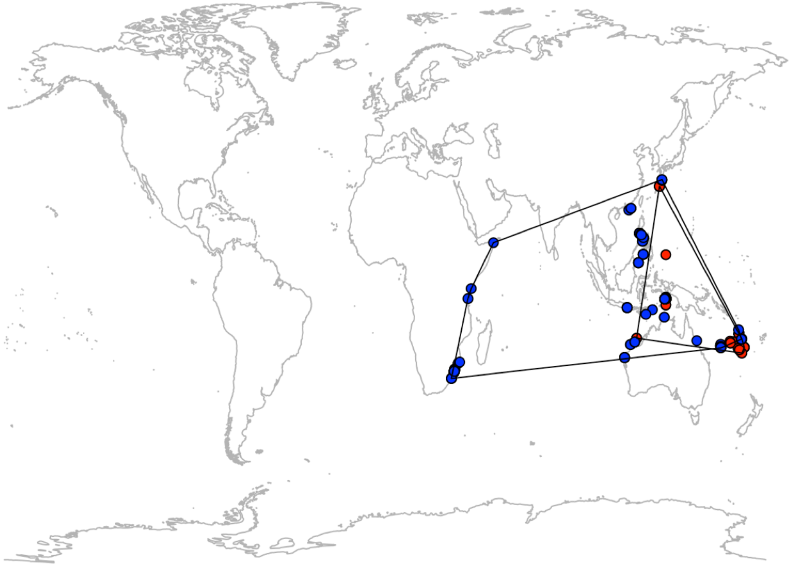
Methodology

- Build a dataset of marine species with their phylogenetic and range information (including marine mammals and invertebrates).
- Compute the ***range overlap*** and examine the pattern of speciation
  a) Identify and discard Outliers
  b) We compute range overlap by computing the convex hull of data points and the intersected areas of two species.
  c) Formula: ***range overlap = areai / min(area1,area2)***, where ***areai*** is the area of intersection of ranges of two species.
- Examine the relationship between range overlap and node age (i.e. age of the species)

Example: How we compute range overlap



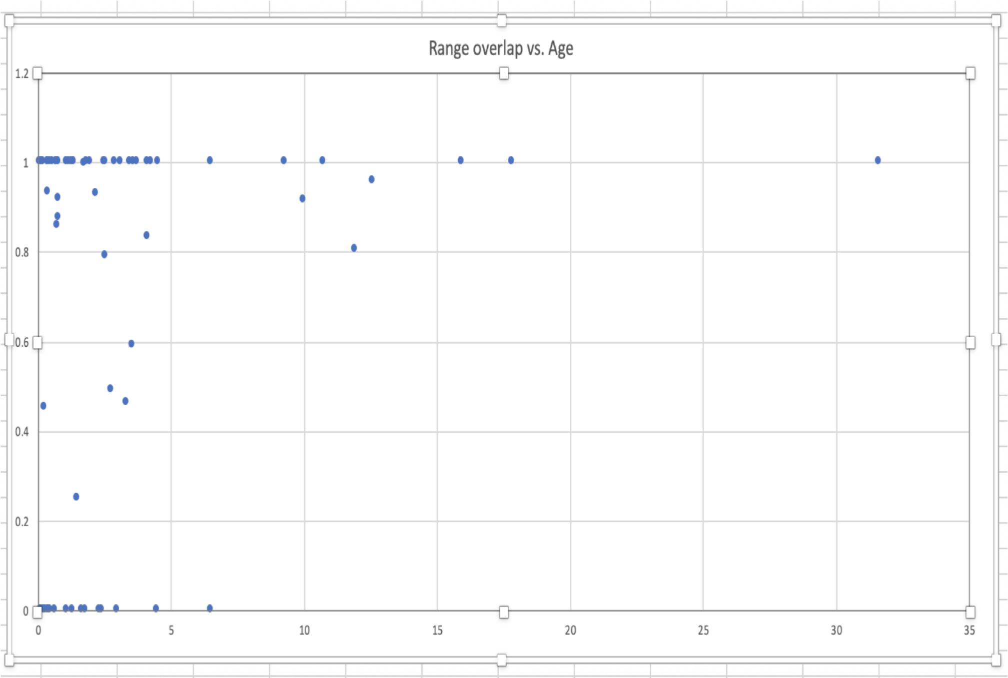
Ex 1: Species pairs with overlap of 0%
(Thecopsammia elongata vs. Thecopsammia socialis)



Ex 2. Species pairs with overlap of 0.97
(Tropidocyathus labidus vs. Tropidocyathus lessonii)

Results / Discussion

- ***> 50%*** species pairs in our dataset have a ***range overlap > 0.8***, while for genus with two species, most of them have perfect overlap.
  - Highly sympatry of our dataset
- ***Perfect overlap*** for really old species
  - Time is long enough for speciation signal to be lost (i.e. meaningless to make inference based on that)
  - Random distribution (influence of ocean current and migrations)



Range overlap(%) vs. Age (myr)

Results & Graphics

Will add something later!

Conclusion

- Sympatric speciation is the hidden speciation mechanisms for some invertebrates and mammals in the ocean, and it happens for many marine species.
  - Lower speciation rates since sympatric speciation is generally slower than allopatric speciation.
  - However, speciation mechanism for old species remains unknown.
- The increasing importance of sympatry may help explain the fact that ocean has lower biodiversity than the land.
- May add something

Thanks!