

Space, time and the sea

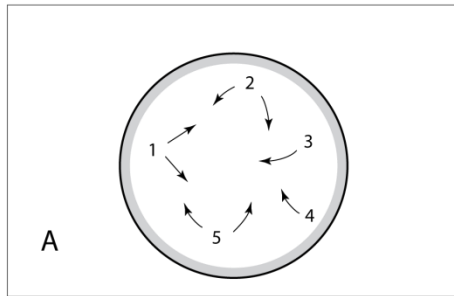


Fig. 1a. A distribution of hypothetical group A. Its center of origin might occur in the area with a highest diversity in the group (1), in the region of the oldest fossil (2), in the area of the most 'advanced' form (3), in the area of the most 'primitive' form (4), or in the area of the basal group (5).

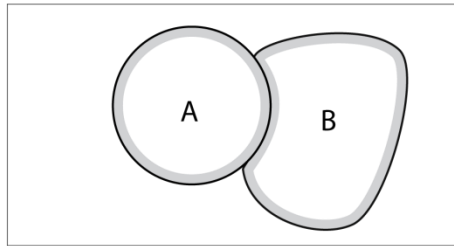


Fig. 1b. Group A and its sister group, B, have allopatric distributions.

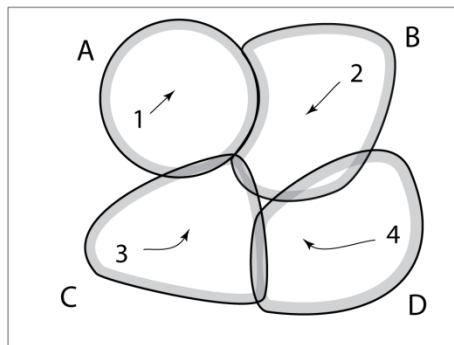


Fig. 1c. Group A + B and its sister groups, C and D, also have allopatric distributions. Hypothetical 'centres of origin' indicated (1-4).

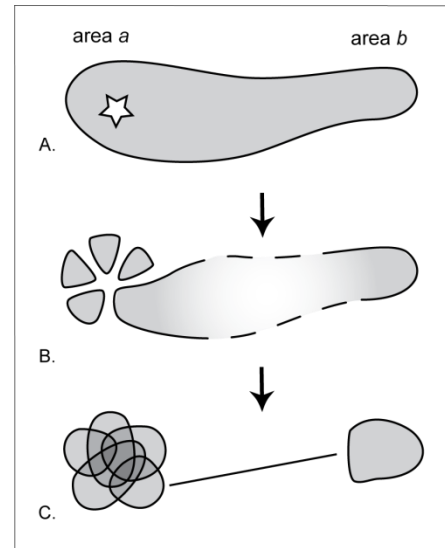


Fig. 1d. A hypothetical example of distribution in a taxon currently found in two areas. A. A widespread ancestor begins to differentiate around a node associated with, for example, formation of a mountain range or inland sea (star). B. The ancestor has differentiated into five allopatric clades, four with a narrow range and one widespread. Their ranges begin to overlap while some of the populations of the widespread clade suffer extinction (broken line). C. The clades now overlap but the ranges still show traces of their original allopatry. Following extinction of intermediate populations, the outlier may appear to be a secondary feature and the result of long distance dispersal.

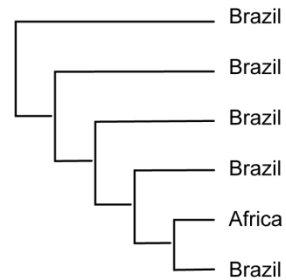
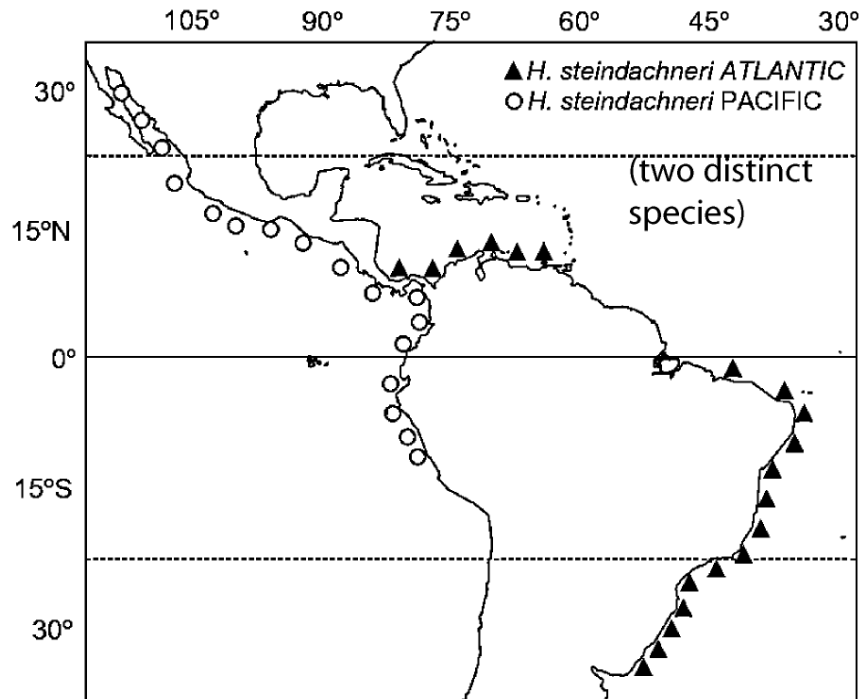


