SHELL VARIATION IN PATELLID LIMPETS: SCALES OF SPATIAL VARIABILITY

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ABSTRACT Species of the genera *Patella* generally display a high degree of shell variation, which is thought to be an adaptation to environmental conditions. The present work examines the variation in the morphometry of the two patellid limpets present in the Azores (*Patella candei and P. aspera*) at multiple spatial scales. Individuals of both patellid species were collected on two sites in each of the nine islands of the Azores. All individuals were measured to estimate: base ellipticity, base eccentricity, conicity and cone eccentricity. Shell variation in *P. candei* was consistent among groups of islands (eastern, central, western) but there was significant variation in shell morphometry at the scales of island and site. Components of variation showed that a substantial proportion of variation was associated with the scale of individuals. Shell variation in *P. aspera* was consistent at the scale of island groups and islands but there was significant variation among sites. Analysis of the components of variability showed that variability in shell morphometry was mostly associated with differences among individuals. Overall, these results suggest that variation in shell morphometry in the two patellid is not influenced by large scale processes, and that shell variation in these species is likely the result of the adaption to local conditions (e.g. microhabitats).

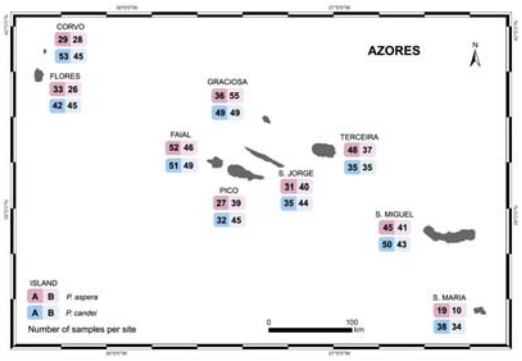

Figure 1. Map of the Azores archipelago showing *Patella* samples.

METHODS

• A total of 1414 specimens were collected in two rocky shores sites from all islands of the archipelago of Azores (Fig.1).

• Individual shells were removed from the soft tissue and their shape was examined by measuring the shell length (SL), shell width (SW), shell width at the apex (SWA), shell height (SH) and shell length from apex to anterior end (SAA) (Fig.2).

• Shell shape was decomposed in four parameters: base ellipticity and eccentricity, conicity and cone eccentricity (Table 1).

•A 3-way hierarchical ANCOVA was used to examine patterns of spatial variation for all parameters, with SL as a covariate. Factors: group of islands (random, 3 levels), island (random, 9 levels) and site (random, 2 levels).

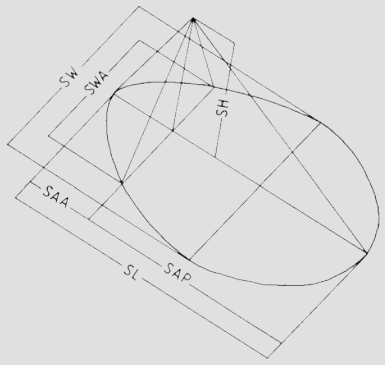

Figure 2. Distances measured in the shells; *in* Cabral (2007), Web Ecology 7: 11–21.

Table 1. Parameters used in the analyses of shell shape; *in* Cabral (2007), Web Ecology 7: 11–21.

Shape parameter	Variable	Trends
Base ellipticity	SW/SL	▶ =1 Circle ▶ <1 Ellipse/Oval/Parabola/Ovule ▶ <1, ratio increases with decreasing ellipticity
Base eccentricity	SWA/SW	▶ ≈1 Circle/Ellipse/Oval/Parabola ▶ <1 Ovule ▶ <1, ratio increases with transition from ovule to ellipse
Conicity	SH/SL	▶ Increases with increasing conicity
Cone eccentricity	SAA/SAP	▶ =1 Centred apex/Symmetrical cone ▶ <1 Apex near the anterior end ▶ <1, ratio increases with decreasing eccentricity

RESULTS

PATELLA ASPERA (Röding, 1798)

