Bromeliads (Bromeliaceae) are a characteristic component of Neotropical forests. Found from ground level to high in the canopy, they contribute significantly to the habitat complexity of Neotropical forests (Benzing, 2000), in particular for invertebrates. Bromeliads in a large subset of the family, called tank bromeliads, are capable of holding considerable quantities of water in their leaf axils, creating aquatic habitats that are inhabited by aquatic invertebrate communities (Fish, 1976; Greeney, 2001; Frank and Lounibos, 2009). Tank bromeliads can occur in high densities, and, based on their three-dimensional distribution in forests, may be the phytotelm (plant-held water body) habitat occurring in the highest densities anywhere. For example, Sugden and Robins (1979) recorded a mean density of 17.5 plants per square metre of ground area in a cloud forest in Colombia. If the volume of water retained per plant is on average of the order of 100 cm³, then such densities translate into tens of thousands of litres of water available for colonization by aquatic animals, per hectare. In the absence of other lentic water bodies, as is often the case in mountainous tropical forest areas, phytotelm habitats provide an important freshwater habitat. The profusion of bromeliads, and their use as breeding habitats by vectors for human diseases such as malaria and dengue, render bromeliads important from a range of perspectives. In addition, bromeliads represent self-contained aquatic communities, present naturally and at high replication, making them potentially valuable as a study system for tackling prominent ecological and evolutionary questions (Srivastava et al., 2004). The well-defined aquatic communities occurring in clusters are highly suitable for studying metacommunity dynamics (Leibold et al., 2004).
Further, bromeliads can be effectively imitated by artificial containers (Srivastava, 2006). These features allow easy manipulation and great flexibility in research design.

Despite the great advantages conferred by tank bromeliads, knowledge of their aquatic invertebrate communities, and what structures them, remains limited—even though research on aquatic invertebrates in phytotelmata dates back at least to 1915 (Picado, 1915; see also Laessle, 1961; Maguire, 1971; Frank and Lounibos, 1983; Kitching, 2000). Most studies on aquatic invertebrates in bromeliads to date have focused on cataloguing species not previously known in phytotelmata (e.g. Mendes et al., 2011). Recently, however, ecological studies have started to contribute to the understanding of this habitat (e.g., Armbruster et al., 2002, Jabiol et al., 2009; Brouard et al., 2011). Some studies point towards the importance of light and organic material (a proxy for productivity; Srivastava et al., 2008) in influencing community assembly (e.g. Dezerald et al., 2013). Habitat complexity, measured as the number of leaves, affects the whole invertebrate system (Armbruster et al., 2002). Most of these observations are based on descriptive data to gain insight in these habitats. For a sound understanding of how environmental factors (patch characteristics) affect the colonization rates and to determine how post colonization processes interact to shape communities, an experimental or manipulative approach in the field is needed (Kraus and Vonesh 2010).

In this project the student will, through a combination of bromeliad sampling and experimental set-ups, investigate the effect of selected factors on community structure and diversity patterns in aquatic microcosms. For this, artificial phytotelmata (plastic containers) will be mounted on trees in a cloud forest in Honduras. Phytotelmata are ephemeral habitat patches and the required high colonisation rate in these systems lends itself perfectly for colonization and community assembly experiments. The well defined habitat patches and enclosed communities provide an excellent system for metacommunity studies and more specifically habitat selection studies (e.g. Kneitel & Miller 2003). Bromeliad communities are often locally abundant, small, well defined and can easily be manipulated experimentally. The high colonisation dynamics in these systems make it a valuable tool for short term (6-8 week) projects. The wide environmental range in which bromeliads are found, mean a lot of variability. This variability combined with the flexibility that goes with the placement of artificial bromeliads offers considerable opportunities to test specific hypotheses. This project departs from the metacommunity concept (Leibold et al. 2004), and evaluates how alfa (in one bromeliad), beta (in between bromeliads) and gamma (in a cluster of bromeliads)
diversity are influenced by selected factors. The student is stimulated to come up with own hypotheses to test. A wide range of classic ecological and biogeographic diversity relationships such as species richness–altitude, richness–environment, richness–size, richness–habitat complexity and richness–isolation relationships can be tested. In general, the extent to which invertebrate communities in bromeliads are structured by classic ecological and biogeographic rules remains fragmentarily evaluated. In addition to the classic biogeography patterns, environment (often measured as productivity; Field et al., 2009), habitat complexity (Hortal et al., 2009) and altitude (Rahbek, 1995; McCain, 2007) are factors affecting species richness in a wide range of taxa globally. The suggested research direction in this project is, however, towards some current "hot topics" in community ecology regarding dispersal and biotic interactions. Most contemporary ecological and conservation research is placed within a metacommunity framework where individual communities are connected by dispersal (Wilson 1992).

Variation in dispersal frequency is one of the main aspects used to classify natural metacommunities in different conceptual categories of theoretical metacommunity models: mass effects, species sorting, patch dynamics, neutral model (Leibold et al. 2004; Logue et al., 2011) and dispersal is usually assumed random. Resetarits et al. (2005) expanded upon this by highlighting three different situations. First of all, random colonization, assumes that organisms either have no control over their dispersal or disperse actively and settle randomly (no habitat selection). As such, local communities can all interact in the same way with a regional species pool (propagule rain) or dispersal dynamics may be driven by the spatial structure of the system. Secondly, the authors define the extreme habitat selection example of philopatry where organisms only breed in their natal patches. Finally, the concept of Interactive habitat selection is launched where attraction or avoidance of patches is continuously updated taking into account changes in habitat quality and biotic interactions. As such habitat selection refers to a dynamic hierarchical process of behavioral responses that may result in the disproportionate use of certain habitat types to promote survival and fitness of individuals (Jones 2001). The occurrence of habitat selection and in particular multispecies habitat selection has strong ecological consequences for metacommunity dynamics (Binckley and Resetarits 2005) and may generate distinct patterns from random dispersal. The distinct patterns result from individuals actively redistributing over habitat patches compared to individuals dispersing randomly and surviving in the appropriate places. However, the mere thriving of a species in an environmentally defined subset of habitat patches does not
necessarily imply a habitat selection strategy. Patterns like these could be generated by an efficient species sorting process, where the species disperses over all habitat patches and is inhibited in the less favorable environments.

Dispersal is a crucial component in diversity patterns and in current theoretical models (e.g. the metacommunity model), but the empirical data, and in particular quantitative data on dispersal and how it affects diversity patterns and community structure, is still limited. Besides providing quantitative insights in the importance of dispersal on metacommunity structure, this project also feeds in the need for experimental work designed to disentangle the processes underlying the patterns of biodiversity observed in tank-bromeliads (Jabiol et al., 2009) and with the broader aim of understanding whether and how processes operating in these small systems could be extrapolated to larger ecosystems (Srivastava et al. 2004).

References