Fig. 1e. The phylogeny and distribution of clades in a hypothetical group (cf. Fig. 4). The African clade is nested in an African-Brazilian group, not a Brazilian group.

Methods of calibrating a phylogeny

1. Use oldest **fossil** of a group. But this only give a minimum age for the group.
2. Use the age of the **island** or strata that a group is endemic to. But young islands often have old taxa.
3. Correlate the geographic distribution of a group with associated **tectonic events**. But tectonic features can be reactivated.



Two sister species of *Haemulon* (Perciformes: Haemulidae) (Rocha et al., 2008).



Pacifigorgia (Octocorallia) (Vargas et al., 2008).

At all biogeographic breaks or splits (nodes), e.g. the Atlantic Ocean, different pairs of taxa show differing degrees of divergence.

1. Evolution is clock-like and the different pairs of taxa split at different times.
2. Evolution is not clock-like and the different pairs of taxa split at the same time. Degree of divergence is related to prior genome architecture.

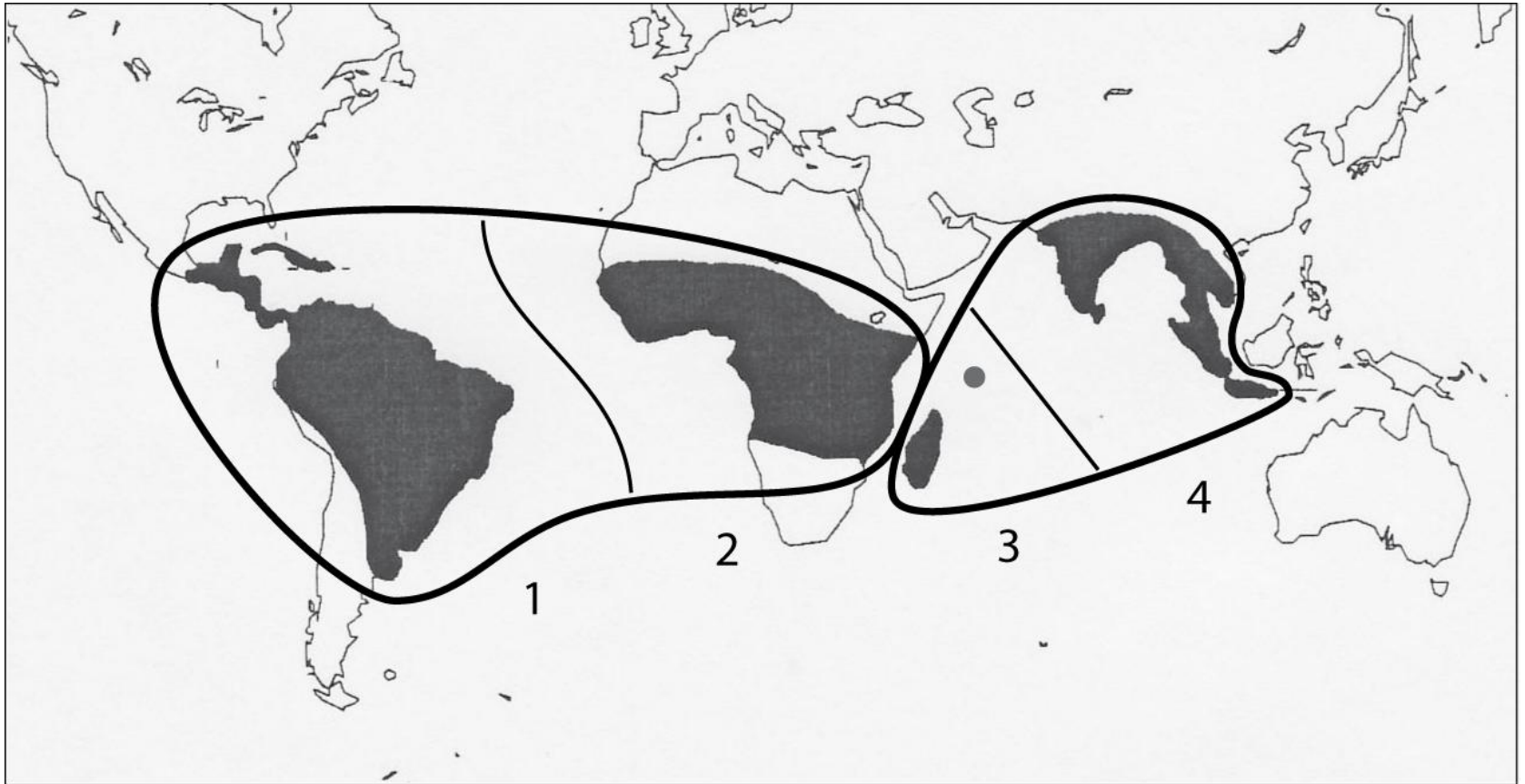
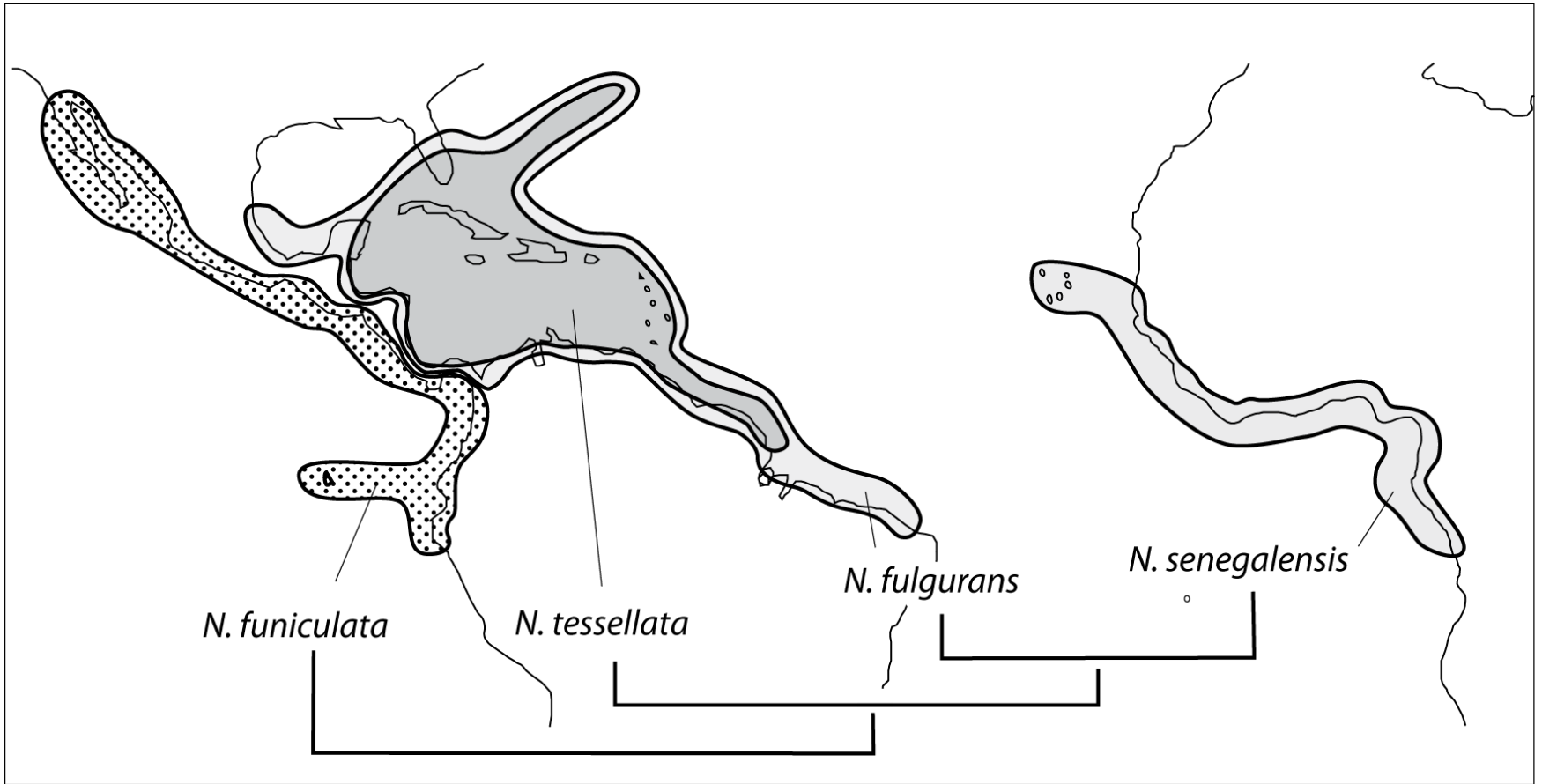


Fig. 41. Cyprinodontiformes suborder Aplocheiloidei (Murphy & Collier, 1997).
The phylogeny is: (1 + 2) (3 + 4).



A clade in *Nerita* (Gastropoda) (Frey, 2010).

(SW Atlantic (NW Atlantic (eastern Atlantic)))

Clepticus (Beldade et al., 2009)

(Pacific (Brazil (Caribbean (mid-Atlantic (east Atlantic))))))

Ophioblennius spp. (Muss et al.,
2001)