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Bionomic differences in odonates and their influence on the efficiency of indicator species of environmental quality

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ABSTRACT

The influence of environmental changes on organisms depends on their bionomic characteristics, such as mobility, body size, and resource use. Thermoregulatory and dispersal abilities may directly affect the use of odonates as bioindicators since organisms with low dispersal ability can track fine-scale environmental variations and are usually resource specialists. We investigated the utility of dragonflies (*Anisoptera*) and damselflies (Zygoptera) as bioindicators testing possible relationships to their bionomic characteristics. We assessed the variation in species richness, composition, and indicator values in Cerrado areas by quantitative sampling of adult odonates in streams surrounded by different vegetation types, ordered by the degree of vegetation cover. Species composition was efficient in discriminating impacts affecting riparian vegetation, with low richness of rare and specialist species in impacted areas. Damselflies had more narrow requirements, associated to different shading, depth, and environmental integrity levels. No relation between body-size and species indicator value was observed. Despite this, the main use of those species as indicators, especially the Zygoptera, may be related to environmental disturbance created by changes on vegetation cover suggesting their potential use in the analysis of the environmental quality of riparian areas.

1. Introduction

Species responses to environmental variables are the first basic knowledge toward a systematic use of indicators of biotope quality (McGeoch, 2008). Individual species behavior is expected to be mediated by bionomic characteristics (e.g., mobility, behavior, choice of territories, habitat specificity, and resource use) (Remsburg and Turner, 2009) and directly affect a species usefulness as an ecological indicators. For instance, an important surrogate for odonate species responses to the surrounding environment is their thermoregulatory abilities, which is a basis of a behavioral classification in flyer and percher species (May, 1976; Corbet and May, 2008). Fliers are large-bodied species, endothermic, and less dependent on environmental conditions. On the other hand, perchers are ectothermic, regulating their body temperature mostly by posture adjustments and microhabitat selection. Body size differences among perchers lay out two further sub-groups: conformers, which depends mostly on heat transfer due to their small body size, and heliotherms, which can heat themselves up direct solar exposure (May, 1976; May, 1991; Heinrich, 1993). This is a simplified classification, since body size variation in perchers may generate a continuum of behavioral characteristics (De Marco et al., 2005). Following the same pattern of thermoregulation, dispersal ability in Odonata is also associated with body size (Samejima and Tsubaki, 2010), particularly wing length (Rundle et al., 2007) and thorax size which is associated with strong and complex musculature (Schilder and Marden, 2004; Rundle et al., 2007).

The set of co-evolved traits which are observed in each species are obviously a complex interplay of evolutionary history and the responses for selecting forces determined by particular habitat features. The strength of those forces shaping individual species responses are expected to be a direct function of species dependence on individual habitats. Thus, dispersal ability may have a special role in determining how environmental tolerance (Crist et al., 1992) and resource use patterns (MacArthur and Levins, 1964) evolved. Generally, organisms with low dispersal

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ability tend to be affected by fine environmental changes, even in natural environmental gradients (Débarre and Gandon, 2010) and are expected to be specialist on resources in their surroundings (MacArthur and Levins, 1964). Thus, we expect that small anthropic disturbances more likely affect species with low dispersal abilities (Driscoll, 2008).

Most *Neotropical Odonata* species have a strong association with freshwater habitats, expressed by male territoriality near water-bodies and low larval mobility (Corbet, 1980), which are good attributes for an indicator species. Several odonates are considered bioindicator species (Ferreira-Peruquetti and De Marco, 2002; Smith et al., 2007; Pinto et al., 2012) and have been used as diversity proxy for other groups of aquatic invertebrates (Simaika and Samways, 2011), riparian vegetation (Sahlén and Ekestubbe, 2001; Bried et al., 2007; Samways et al., 2011), in habitat integrity assessments (Foote and Hornung, 2005; Reece and McIntyre, 2009; Simaika and Samways, 2009a), and in ecological restoration (D'Amico et al., 2004). However, in order to be accepted as an efficient indicator, a species should have two main characteristics: specificity (higher abundance in a group of sites or set of environment characteristics), and fidelity (with occurrence limited to a group of sites or environmental characteristics) (Dufrêne and Legendre, 1997; McGeoch et al., 2002). Those properties may change from habitat to habitat, but we expect that some general patterns may emerge since specificity should be directly related to habitat dependency and possibly related to a particular set of traits, for instance, small-body size and conformer thermoregulatory behavior.

In this study we investigated the efficiency of odonates as indicators of environmental quality. We hypothesized that species richness is positively related to physical environmental integrity, and that species composition in these sites are especially distinct due to the presence of rare specialized species. We also tested the differences between the two suborders: *Anisopter*a (dragonflies), with larger body size, and higher dispersal ability, are consequently more likely to be generalists; and Zygoptera (damselflies), with smaller body size, and lower dispersal ability, are consequently more likely to be specialists. Thus, we expect that the proportion of damselfly species recognized as good indicators are higher than for dragonflies.

