

Do man-made habitats affect patterns of spatial distribution of mollusc?

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Introduction

The fragmentation of natural habitats, together with its loss, is considered a major threat to biodiversity (Cole et al. 2012).



Figure 1. Building barriers?

Man-made habitats, e.g., seawalls and coastal defence structures, are a common feature causing the fragmentation on the shoreline of many urbanized coastal areas and will become more widespread in response to rising and stormier seas (Moschella et al. 2005).

Fragmentation can alter functional connectivity of habitats and determine the spatial distribution of organisms, since the movement and dispersal of individuals can be interrupted (Goodsell 2009).

However, ecological consequences of coastal defence structures have not been extensively studied and we know little about their effects in marine systems (Goodsell et al. 2007). One of the most important factors affecting the connectivity among fragments or patches is the ability of the organisms to disperse despite potential barriers. Spatial patterns of molluscs with planktonic larvae or direct development (non-planktrophic larvae) has been compared before, but there is a growing interest in understanding the role of the man-made habitats in determining the patterns of spatial abundances of marine organisms.

Aim: Explore the role of type of larval development (planktrophic vs non-planktrophic) on spatial variation in the abundance of rocky shore gastropods, testing the influence of habitat fragmentation (natural – beach; artificial – seawall) on observed patterns.

Our prediction:

Organisms with planktrophic development will be less affected by fragmentation because they have a greater ability to disperse among fragments.

Results and discussion

- Results of analyses of variance indicated no significant effect of type of shore on abundance of both gastropods with planktonic and non-planktonic larvae ($p > 0.05$).
- Spatial differences between locations and sites were more commonly found in abundance of gastropods with non-planktonic larvae: While only *P. candei* varied significantly at scale of site ($MS = 29.72$, $F = 3.18$, $p < 0.05$), the gastropods with non-planktonic larvae *E. fulgida* and *L. adansoni* varied at the scale of site ($MS = 3789.50$, $F = 9.51$, $p < 0.01$ and $MS = 82300.00$, $F = 17.11$, $p < 0.001$, respectively), and *O. atomus* varied significantly at scale of location ($MS = 131000.00$, $F = 20.20$, $p < 0.05$) (Fig. 3).

- Large variance of abundance of gastropods with planktonic larvae mostly occurred at small spatial scales (larger values of estimates of components of variance due to residual), as commonly reported for rocky intertidal assemblages by other studies (e.g. Fraschetti et al. 2005) (Fig. 4). Variability of most gastropods with non-planktonic larvae increased at bigger spatial scales (site and location) for fragmented habitats.

