The influence of sediment-ingesting animals on carbon cycling

PhD project 2010

Supervisors: Prof. G. Wolff, Dr. L. Robinson & Prof. P. Thorne (Proudman Oceanography Laboratory)

Motivation

Sediment processing by invertebrates living within or on the sea floor is known as bioturbation. This important process is well described (e.g. Meysman et al., 2006), but its influence on carbon cycling itself is much more poorly understood (Levin et al., 1997). For instance, while sediment grains probably pass through invertebrates many times during their burial, they nonetheless retain an organic carbon signature. This implies that the material is not, and perhaps cannot be broken down, even by animals that feed on the most recalcitrant material, for example the common lug worm, Arenicola marina (e.g. Banta et al., 1999). A better understanding of the processes underlying the cycling of matter in ecosystems dominated by bioturbators is required. This will help underpin our understanding of the role of particular functional groups in driving overall ecosystem processes.

Figure: Arenicola marina, the common lugworm.

Specific Objectives

The PhD student will study the turnover of carbon by the marine benthos by using an experimental mesocosm approach, mimicking the sedimentary environment. Specifically, they will study:

1. The turnover rates of individual components of sedimentary organic matter, i.e. proteins, carbohydrates, lipids etc.
2. The influence of the bioturbating organisms on the turnover rates of organic matter components
3. The degree of assimilation vs. catabolism of organic matter by the bioturbating organisms
4. The formation of “unreactive” organic matter associated with the mineral matrix.

Approach

Isotopically labelled food materials will be introduced to single and multi-species experiments in order to track the fate of carbon, at the bulk and molecular level. Mesocosms will initially be small scale, but a new large-scale facility to be built by the School of Biological Sciences could allow scaling up to a more realistic “ecosystem” approach. The student will thus investigate the extent to and the rates at which carbon is partitioned between the different microbial and animal groups, versus that which it is remineralised or ends up being associated with the sediment particles.

The student will receive training in biological, organic, inorganic and isotopic geochemical techniques. A highly innovative part of the project will be in using acoustic techniques to develop a direct measurement of the rate of bioturbation and the extent of sediment processing. The student will participate in the training programme of the Department and University. Development of transferable skills will be encouraged through attendance of national and international meetings and participation in Departmental seminar and workshop programmes.

Publications relevant to the research area

- Meysman, Filip J. R., Middelburg, Jack J., Heip, Carlo H. R. (2006) Bioturbation: a fresh look at Darwin's last idea. Trends in Ecology & Evolution 21: 688-695
- Levin L, Blair N, DeMaster D, et al. (1977) Rapid subduction of organic matter by maldanid polychaetes on the North Carolina slope. Journal of Marine Research 55: 595-611
- Banta GT, Holmer M, Jensen MH, et al. (1999) Effects of two polychaete worms, Nereis diversicolor and Arenicola marina, on aerobic and anaerobic decomposition in a sandy marine sediment. Aquatic Microbial Ecology 19: 189-204.