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Translating Knowledge into Actions

Tree hole aquatic habitat: a model for ecological experiments

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Letter to Editor

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An ecosystem is a complex entity with several interacting components. Ecologists face problems of devising appropriate research design to understand complexity of ecosystem. It requires a realistic model to test the ecological theories. A large landscape is too big and too complex to conduct a good scientific research. Therefore, research experiments that miniature large ecosystems are often recommended to make a realistic prediction of ecosystem process. Natural small scale habitats such as tree hole aquatic habitats provide basic features of a large aquatic ecosystem and offer several methodological advantages over lakes, streams, and other comparatively large systems (e.g. Maguire 1971). First, tree holes can be treated as individual units for sampling. Second, they are rich in species diversity and abundance, mainly those of insects (e.g. Kitching 2000). Third, water-filled tree holes are the most tractable small aquatic systems, partly because they are relatively persistent, and can be mimicked with plastic cups, bamboo sections, or other inexpensive materials. Furthermore, tree holes have a defined boundary and size. In such habitats, both biotic condition (e.g., predation) and abiotic condition (physio-chemical characteristics) vary greatly, which makes them easily colonized by specialized communities starting from autotrophic fungi to predaceous amphibians (Yanoviak 1999).

Tree holes have short period for community colonization/generation and therefore they can be manipulated the energy source. They have a definitive ecosystem boundary. Laboratory microcosm has the limited overgeneralization potential of the ecosystem (Carpenter et al. 1998, Srivastava et al. 2004) (**Figure 1**). Tree hole habitats are similar to artificial one such as plastic containers that can maintain natural conditions by accumulating rain water and fallen leaf litter. The heterotrophic community in such habitats is easily manageable and mimics natural realism — the two main characteristics required for experimenting model ecosystems.

The tree hole aquatic ecosystem can be a model to test two principle ecological mechanisms: complementarity and selection (Loreau and Hector 2001). The 'complementarity mechanism'

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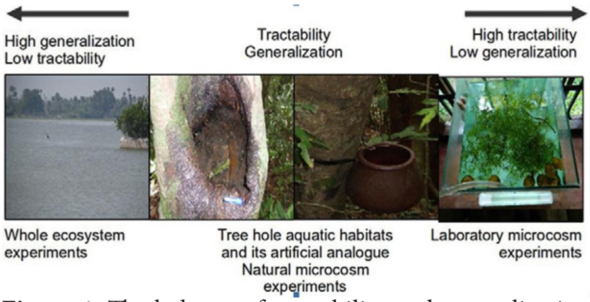

Figure 1: The balance of tractability and generalization in the tree hole aquatic habitat

explains that species rich systems use more resources and are more productive. It is because each species uses slightly different resources and overall species richness contributes for ecosystem productivity. 'Selection mechanism' explains that there is a variation between individual species in its ability to utilize resource, and certain species is more productive than others. Thus, productivity is the average contribution of each species. It is assumed that both these mechanisms are interplaying to improve ecosystem function (Loreau 2000). Bell et al. (2005) found that bacterial diversity was crucial for ecological functioning in tree hole aquatic habitats. Here bacterial diversity was negatively associated with 'respiration - an ecosystem service'. This study showed that influence of bacterial species richness and composition was more important than selection mechanism for ecosystem functioning in the bacterial community.

Pimm et al. (1991) showed that structure of a food web depends on availability of energy and dynamic constrains. Local dynamic constraint refers to variability of food web characteristics (e.g. length of food chain) in various ecosystems due to differences in environmental factors. Accordingly, the shorter the food chains the more stable an ecosystem would be (Pimm and Lawton 1977). Such hypotheses can be tested by performing experiments in the tree hole aquatic habitats. Jenkins et al. (1992) demonstrated influence of dynamic constraints on food web by using artificial analogues of tree hole aquatic habitat. In this study, they lowered temporal food web dynamics during low rainfall in an experimental container, and found that lowering had the most pronounced effect on the most productive habitats. This experiment gave an evidence for the support of dynamic constraint. Diverse communities are expected to have less temporal variability in biomass than species-poor counterparts (Odum 1971). However, experiment on the tree hole habitat is not sufficient to test "more individual hypothesis" (i.e., more productivity results in higher abundance, and species richness is a function of abundance - Srivastava and Lawton 1998) because theory governing species-productivity relationship is complex and it fails to consider the colonization, extinction pattern and size variability of inhabitants in the tree hole habitat.

Tree hole aquatic habitat is an ideal place to assess impacts of anthropogenic pressures on ecosystem (Taub et al. 1997). Several authors (e.g., Paradise and Dunson 1997, Paradise and Kuhn 1999), for example, tested effect of acidic deposition on tree hole communities and found that the biota of tree hole habitat is differentially affected by acidic deposition. The low pH was found to have a determinant role on the growth of certain key inhabitants and on community interactions by affecting the process of chain commensalisms that occur in tree hole aquatic habitat. Therefore, tree hole habitats have been used as a bio-indicator of forest ecosystem to test acidic deposition. Furthermore, temporary waters such as tree hole aquatic habitats, in general, are ideal ecosystem unit to study species adapted in the highly variable environments. A subtle change in the water quality such as pH may affect largely on the species emergence structure, especially the Odonate larvae, a known predator, which could influence the entire population. It is therefore concluded that tree hole aquatic habitats can be used for several ecological experiments that mimic large natural ecosystems.

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Biography

Dr. K.S. Anoop Das is an Assistant Professor at MES Mampad College, Kerala. He studies on climate change, sacred groves, functional diversity and the visual ecology of birds and butterflies.

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