N = 642

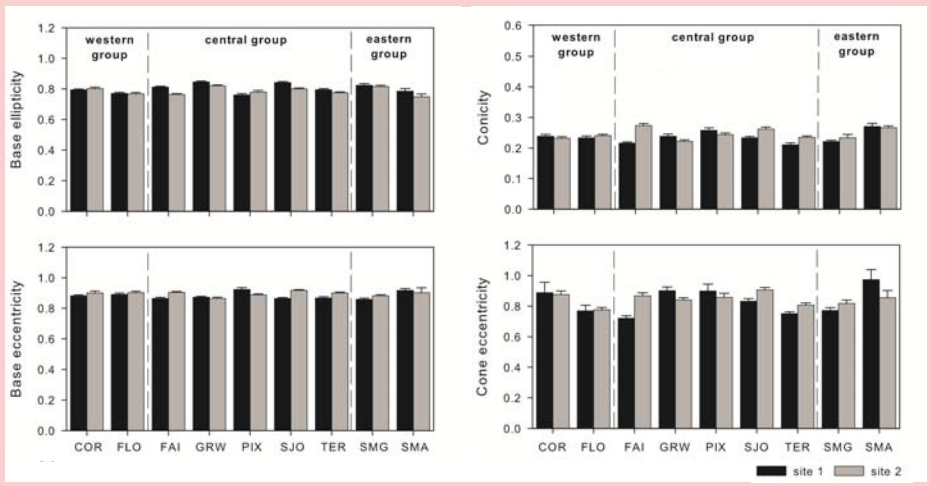

Table 2. Mean values (±SE) of *P. aspera* shell shape parameters across the archipelago of Azores.

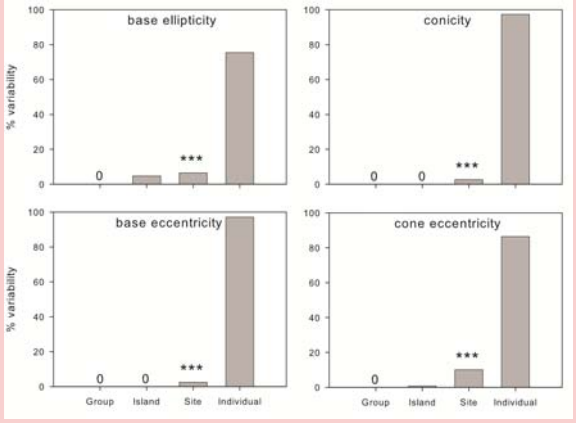

Table 3. Variance components (%) from a hierarchical ANCOVA of *P. aspera* shell shape parameters across four spatial scales in the Azores.

PATELLA CANDEI (d´Orbigny, 1839)

N = 772

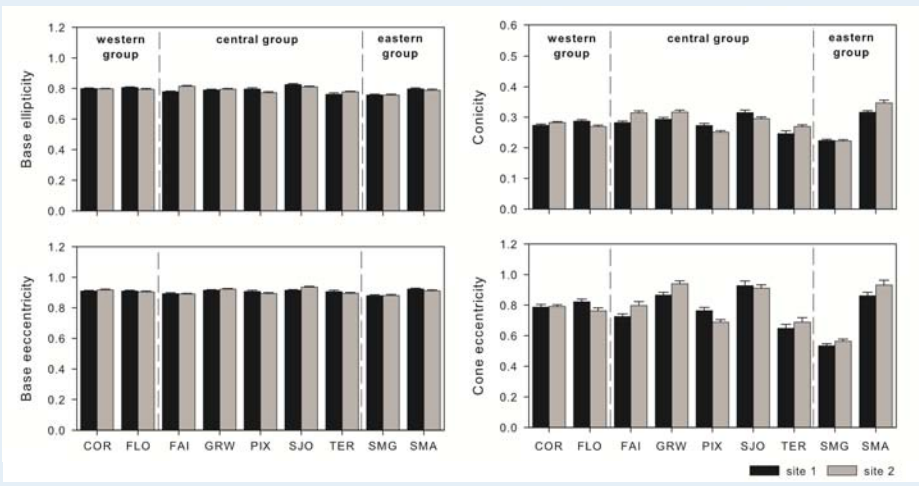

Table 4. Mean values (±SE) of *P. candei* shell shape parameters across the archipelago of Azores.

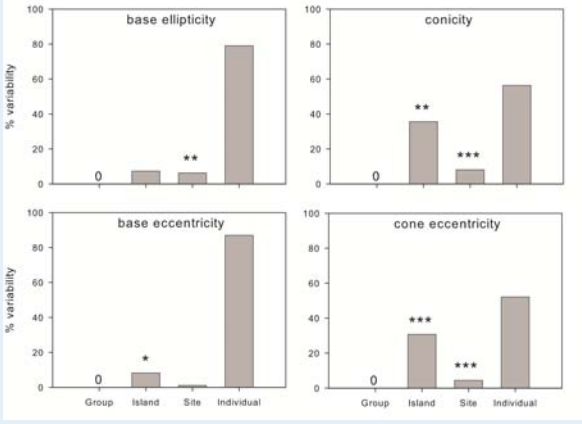

Table 5. Variance components (%) from a hierarchical ANCOVA of *P. candei* shell shape parameters across four spatial scales in the Azores.