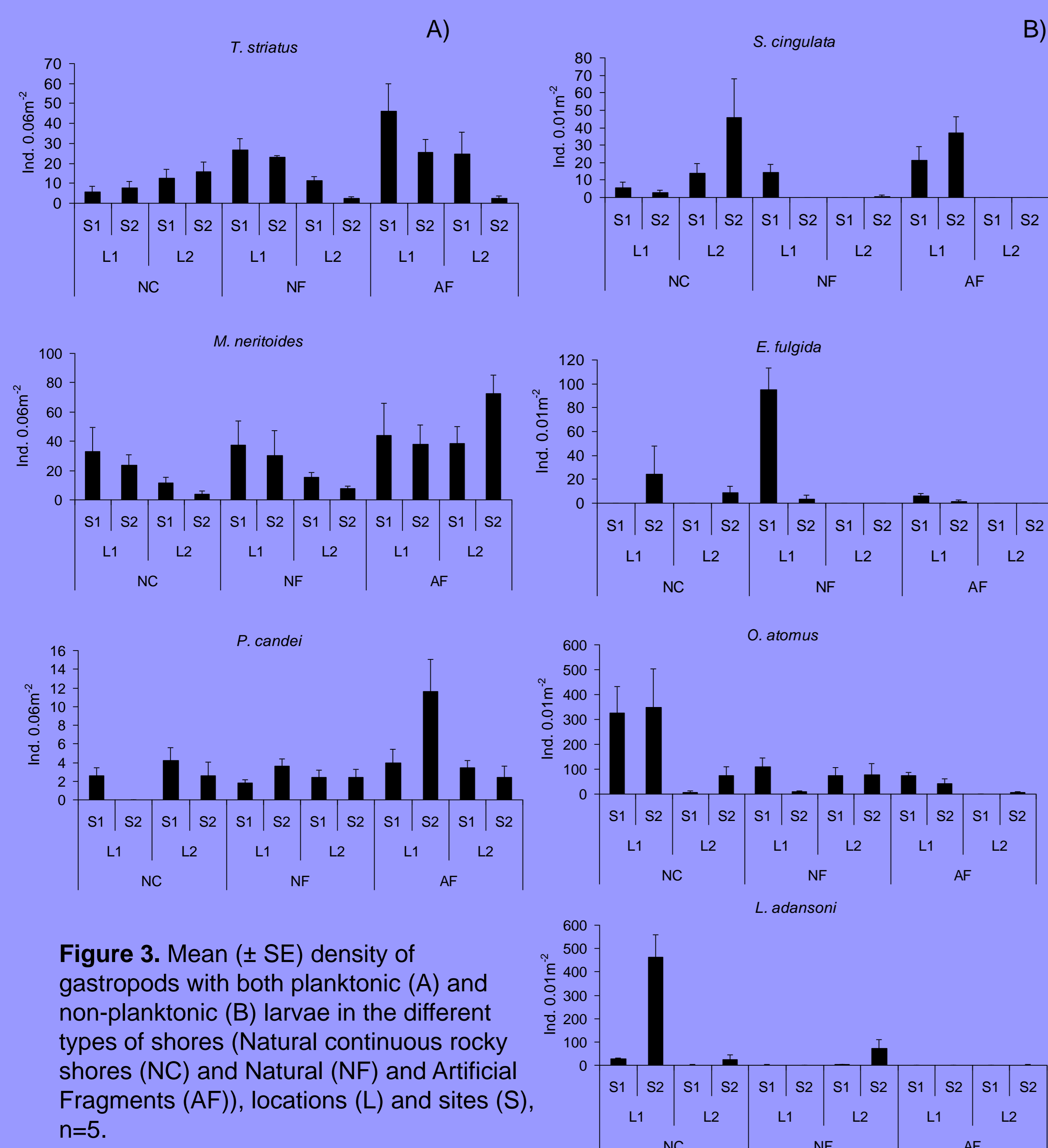


Figure 3. Mean (\pm SE) density of gastropods with both planktonic (A) and non-planktonic (B) larvae in the different types of shores (Natural continuous rocky shores (NC) and Natural (NF) and Artificial Fragments (AF)), locations (L) and sites (S), $n=5$.

Material and methods

We tested this hypothesis by comparing the abundance of molluscs with both planktrophic and direct development in between two continuous sites:

- Connected (sites part of a continuous stretch of rocky shores)
- Fragmented (sites separated by a different type of habitat)

We further tested if the effects of shore fragmentation differed according to whether fragmentation was:

- Natural (a beach between the two sites) or
- Artificial (a seawall between the two sites)

Two natural rocky shores of each type (i.e., continuous rocky shores, natural and artificial fragments), separated from each other by kms, were sampled for replication. At the mid-intertidal level, the gastropods with planktonic larvae *Tectarius striatus* (King, 1832), *Melaraphe neritoides* (Linnaeus, 1758) and *Patella candei* d'Orbigny, 1840, were identified and quantified *in situ* in quadrats randomly deployed on the shore. Randomly replicates of seaweed turfs, composed mostly by articulated coralline algae, were collected in the chosen locations and target gastropods with non-planktonic larvae (*Sinezona cingulata* (O.G. Costa, 1861), *Eatonina fulgida* (Adams J., 1979), *Omalogyra atomus* (Philippi, 1841), *Lasaea adansoni* (Gmelin, 1791)) were sorted and quantified in the laboratory.

