

Severing the Web: Changing Biodiversity in Converted Northern Temperate Ancient Coastal Rainforests

This paper describes differences in arthropod community structure and diversity between ancient forest and regenerating coniferous forests in the Upper Carmanah Valley on Vancouver Island, British Columbia.

Within the canopies of five ancient Sitka spruce (*Picea sitchensis*) trees, arthropods associated with branches were collected by cutting 270 branches over six time intervals; contents were examined in the laboratory where 1,268 individuals were enumerated and assigned to feeding guilds. Arthropods associated with the branches in the canopy were dominated by individuals in the phytophagous, predator, and parasitoid guilds (Table 1). Numerical dominance of functional groups in this study supports previous findings from deciduous forests by Schowalter and Crossley (1987) and coniferous forests by Schowalter (1989, 1995). Individual trees and seasonality both contributed significantly to the proportional structuring of the phytophagous and predator guilds. Vertical partitioning was not a significant factor in guild proportionality. The documentation of high predator loading in a structurally and functionally diverse ecosystem such as ancient forest canopies is in agreement with results from my current canopy

studies in three coniferous forests on Vancouver Island, and is in concert with previous studies that support observations on reduced herbivory in mature, structurally complex forests (see Stork et al. 1997). I suggest that ancient forests provide a unique habitat template (sensu Southwood 1996) and that such a template is important for examining questions about the maintenance of biodiversity in forest ecosystems.

Using replicated 5-cm deep cores of moss/soil mats and Malaise traps, I collected samples from the interior of an ancient Sitka spruce forest, from the transition zone (edge between ancient forest and clearcut), and from a clearcut (6 years old). For the interior, the canopies of two ancient Sitka spruce trees and the ground below the trees were sampled while only the ground was sampled in the transition and clearcut sites. At all sites, samples were taken bi-weekly throughout the growing season. I recorded 71 species of Oribatida (2,117 specimens), representing 51 genera and 34 families. Taxonomic distinctness was most pronounced in the canopy moss/soil mats where oribatid mites are members of a distinct arboreal community that is not just a random subset of the ground fauna. Comparisons between the high-canopy and three ground sites indicated that, overall, species percent similarity was low (Figure 1). Respectively, 30 and 28 species of oribatids were recorded from the two canopy sites, of which 12 species are canopy specific. Species exhibiting strict arboreal specificity are all in the Brachyphlina, i.e. from the families Thyrisomidae, Damaeidae, Eremaeidae, Oripodidae, Gymnodamaeidae, Oppiidae, Peloppiidae, Galumnatidae, and Cymbaeremaeidae. I also randomly selected ten trees bi-monthly from adjacent 10-, 40-, and 80-year-old second-growth sites. Canopy moss/soil mats could not be sampled as they were not present in any of the trees and therefore all oribatid mites associated with ancient forest suspended moss/soil mats were absent. I consider oribatids

TABLE 1. Guild structure of the arthropod fauna collected from the branch clipping program. Data for tree, time, and height were pooled and expressed as the percentage of mean number of individuals per kilogram of dry plant material. All samples were collected in 1991 from the Upper Carmanah Valley, British Columbia (total number of individuals=1268).

GUILD	PERCENTAGES
Phytophages	41.3
Predators	37.2
Parasitoids	11.8
Epiphyte fauna	8.3
Scavengers	0.1
Tourists	0.4