CONCLUSIONS

• Variability in shell morphometry was mostly associated with differences among individuals.

• This study suggests that variation in shell morphometry in *P. aspera* and *P. candei* is not influenced by large scale processes as would be expected given the pelagic phase in the life cycle of these two patellids.

• Shell variation in these species is likely the result of the adaption to local conditions (e.g. microhabitats).

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representing a good tool to study predator-prey relationships in marine mollusc communities and the influence of abiotic factors on predator-prey relationships.
The complexity found in modern eastern Pacific environments is reflected in the mollusc assemblages it supports. Earlier data showed a much higher trophic diversity and predation intensity in muddy substrate communities as compared with those from coralline algae. Here we were interested in the possible influence of substrate type on feeding habits of predatory snails in upwelling versus non-upwelling settings on the tropical eastern Pacific coast of Panama.
As expected, taxonomic distribution and substrate type are directly related. Predation intensity varies from 35.1% in mud substrates to13.0% in hard substrates for gastropods, and from 17.3% - 4.5% respectively for bivalves. On the other hand it seems that hydrology (i.e. upwelling / non upwelling) has no big influence in predation intensity. In both substrates gastropods show a much higher predation intensity. Prey selectivity seems to be present only concerning gastropods and scarcely on bivalves. Naticids are the dominant predator in both habitat types. Muricids are responsible for less than 10% of total drill holes found mostly on hard substrate.

T20.P6

SHELL VARIATION IN PATELLID LIMPETS: SCALES OF SPATIAL VARIABILITY

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Species of the genera *Patella* generally display a high degree of shell variation, which is thought to be an adaptation to environmental conditions. The present work examines the variation in the morphometry of the two patellid limpets present in the Azores (*Patella candei* and *P. aspera*) at multiple spatial scales. Individuals of both patellid species were collected on two sites in each of the nine islands of the Azores. All individuals were measured to estimate base ellipticity, base eccentricity, conicity and cone eccentricity. Shell variation in *P. candei* was consistent among groups of islands (eastern, central, western) but there was significant variation in shell morphometry at the scales of islands and sites. Components of variation showed that a substantial proportion of variation was associated with the scale of individuals. Shell variation in *P. aspera* was consistent at the scale of island groups and islands but there was significant variation among sites. Analysis of the components of variability showed that variability in shell morphometry was mostly associated with differences among individuals. Overall, these results suggest that variation in shell morphometry in the two patellid is not influenced by large scale processes as would be expected given that *P. candei* and *P. aspera* both have a pelagic larvae. In addition, this study suggests that shell variation in these species is likely to be a result of an adaptation to local conditions (e.g. microhabitats).

T20.P7

MALACOFAUNA ASSOCIATED WITH MARINE SPONGES IN THE AZORES ARCHIPELAGO

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Marine sponges (Porifera) provide habitat, refuge and food to a wide variety of organisms thus playing key ecological roles in benthic communities. The macrofauna associated with three sponge species, viz. *Haliclona fistulosa* (Bowerbank, 1866), *Myxilla macrosigma* Boury-Esnault, 1971 and *Tedania anhelans* (Lieberkühn, 1859), was studied and compared with that inhabiting the adjoining algal cover.
Molluscs were shown to constitute the second and third most abundant group associated with the algae and the sponges, respectively. A total of 2079 individuals were identified and assigned to 68 taxonomic units (TUs), representing 52 genera, 35 families, 12 orders, and 3 classes. The algal-associated molluscan assemblages were more abundant but equally speciose (N=1575; S= 53) than the sponge-associated assemblages (N=504; S=52). Sixteen TUs were found exclusively on the algal cover, whereas 15 TUs were only found associated with the sponges. Thirty-seven TUs were shared among hosts. The species *Ammonicera rota* (Forbes & Hanley, 1850), *Bittium nanum* (Mayer, 1864) and *Tricollia pullus azorica* (Dautzenberg, 1889) strongly dominated both assemblages. Half of the species occurred in very low frequencies (less than 3 individuals).
These findings highlight the important role that sponges play as habitat for the littoral malacofauna of the archipelago.