2. Material and methods

2.1. Study area

The study area is within the Cerrado biome. Currently, the cerrado has more than 2000,000 km^2 (Klink and Machado, 2005) and is a “hotspot” (Myers et al., 2000), being the most species rich Savannah in the world (Furley and Ratter, 1988). According to the Köppen scheme, the climate in the region is Aw (Cwa) (Sano et al., 2008) with high temperatures (annual mean is 25.6° C). There is a marked seasonality in rainfall, with dry (April–September) and rainy (October–March) seasons (Nimer, 1979).

Sampling sites are in the Rio Tocantins watershed comprising three municipalities at the Goiás state, Central Brazil (Fig. 1): Barro Alto, Niquelândia (near Serra da Mesa dam) and Alto Paraíso. Barro Alto and Niquelândia maintain large cattle ranching and mining activities. Conversely, the region around Alto Paraíso is more preserved and close to the Chapada dos Veadeiros National Park (CVNP). In this locality, we sampled sites within and around the CVNP.

The Cerrado biome in the study area (Sano et al., 2008) has four main phyto physiognomies: (i) cerrado sensu stricto characterized by shrubs with twisted trunks and thick corks; (ii) Vereda or Buritizal are composed mainly by “Buritis” palms by the genus Mauritia, associated to water bodies; (iii) gallery or riparian forests

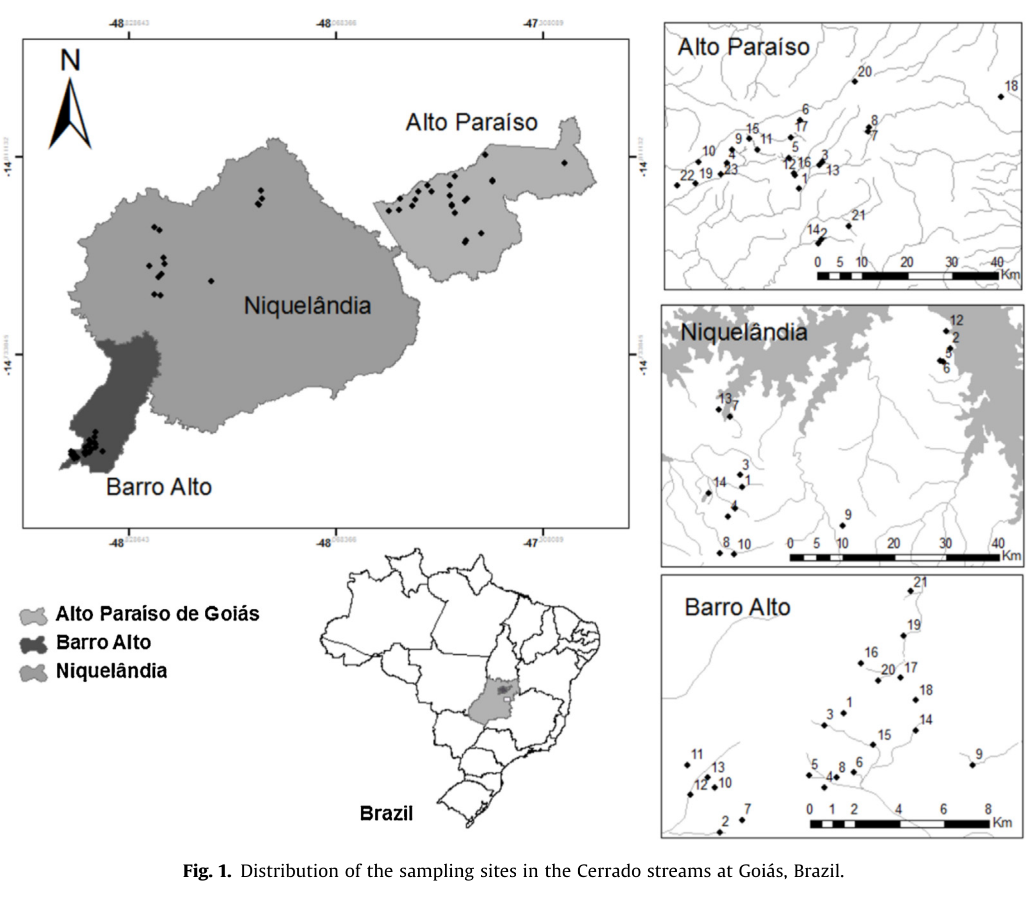

Fig. 1. Distribution of the sampling sites in the Cerrado streams at Goiás, Brazil.