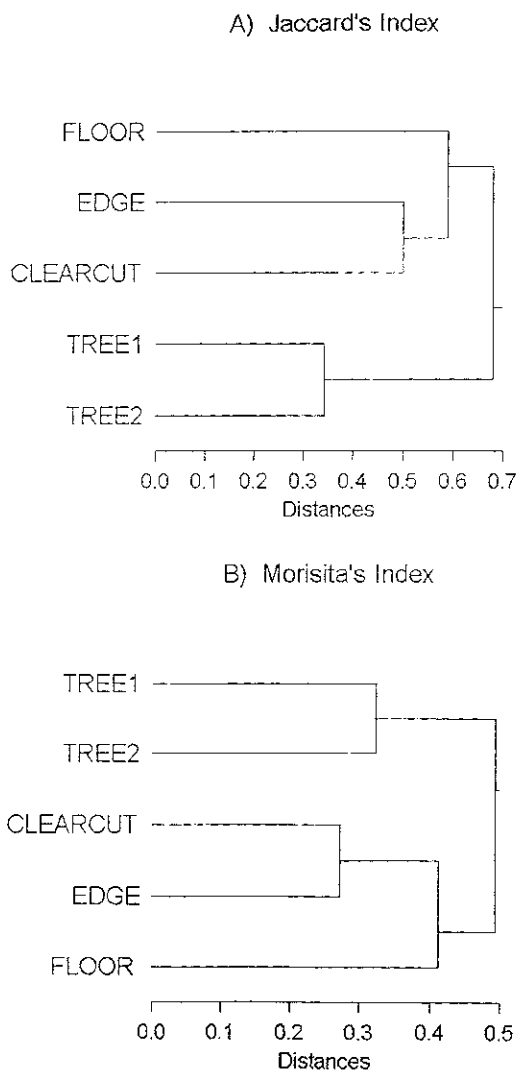


Figure 1. Dendrograms showing percent dissimilarity between oribatid mites found at five sample sites in the Upper Carmanah Valley. Data are pooled from all core samples (120) collected over six monthly sample times, May-October 1991. Jaccard's similarity values were calculated from the number of identified species of oribatids collected at each site, and Morisita's similarity values were calculated from the number of individuals in each identified oribatid species collected at each site.

of the ancient forest canopy to be inhabitants of islands, in the sense that they are isolated from their ground counterparts, do not occur in second-growth forests, and have a distinct fauna that is characterized by two ecological groups of spe-

cies: wandering species with high dispersal capabilities, and arboreal species with low dispersal capabilities. I suggest that oribatid mites can be used as a surrogate for other ancient forest soil microarthropods, and predict that arboreal specificity will also be pronounced in these taxa.

I examined features related to the Centinelan extinction concept (extinction of species unknown before their demise and hence unrecorded) (see Winchester and Ring 1996), and asked whether or not this is applicable to northern temperate ancient forest arthropods. Examination of identified arthropod species (1900 to date) indicates that the structurally complex habitat in ancient forests acts as a reservoir for biological diversity. Of particular importance to the maintenance of arthropod biodiversity is the documentation of those species that are new to science or species that are restricted to habitats found only in ancient forests. The new species so far recorded (approx. 300) represent a contribution towards categorizing the endemic arthropod fauna of this ancient forest. None of these was collected from adjacent second-growth stands of varying ages (10-40 years old). I expect that, with continued taxonomic resolution, this list of undescribed species that are restricted to ancient forest will increase significantly. Specific examples include *Hypogastrura arborea*, *Anaclilaea vallis*, *A. winchester*, *Cinara n. sp.*, and *Miniliomosina sitka*.

Habitat specificity is well documented for the oribatid mites (Behan-Pelletier and Winchester in press; Winchester 1997a, 1997b; Winchester and Ring 1996) and for the staphylinid beetles where I have documented eight new species of Omaliinae which appear to rely on ancient forests as a source area to maintain reproductively viable subpopulations (Campbell and Winchester 1993). I suggest that continued harvesting of ancient forests without adequate knowledge of the arthropod fauna these forests contain means that some are candidates for the Centinelan extinction concept.

In summary, the patterns of biodiversity in the terrestrial arthropod communities of Pacific Northwest forests remains largely unstudied. Ancient forests provide important ground habitats including a supply of over-mature, fallen logs that are allowed to decay under natural conditions in the shade of the forest canopy, deep layers of undisturbed forest floor litter that have not been

eradicated by the extreme conditions of clearcuts and the subsequent exposure to desiccation and erosion.

Microhabitats associated with the canopy of ancient forests are not replicated in any second-growth canopies that I have surveyed to date (approx. 1000 trees) and it is unlikely that these habitat features will develop in second-growth forests that are in an 80-120-year rotation. I suggest that there are enough differences in ancient forest canopy microhabitat conditions to promote the development of taxonomically discrete species assemblages. Such assemblages will be lost if these canopy habitats are not retained or allowed to develop in second-growth forests.

Forest conversion affects arthropod diversity by altering key patterns of natural processes that are inseparably linked with forest structure, and function and historical events. Summarizing these key patterns and documentation of changes due to disturbances should identify ecological roles of arthropods that are at the heart of the biodiversity challenge. These components must be addressed if the issues that surround sustainable forestry and

the maintenance of biological diversity (form and function) in ancient and converted forests are to be seriously considered.

Acknowledgements

The study of arthropod biodiversity in ancient temperate forest incorporates several ideas and talents. I acknowledge with thanks the Western Canada Wilderness Committee who made available the research facility and the fixed canopy access system in the Upper Carmanah Valley. Field work was supported by FRDA research grants from the BC Ministry of Forests, Research Branch. Acknowledgement is made to A. MacKinnon and B. Nyberg of that Branch for their continued support. I am indebted to numerous taxonomic experts for identifications and the continued advice that they provide for my canopy projects. I also thank the many research assistants, lab technicians, and climbers who have generously contributed large amounts of time to this project. Finally, to my colleague, Dr. R.A. Ring, a special thanks for your continued support and involvement in all aspects of the canopy work.

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