T20.P8

HOW AND WHY GASTROPOD SHELLS BECOME REMODELED HOMES FOR TERRESTRIAL HERMIT CRABS

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Gastropod shells represent a critical resource that hermit crabs occupy as homes. However, terrestrial hermit crabs do not merely occupy gastropod shells they also architecturally remodel them through a process of niche construction. Here I detail the before-to-after changes in these remodeled shells (*Nerita scabricosta* as well as other species) and I present an ecological, evolutionary, and behavioral synthesis of how and why terrestrial hermit crabs perform this niche construction of gastropod shells. I report data from my long-term study population in the field (*Coenobita compressus* in Osa Peninsula, Costa Rica), the results of laboratory experiments, and a novel synthesis of information from the broader literature.
Compared to their marine ancestors, terrestrial hermit crabs faced a radically different suite of predators as well as substantially altered locomotion costs in their new terrestrial environment. In particular, the transition from sea to land dramatically relaxed

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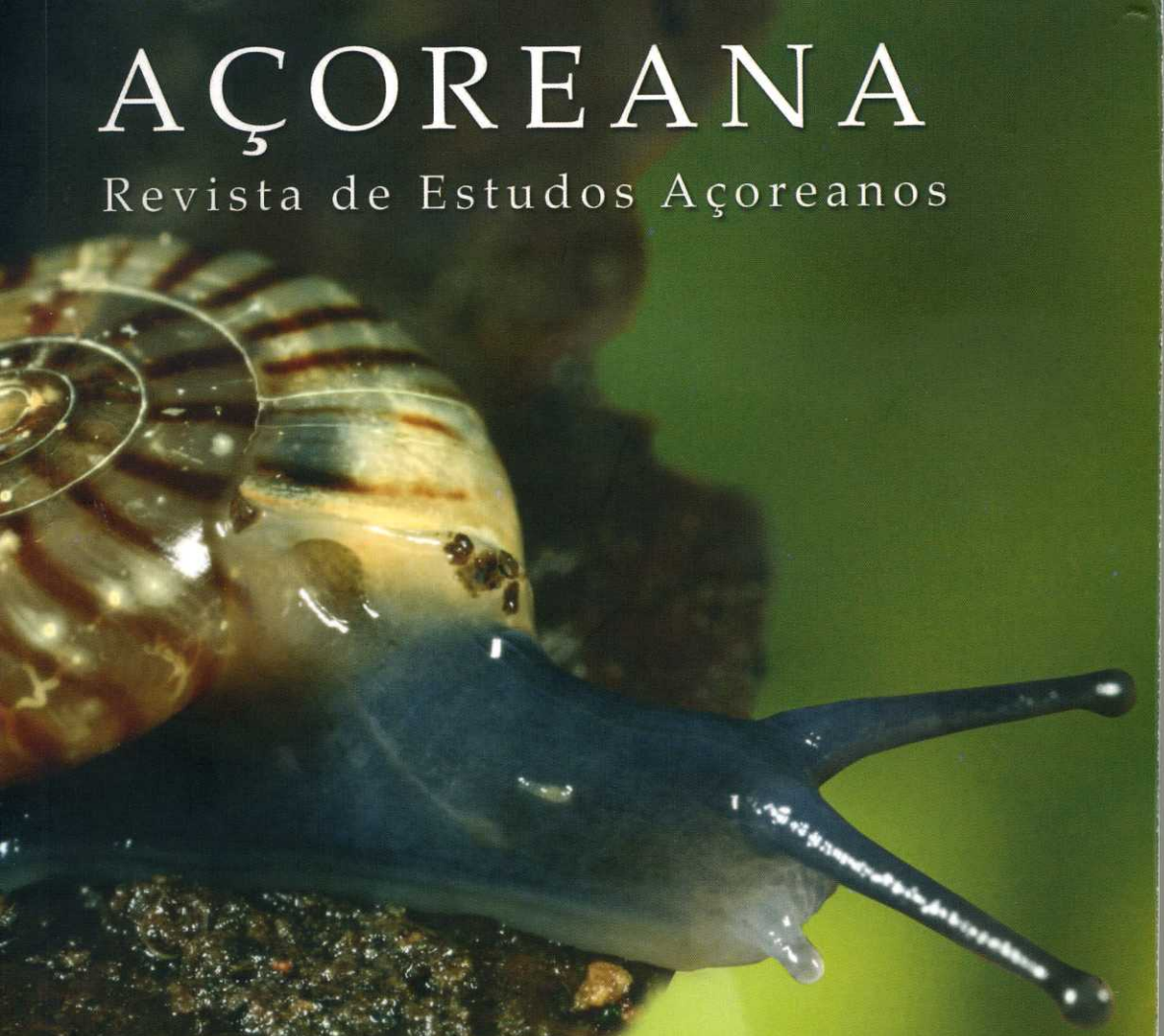

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