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### Multitrophic Interactions within Natural Microcosms: Patterns and Processes

#### Title

Digestive mutualism in *Nepenthes* pitcher plants: role of the 'macrobiota' and its variation among plant species

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#### Abstract (200 words)

Carnivorous *Nepenthes* plants derive essential nutrients from arthropods captured in their pitcher-shaped leaves. The pitchers secrete a digestive fluid and house specific microbiota and 'macrobiota', mostly mosquito larvae, that aid in digestion, breaking the prey down into an easily assimilated form. We tested and measured the occurrence of such facilitation processes among Bornean *Nepenthes*. In a field experiment, prey items were introduced into the fluid of newly open pitchers of four *Nepenthes* species and their state was compared one month later between control pitchers and pitchers initially closed by insect screening mesh. The same experiment was performed in water-filled glasses. Metazoan diversity, tank dimensions and fluid pH were then measured in the 150 tanks.

Prey in macrobiota-deprived pitchers experienced lower degradation than in control pitchers in all *Nepenthes* species but not in water-filled glasses. Macrobiota exclusion impacted less species characterized by narrower pitchers and more acidic fluids. Rate of prey degradation increased significantly with abundance and diversity of inquilines. Therefore, *Nepenthes* pitcher plants are highly dependent on their 'macrobiota' to decompose prey. Such digestive mutualisms are even crucial in species whose pitchers have large aperture and less acidic fluids, housing a more diverse infauna and secreting presumably fewer digestive enzymes.

#### Keywords

Carnivorous pitcher plants; Digestive mutualism; Diptera; Insect diversity; Microcosm; *Nepenthes*; Phytotelmata; Trophic interactions