

in general being ammoniotelic and terrestrial species ureotelic or uricotelic. (Delaunay, 1931, Needham, 1935). However, apparently all gastropods accumulate uric acid to some degree (Duerr, 1967). Uric acid may be retained for long periods before being voided, or may even be retained indefinitely in a kidney of accumulation (Potts, 1967, Wilbur, 1983).

The position of littoral molluscs with regard to nitrogen excretion may be thought of as intermediate between land and aquatic snails ; prosobranch species that live high in the intertidal zone contain more uric acid than those species from lower down (Potts, 1967, Needham, 1938). However, I am not aware of previous studies *within* species of uric acid variation related to position on the shore.

Littorina saxatilis and *L. arcana* collected from a boulder field low in the intertidal zone had a uric acid concentration significantly higher than snails collected from nearby cliff crevices that were at the upper limit of their range. Xanthine dehydrogenase activity also differed between animals from the two sites in the same manner as did the uric acid concentration, indicating that the higher levels of uric acid are not due merely to accumulation, but also at least in part to increased synthesis. The absolute concentrations of uric acid varied with different collections, suggesting a possible seasonal fluctuation in uric acid. *L. arcana* had a greater concentration of uric acid than *L. saxatilis* when both were from the boulder field, but the two did not differ significantly when taken from crevices.

Samples from the two sites were marked and translocated ; by four weeks the translocated animals showed a tendency to develop a uric acid concentration similar to that of natives of the site, indicating a physiological adjustment rather than a genetic adaptation. Although the crevice-dwelling animals are higher in the intertidal zone, it is suggested that they are in fact less subject to dessication and that the higher uric acid concentration of boulder field snails reflects a water conservation mechanism that is not required in the crevices.

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TBT concentrations in coastal waters determined by the degree of imposex in different prosobranch species

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Tributyltin (TBT) is a very effective biocide in various formulations (Hall & Pinkney, 1985). Especially its use in marine antifouling paints has an adverse impact on nontarget organisms and led to a ban of TBT based paints in several countries (Huggett *et al.*, 1992). Because the analysis of organotin compounds in water and tissue is rather time consumptive and expensive there is an urgent demand for a more simple but reliable method to

assess the TBT pollution in the environment. Under the variety of pathological conditions produced by this biocide in animals at relatively low concentrations, none rivals that of the imposex phenomenon in prosobranch gastropods speaking in terms of sensitivity. Imposex or pseudohermaphroditism is characterized by the superimposition of male sex characters (penis, vas deferens and/or prostate) on females and is induced by concentrations as low as 0.5 ng TBT as Sn/l. The final point of imposex development is a sterilization of females by malformations of the pallial oviduct with resulting reproductive failure or even a protogyne sex change in very sensitive species (Floroni *et al.*, 1991).

The degree of imposex in a population can be determined by different biomonitoring indices. The average female penis length and the vas deferens sequence (VDS) index, calculated as the mean imposex stage of a population, proved to be the best and most valid indices (Floroni *et al.*, 1991). Because imposex development is initiated by TBT in a time and concentration dependent manner, also the TBT pollution of a coastal region can be assessed by analysing the imposex levels of different species in this area. The imposex development in dependence of ambient TBT concentrations has been calibrated for various prosobranchs (Oehlmann *et al.*, 1991, 1992 ; Stroben *et al.*, 1992a-c). As a result scales were obtained which allow to calculate the TBT pollution of the coastal environment basing on imposex intensities in populations of six different species (*Trivia arctica*, *T. monacha*, *Nucella lapillus*, *Ocenebra erinacea*, *Hinia reticulata* and *H. incrassata*).

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Tide level preference of *Littorina brevicula* in relation to its reproduction

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Littorina brevicula is one of the most common snails found in the upper intertidal zone of Japan. Its reproductive season is winter and it produces pelagic egg capsules by the late winter (Kojima, 1957). In Amakusa, Japan, *L. brevicula* shows a behavioral dimorphism on seasonal migration. Some part of the snails migrate to the lower zone in the winter, while the others stay in the upper zone (Takada, 1992). Thus, the population of *L. brevicula* is divided into two sub-populations during its reproductive season. These facts leads to a hypothesis that the behavior of migration is genetically controlled and it is ensured by the reproductive isolation between the two sub-populations.

In order to test this hypothesis, the following three points were investigated ; 1) consistency of migration behavior, 2) tide level preference, and 3) schedule of migration and