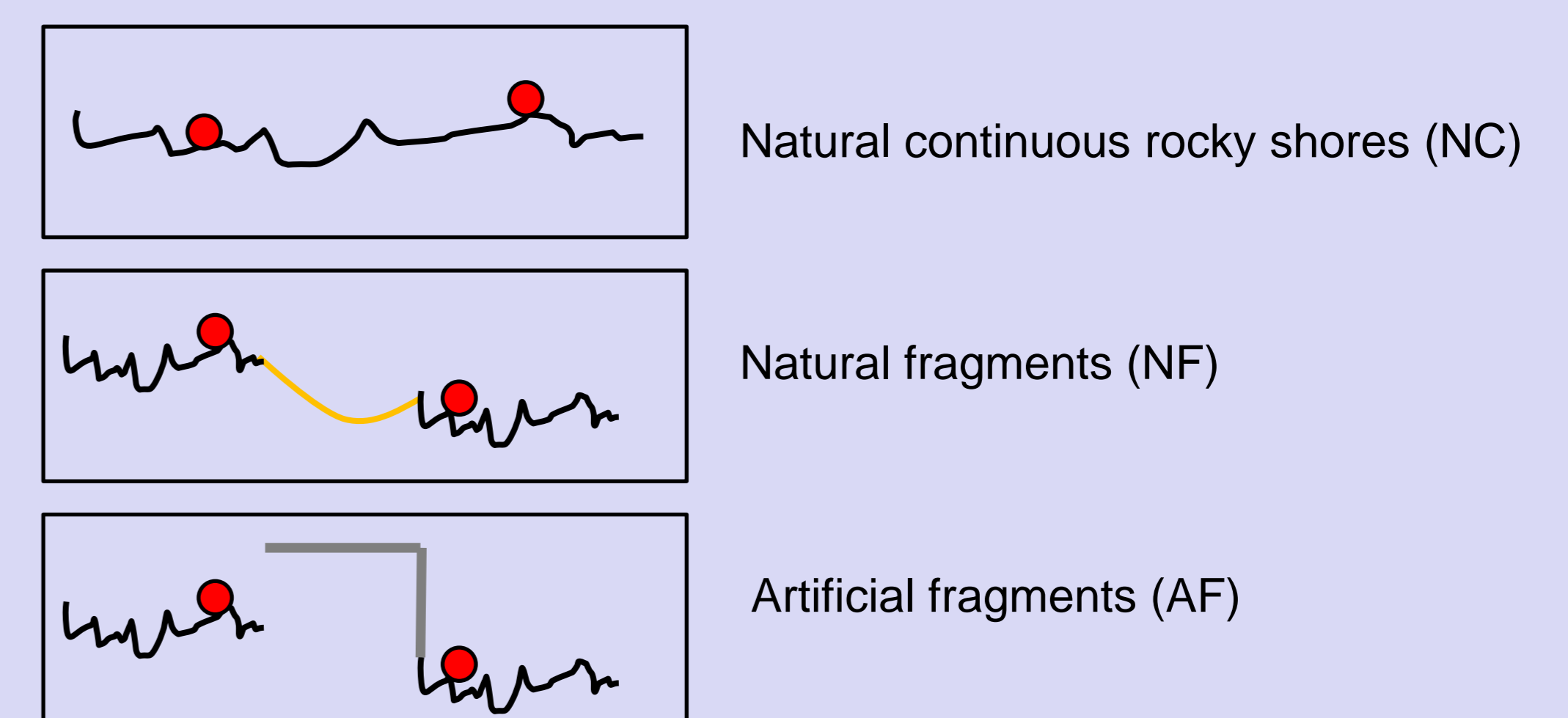


Figure 2. Sampling design

Data analysis

Patterns of distributions of the abundance of individual species were examined by means of analysis of variance (ANOVA) with three factors: type of shore (3 levels, fixed), location (2 levels, nested in type of shore) and site (2 levels, nested in location). The magnitude of each spatial scale contribution to patterns of distribution were established through calculation of estimates of spatial variance.

