fall into one of three feeding types and this paper synthesises the literature on the community ecology of the most intensively studied examples of each type.

Epilithic grazers feed directly off hard substrata, mainly eating microalgae, including the sporelings of macroalgae. They can also feed on ephemeral macroalgae. Low shore species have a stronger influence on the community, but the effects of grazing depend very much on snail density. Epilithic grazers affect perennial algae indirectly by removing ephemeral species and reducing competition for space or light. They also influence the recruitment of perennials as mature algae often represent sporelings which have "escaped" grazing and have grown to a size at which they are no longer vulnerable to grazers.

Macroalgal grazers live on, and eat perennial macroalgae. They affect canopy forming perennials directly by grazing and influence ephemeral algae indirectly by reducing canopy shading. Unlike epilithic grazers their effects on the community depend not as much on grazer density as on the fine details of the interaction between grazer and alga. These include the part of the plant which is eaten, the seasonality of grazing pressure and the population dynamics of both grazer and alga. Macroalgal grazers can devastate canopy species with subsequent effects on understorey algae. But at similar densities the same grazer can have very little effect on another canopy species.

Epiphytic/detrital feeders live on macrophytic plants (usually angiosperms), but do not feed on them. They may graze epiphytes from their surface, or feed on dead, standing material rather than the living plant itself. They have no direct effect on plant abundance or distribution, but may reduce epiphytic shading and can have a very important role in the community through recycling nutrients and energy from detrital material.

Shape variation in *Littorina saxatilis* along the west coast of Britain.

P.J. Mill and J. Grahame
Department of Pure and Applied Biology, the University of Leeds, Leeds LS2 9JT, UK

Previous work on shell shape in *Littorina saxatilis* (Grahame & Mill, 1989, 1992; Grahame, Mill & Brown, 1990) has indicated that, not only is there local adaptive variation in shape, but that there are geographical variations which may take the form of clines, and/or involve character displacement when the species is sympatric with *Littorina arcana.*

Data from 23 sites on the west coast of Britain, totalling 35 samples and 606 shells of female *L. saxatilis*, indicate strong correlations between the various measurements of aperture size (aperture width and length, and operculum area) as would be expected ; also between columellar length and the width of the second whorl. Negative correlations occurred between lip length and aperture width, lip length and operculum area, apical angle and columella length, and apical angle and the width of the second whorl.

Principal Component analysis indicates that 81 % of the variation in the raw, log-transformed data can be accounted for primarily by size. However, the removal of size as a primary source of variation, by use of the geometric mean, has revealed some interesting trends. At the southern end of the range PC1 (which accounts for 38.6 % of the variation) shows a trend in which the relative size of the aperture decreases northwards from Cornwall to the Isle of Man while the jugosity of the aperture (lip length) increases. However, the two most obvious trends involve PC5 (3.4 %) and PC6 (2.7 %). These include the aperture becoming relatively longer and narrower from Cornwall upto at least the Outer Hebrides, while the width of the second whorl becomes relatively larger with respect to columella length. Plotting these components against each other shows that Lewis/Harris shells form a very discrete group.

Comparison of this data with that from the south coast indicates that, with the exception of PC5, the corresponding Principal Components are strongly correlated with each other. However, the trends differ. Thus PC2 (28.2 %) and PC3 (15.3 %) indicate, respectively, that in the west the columella length and operculum area are both relatively larger with respect to lip length and apical angle, while the basal whorls are relatively larger with respect to lip length and columella length. There are no obvious trends in PC5 and PC6 but a plot of these against each other indicates that the shells from south east England form a fairly discrete group.

In summary, clines in shell shape have been demonstrated along both the west and south coasts, but each involves different aspects of shape. However, examination of PC2 in both analyses indicates a taller spire in west coast sites and a greater degree of aperture jugosity in south east England.

REFERENCES

GRAHAME, J. & P.J. MILL, 1989. *J. mar. Biol. Ass., UK.*, 69 : 837-855.

GRAHAME, J. & P.J. MILL, 1992. *Proc. Third Int. Symp. Littorinid Biology* (eds J. Grahame, P.J. Mill & D.G. Reid), 99-106.

GRAHAME, J., P.J. MILL & A.C. BROWN, 1990. *Hydrobiologia*, 193 : 223-231.

New perspectives on sensitivity of littorinids to TBT pollution

J.Oehlmann[1], S. Liebe, B. Watermann[2], E. Stroben[1], P. Fioroni[1] and U. Deutsch[1]

1) Institut fur Spezielle Zoologie und Vergleichende Embryologie der Universität Münster, Hüfferstraße 1, D-48149 Münster, and 2) LimnoMar, Wulfsdorfer Weg 200, D-22926 Ahrensburg

In a basic study of tributyltin (TBT) effects along the German North Sea coast between Emden and Cuxhaven we have analysed 11 *Littorina littorea* populations suffering from different TBT exposure (range of TBT body burden : 151-1289 µg as Sn/kg dry wt.). Especially in direct proximity to marinas and harbours TBT concentrations in edible winkles increase and females exhibit malformations of the pallial oviduct. Contrary to TBT induced imposex development (= "imposed sex", superimposition of male sex organs on females) in other prosobranch species (for review Fioroni *et al.*, 1991) this phenomenon was termed "intersex" and can be described by a scheme with 5 different stages. From stage 0 (normal female) to stage 1 (bursa copulatrix split ventrally), 2 (entire pallial oviduct split ventrally), 3 (prostate gland instead of the capsule/covering gland complex) and 4 (as stage 3 but with penis and sperm groove) a gradual transformation of the pallial oviduct into the corresponding male structures occurs.

It seems highly improbable that the reproductive performance of *Littorina littorea*