

used these topologies were  $\pm$  comparable to those obtained with the Distance Wagner method ; (6) Fitch & Margoliash and UPGMA trees were clearly susceptible to data input orders. Hence, none of the methods used in this contribution could confirm the placement of *L. striata* within the genus *Littorina*.

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### The relationship between size, position on shore and shell ornamentation in *Littorina striata*

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Shells of small (< 7 mm) *Littorina striata* are frequently nodulose, but shells of larger individuals are striate. Nodulose *L. striata* dominated the littoral fringe of a black basalt Azorean shore where daytime rock temperatures rise significantly higher than nearby shores of different rock composition or colour. There was no evidence of intraspecific size-partitioning on the latter shores, where the numbers of striate and nodulose *L. striata* were approximately equal between high eulittoral (low-shore) and high littoral fringe (high-shore) localities. It is hypothesized that small *L. striata* attain a resting posture better able to minimize heat absorption from the substratum than attained by larger individuals. Smaller individuals also take advantage of both posture and a nodulose shell surface to more effectively re-radiate absorbed incident radiant thermal energy to the atmosphere by convection. Thus, small, nodulose *L. striata* are especially well adapted to occupy geologically young basaltic rocks commonly fringing islands of the mid-Atlantic. This investigation was conducted during the Second International Workshop of Malacology of the Azores and is to be published in full in the Proceedings of the Workshop.

### Morphometrics of small rough periwinkles

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The taxonomic status of *Littorina neglecta* has been the subject of controversy since its description in 1844. Later regarded as a subspecies of the widespread, variable *L. saxatilis* (eg. James 1964), it was then re-established as a full species (Heller 1975). Recently *L. neglecta* has been considered a barnacle-dwelling 'ecotype' of *L. saxatilis* (Johannesson & Johannesson 1990). Similar morphs exist in other species of rough periwinkle which may support an 'ecotype' status for *L. neglecta* (Reid 1993). Prior results have relied on comparatively small data sets. The present study provides results from an analysis of shell shape in about 2 500 specimens of rough periwinkles from around the North Atlantic, using the methods of Grahame and Mill (1989). The majority of specimens analysed were less than 5.5 mm in columella height, the largest recorded size for *L. neglecta* in this study.

Principal component and discriminant analyses revealed that shape differences in all small rough periwinkles are very subtle. The situation is further confused in *L. neglecta*, as the identification features used by other authors do not stand up to rigorous analysis. However, when four categories, equivalent to *L. nigrolineata*, *L. arcana*, *L. neglecta* and *L. saxatilis*, are defined using the combination of colour plus sculpture, morphological analysis confirms the differences shown.

The 'ecotype' label cannot be applied to *L. neglecta*, since micro-sympatric specimens of *L. neglecta* and *L. saxatilis* from the British east coast were shown to be morphometrically distinct, with few intermediate shell forms. *L. neglecta* was found to occur well within the range of *L. saxatilis*, while small, reproductively mature *L. saxatilis* occurred in the same barnacle habitat as *L. neglecta*. Moreover, size effects do not account for the differences between the two categories. Thus large *L. neglecta* are distinct from both large and small *L. saxatilis*, and small, mid-shore *L. saxatilis* classify with large high-shore *L. saxatilis* in the analysis, rather than with *L. neglecta*.

Based on the apparent shell homogeneity of *L. neglecta* over its range, and its distinctiveness from *L. saxatilis*, it is proposed that *L. neglecta* is at a more advanced evolutionary stage than is possible with an 'ecotype'. However, this character set on its own cannot be used to infer specific status as defined by the Biological Species Concept.

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## Morphological changes in the digestive epithelium of *Littorina littorea* in relation to the reproductive cycle.

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The use of molluscs as indicators of pollution in the marine ecosystem has become world-wide. Special attention has been paid to cellular responses as they take place before the effects of contaminants become evident at other levels, and therefore they can be used to provide an early indication of environmental stress.

This study forms part of a larger project in which five planimetric parameters have been used to study changes in the digestive epithelium of *Littorina littorea* under different environmental and physiological conditions.

The visceral hump of *L. littorea* is formed mainly by digestive gland, gonad and connective tissue, and it is well known that the relative proportions of these tissues vary greatly during the reproductive cycle. The aim of this study was to examine the effect of the reproductive cycle on the planimetric parameters in order to assess the value of their changes as indicators of environmental stress.