Biodiversity and conservation of Diptera in heterogeneous land mosaics: A fly’s eye view

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Abstract

Classical landscape ecology views spatial heterogeneity of habitats at relatively large ‘human scales’, and it is at such scales that most decisions of land management and nature conservation are made. The present paper makes use of a wider range of spatial scales to examine land mosaics from the ‘fly point of view’. Taking examples from the Diptera faunas of mountainous land mosaics, it is demonstrated that: (i) large scale, ‘patch content’ landscape management has a direct bearing on Diptera community structure, (ii) borders between large scale patches are not necessarily perceived by flies (or other insects) in the same way as we perceive them, (iii) border complexity between patches at any scale may be as important as patch content as an axis of habitat definition. In this sense, ‘border’ is not to be confused with ‘edge effects’. It is concluded that attention to both patch content and patch border complexity of land mosaics, viewed at the relevant spatial scales, is necessary for future successful conservation of Diptera biodiversity and for the efficient use of these insects in environmental assessment studies.

Introduction

Spatial heterogeneity is a characteristic of our world – we live within mosaics of patches. These patches vary in content and their borders may be clear or fuzzy, straight or wiggly. Study of ecological patterns and processes in relation to such spatial heterogeneity is the basis of ‘landscape ecology’, which is classically ‘large scale’ and views an area or ‘landscape’ as discrete patches of particular habitat types, sometimes linked by ‘corridors’ of the same habitat, enveloped in a ‘matrix’ of different, but otherwise rather undefined ground cover. This is the normal human perception and definition of landscape ecology that arose within the realms of geography and botany and that has become the template for land planners and managers armed with Geographical Information Systems and satellite images. (e.g., see Forman 1995; Haslett 1996). It is therefore hardly surprising that most land management and conservation decisions are made at this level. However, for many organisms, including Diptera and other insects, this approach is often inappropriate, and causes considerable problems in the field of insect conservation biology.

The problems arise from a variety of sources. First, there are the ecological requirements of the organisms. In landscape ecology this translates as the set of conditions and resources present within each of the patches of a mosaic. Thus ‘patch content’ dictates where the animals are most likely to be found, and echoes the traditional entomological view of a ‘patch of habitat’ (e.g., Collins and Thomas 1991; Samways 1994). Second, there is the spatial scale of the landscape mosaic. Here, the situation begins to become complicated, because there is not just a single mosaic within an area, but an almost infinite series of them nested within different spatial scales. We have little idea as to how organisms other than ourselves perceive and react to patterns of spatial heterogeneity over their own ranges of scales (Haslett 1994a). The problem is particularly relevant when considering insects such as flies, which, as adults, have small body size, but which are...
at the same time extremely mobile. Thus they use and travel through mosaics at a variety of spatial scales. This is in stark contrast to the larvae, which are much less agile and are usually confined to their own microcosm ‘landscapes’. Third, the complexity of boundaries between patches in any particular mosaic may have important influences. This does not refer to ‘edge effects’ (edges as ‘areas’ of transition), but rather to the complexity of the edges themselves as lines, as defined at any particular spatial scale.

All this implies that observed patterns of biodiversity of the Diptera (and other insects) are closely linked to the form of the habitat mosaic at different, relevant spatial scales. This means that to be effective, conservation and land management strategies must also consider the ‘fly’s eye view’ of the landscape.

The relevance of some aspects of habitat mosaics and scale that are central to Diptera biodiversity and conservation are illustrated in this paper. Specific examples from studies undertaken in and around the German and Austrian Alps have been used. Reference to a mountain region is particularly useful in this instance because of the exceptionally high complexity of mountain landscape mosaics over a wide range of spatial scales (Haslett 1994b). Although many of the arguments presented below have already been published elsewhere, in a variety of contexts (references are given in the appropriate sections of the text), the focus here is on the Diptera, to underline the importance of this group in the practicalities of biodiversity conservation and environmental assessment.

**Flies in human-scale landscape mosaics**

*Patch content and land use: Sciomyzidae assemblages in the Salzach valley*

Sciomyzid flies, because of their specialist parasitic associations with snails (see Vala 1989), are extremely useful descriptors of riparian habitats. As part of a large, multi-disciplinary Environmental Assessment study, samples of adult sciomyzids were taken from 26 sites in various habitats representing different types of land use and management along a 70 km stretch of the River Salzach on the northern edge of the Austrian Alps, near Salzburg (Haslett, unpublished report). A total of 22 species were collected, and the site/relative abundance data were subjected to TWINSPLAN cluster analysis (Hill 1979). The resulting dendrogram of site clusters is shown in Figure 1A. It reveals a gradation of site groups from old, dry woodlands (Group I) to woodland/meadow mosaics with increasing degrees of wetness (Groups II–IV), to strongly human-influenced, early successional wetland and river edge (Groups V and VI). This gradient is also reflected in the proportions of sciomyzid species with different life strategies (Figure 1B); from those whose larvae are primarily associated only with terrestrial snails to those with aquatic or terrestrial snail associations, to those that are parasitic only on aquatic molluscs (Vala 1989).

These results proved extremely helpful to the Environmental Assessment Exercise concerned, but more relevant here, they illustrate that Diptera species assemblages and the relative abundances of individuals may indeed be used to characterise habitat mosaics, and are sensitive to variations in human land use and management. This emphasises the classical ‘patch content’ approach to land mosaics at large, human scales and endorses its validity under certain circumstances.