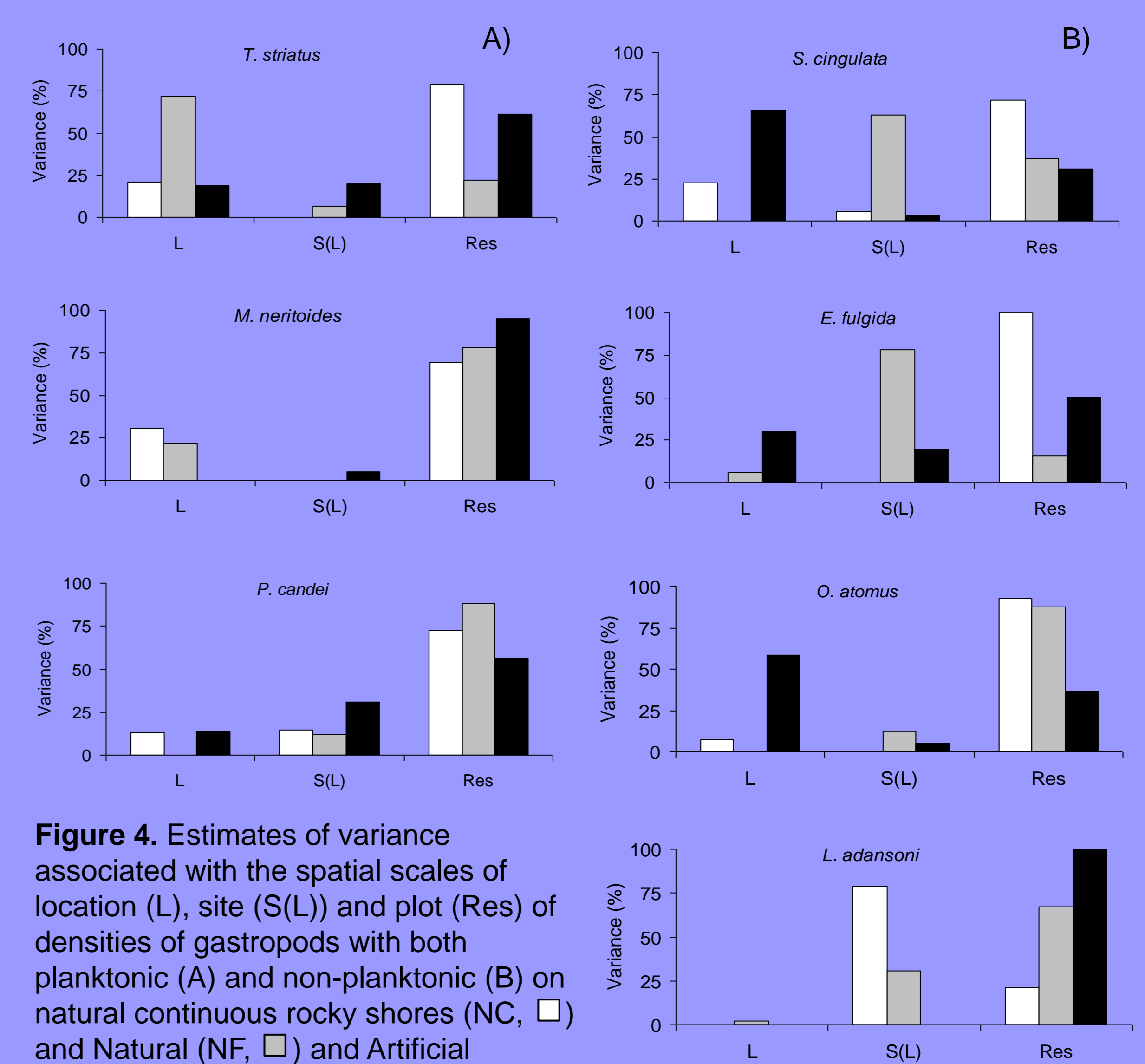


Figure 4. Estimates of variance associated with the spatial scales of location (L), site (S(L)) and plot (Res) of densities of gastropods with both planktonic (A) and non-planktonic (B) on natural continuous rocky shores (NC, □) and Natural (NF, ◻) and Artificial Fragments (AF, ■).

Conclusions

- Strongly aggregated patterns characterized the distribution of organisms with direct development, while the existence of planktrophic larvae allowed a more homogeneous distribution of organisms.
- Contributions to patterns of distribution varied among different types of shores and larval development

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