

Explaining abundance-occupancy relationships in specialists and generalists: a case study on aquatic macroinvertebrates in standing waters

Wilco C.E.P. Verberk^{1,3,*}, Gerard van der Velde^{2,3} and Hans Esselink^{3,1†}

¹*Department of Animal Ecology and Ecophysiology, Institute for Wetland and Water Research, Radboud University Nijmegen, Heijendaalseweg 135, 6525 AJ Nijmegen, The Netherlands;* ²*National Natural History Museum Naturalis, P.O. Box 9517, 2300 RA Leiden, The Netherlands;* ³*Bargerveen Foundation, Radboud University Nijmegen, P.O. Box 9010, 6500 GL Nijmegen.*

Summary

1. A positive interspecific abundance-occupancy relationship is one of the most robust patterns in macroecology. Yet, the mechanisms driving this pattern are poorly understood. Here we use biological traits of freshwater macroinvertebrates to gain a mechanistic understanding and disentangle the various explanations. We ask if mechanisms underlying the abundance-occupancy relationship differ between species and whether information on individual species can be used to explain their contribution to the interspecific relationship.

2. We test the hypothesis that the importance of metapopulation dynamics or niche differences in explaining the relationship differs between species, varying in relation to habitat breadth. In addition, we analyse how a species' biological traits shape its habitat breadth and its abundance and occupancy.

3. The abundance and occupancy of the 234 different aquatic macroinvertebrate species were strongly and positively related. Marked differences were found between habitat specialists and habitat generalists in the goodness of fit of abundance-occupancy relationships. The occupancy frequency distribution was bimodal for habitat generalist, allowing 'satellite species' to be distinguished from 'core species'.

4. Habitat generalist appeared to be more widespread but less abundant than habitat specialists, suggesting that the jack-of-all-trades may be master-of-none. Species traits (trophic position and other life-history traits) explained a significant part of the variation around the general relationship. Among habitat specialists, more species showed synchronised life cycles, a low dispersal capacity or clustered oviposition, being better adapted to predictable habitats. Among habitat generalists, more species had long-lived adults, spreading reproductive effort in time and space, and were strong dispersers, being better adapted to unpredictable habitats.

5. Interspecific abundance-occupancy relationships can be best understood by examining the contribution of individual species. For habitat specialists, the interplay between niche differences (diet and habitat use) and the underlying spatial distribution of environmental conditions result in competitive displacement and differences in species' success. For habitat generalists, differences in colonisation and extinction rates between species are more important. Therefore, both metapopulation dynamics and niche differences can operate simultaneously but apply to different species, thus constituting different endpoints of the same continuum.

Keywords: Aggregation; Aquatic insects; Biological traits; Causal mechanisms; Core-satellite hypothesis; Dispersal; Density; Distribution; Niche breadth; Macroecology; Metapopulation dynamics; Range; Reproduction

*Corresponding author: Dr. Wilco C.E.P. Verberk (wilco@aquaticceology.nl)

† Deceased 30 August 2008

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Verberk WCEP, van der Velde G & Esselink H (2010) Explaining abundance-occupancy relationships in specialists and generalists: a case study on aquatic macroinvertebrates in standing waters. *Journal of Animal Ecology* 79: 589-601. <http://www3.interscience.wiley.com/journal/123295266/abstract>