

Spatiotemporal density patterns of the pest predator *Rhynchium haemorrhoidale* (F.) along a land-use gradient in cacao agroforestry systems

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Abstract Tropical insect species show year-round breeding activity due to favourable climatic conditions. However, most species also display seasonal reproductive peaks, but little is known about underlying causes of temporal density changes. We investigated population dynamics of the pest predator *Rhynchium haemorrhoidale* (F.) (Hymenoptera: Eumenidae) and its natural enemies in relation to season, climate and varying shade tree composition in cacao agroforestry systems in Central Sulawesi (Indonesia). Nesting of *R. haemorrhoidale* showed clear seasonality with highest densities in the wet season and lowest in the dry season, which was not related to changes in temperature. Wasp densities increased with land-use intensity, presumably because less-shaded areas offer more favourable climatic conditions and higher densities of the major prey, the cacao pest *Agathodes caliginosalis* (Lepidoptera: Pyralidae). Pupal body size was higher in June than in November indicating increasing intraspecific competition due to high wasp densities and food shortage at the beginning of the wet season. Body size between habitat types was similar, thus season appeared to be more important than habitat in terms of food supply. High wasp densities in the wet season were associated with high diversity of the altogether seven parasitoid species. In conclusion, we found a pronounced seasonality of the wasp *R. haemorrhoidale* and a preference for little shaded agroforestry, which may be due to enhanced temperature and density of its prey. Our data indicate a high potential for biological control of a major cacao pest by management of nesting sites of *R. haemorrhoidale*.

Keywords Biological pest control - Ecosystem functioning - Host-parasitoid interactions - Intraspecific competition - Population dynamics - Resource availability