The prevalence of methane subsidies to river food webs

(Supervisors: Hildrew, Woodward, Trimmer & Grey)

Rationale: Recent evidence has emerged of significant methane-derived carbon subsidy in the R Lambourn (Trimmer et al 2009), a species rich chalk river in southern England. This finding, if applicable to other systems, could revolutionise how we view nutrient cycling and flux through river food webs. At present, however, we have few data from other systems on the extent, ubiquity, and magnitude of methane-derived carbon inputs and their uptake by the biota. Cased caddis (Trichoptera) larvae, which are dominant members of many river food webs, were among the taxa that showed strong depletion in isotope ratios associated with heavy reliance on methane-derived carbon as the basis of their biomass production – and *Agapetus* and *Silo* spp. were particularly ^{13}C-depleted.

Above (left) a classic English chalk river with *Ranunculus* spp.; and (right) the experimental stream channels at the FBA, Dorset

Our central hypothesis is that these species could be using this novel carbon source in a wide range of other rivers, and given that they can reach exceptionally high numbers, the magnitude of the subsidy within these food webs as a whole could be substantial.

We need to address three main questions:
1 *How widespread is the phenomenon of extreme ^{13}C-depletion among consumers associated with methane-derived carbon inputs and how does this track methane concentration in rivers?*

2 *Are cased caddis in general, especially members of the Limnephilidae, Glossosomatidae & Goeridae, exploiting this carbon source to a greater extent than other taxa, as suggested from the Lambourn data?*

3 *Can we measure the extent to which secondary production in the field is enhanced by this alternative carbon resource?*

Methods
*1 Empirical spatiotemporal surveys***:** we will survey 30 rivers (10 each from limestone, chalk, and sandstone geology) where these taxa are prominent, in order to quantify the role of dissolved methane in the food web using a combination of stable isotopes and more traditional community and ecosystem based approaches. The extensive survey across multiple sites focussing on gravel habitats will be

carried out on a single occasion, and will be complemented with more intensive monthly sampling at a subset of 9 focal sites (3 per geology type), which will be identified using data from the main survey.

We will quantify methane concentrations in both pore water and overlying water using replicated sampling with mini-piezometers and headspace concentrations of methane will be calculated from peak areas calibrated against known standards and the total amount of methane n a gas-tight vial (headspace plus water, after Trimmer et al 2009). Gas will also be retained for stable isotope analysis. We will quantify benthic invertebrate abundance using 5 replicate Surber samples (25cm x 25cm; 330μm mesh aperture) per site per date (after Woodward et al 2005), which will be frozen immediately in the field using a 60L Engel portable freezer. These will be supplemented with additional individuals collected by hand, prepared and analysed for $\delta^{13}C$, and the proportion of methane-derived carbon subsidy estimated after Trimmer et al 2009b.

2 Secondary production estimates:
We will measure secondary production of our focal cased caddis taxa using the size-frequency method (e.g. Benke et al 2001; Woodward et al 2005) in the 9 sites targeted for more intensive temporal sampling, to measure the contribution of methane-derived carbon to consumer biomass production.

This studentship is aligned to the NERC project NE/H02235X/1 '*Manipulating the chemosynthetic and photosynthetic support of river food webs'* awarded to Grey, which seeks to: quantify the relative importance of chemosynthetic versus photosynthetic production at the base of the food-web and how that propagates to primary consumers; the importance of density dependence upon the strength of any methane-derived carbon subsidy; the wider ecological significance of such a subsidy in terms of fitness; and how methane cycling might affect the whole food web via feedback of isotopically light CO_2. The work of a PDRA will be experimentally based at the FBA River Lab in Dorset.

The Project Student will assess how common a phenomenon this is across a range of river systems throughout the UK via a field survey and focus more on the affect of methane subsidies to secondary production, and thus contributes to the wider ecological significance of chemosynthetic production.

The student will receive training in experimental design, field ecology, invertebrate taxonomy, and state-of-the-art stable isotope analyses and gas chromatography. They will acquire skills in statistics and report writing, and become part of an active research environment.

Applications are invited from candidates with, or expecting to be awarded, at least an upper-second class honours degree in an area relevant to the project. To apply, please complete an online application form via the following link:

http://www.sbcs.qmul.ac.uk/prospectivestudents/research/howtoapply/index.html