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SHORT COMMUNICATION

# Abundance of Odonata in different microhabitats at an oxbow lake in the Peruvian Amazon

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## ABSTRACT

The relationship between Odonata and vegetation in Amazonia has been studied primarily in streams. In this study, I examined the abundance of adult Odonata in two vegetation types (shrubs and herbs) surrounding an oxbow lake in the Peruvian Amazon. Daytime visual samplings of Odonata were carried out in time blocks along transects in each habitat. Thirteen taxa were identified. Five species were similarly abundant in both habitats, three used mainly herbs, and one mainly shrubs, with no variation among time blocks. The results suggest that most Anisoptera and Zygoptera are adapted to unshaded areas of the lake. Some Odonata also were observed during sunless days with light rainfall, suggesting they are adapted to rainy conditions in tropical climate.

**KEYWORDS:** Anisoptera, Zygoptera, Cocha Cashu, rainforest, habitat use

# Abundancia de Odonata en diferentes micro-hábitats en un lago de herradura en la Amazonía peruana

## RESUMEN

La relación entre Odonata y vegetación en la Amazonía ha sido estudiada principalmente en arroyos. En este estudio, se examinó la abundancia de adultos de Odonata en dos tipos de vegetación (arbustos y hierbas) alrededor de un lago de herradura en la Amazonía peruana. Muestreos visuales diurnos fueron realizados en bloques temporales a lo largo de cada hábitat. Trece taxones fueron identificados. Cinco especies fueron similarmente abundantes en los dos tipos de hábitat, tres usaron principalmente hierbas y una principalmente arbustos, esto no varió entre los bloques temporales. Los resultados sugieren que la mayoría de Anisoptera y Zygoptera están adaptados a áreas sin sombra del lago. Algunas libélulas fueron observadas durante días sin sol y con llovizna, sugiriendo que se encuentran adaptadas a condiciones de lluvia en climas tropicales.

**PALABRAS CLAVE:** Anisoptera, Zygoptera, Cocha Cashu, bosque tropical, uso de hábitat

Vegetation provides multiple uses for Odonata by providing microclimates, oviposition substrates, perching structures, and protection from predators or unfavorable weather (Buchwald 1992). Thus, vegetation can influence Odonata species richness (Ferreira-Perruqueti and De Marco Jr. 2002), endemism, and species turnover (Bota-Sierra *et al*. 2021). In Amazonia, numerous studies have assessed the relationship of Odonata to habitat integrity and highlighted the importance of vegetation (e.g., Carvalho *et al*. 2018). However, most of this research was conducted in streams (see the supplementary material in Gómez-Tolosa *et al*. 2021).

The Madre de Dios region in southwestern Amazonia in Peru harbours ~200 Odonata species (Hoffmamn 2009), which amounts to one third of the known Peruvian odonate fauna (591 species, J. Hoffmann, pers. comm.). In Manu National Park (Madre de Dios, Peru), 136 species were recorded (Louton *et al*. 1996). Here, I evaluated habitat use by Odonata throughout the day in an oxbow lake, which is a water body formed by cut-off river channels.

The study was carried out at Manu National Park, specifically at Cocha Cashu (11°53'18.470"S, 71°24'28.307"W), a permanent oxbow lake in the Amazonian lowland connected to the Manu River by a drainage channel (Groenendijk *et al.* 2019). It has a 24-ha surface and a maximum depth of 2 m (Groenendijk *et al.* 2019), and is in the phytoplankton-dominated state (Terborgh and Davenport 2013). Its margins are populated by herbs, shrubs, and isolated trees (Groenendijk *et al.* 2019).

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Odonata were surveyed over 18 non-rainy days during the beginning of the rainy season, from October 23 to November 16, 2017. I classified vegetation formations as shrubby or herbaceous (Figure 1) and established 21 5-m transects (eight in shrubs and 13 in herbs) along the southern margin of the lake (900 m of shoreline). Transects were separated by at least 20 m to minimize spatial autocorrelation (*sensu* Oppel 2005). Odonata adults were observed along the transects with 10×42 binoculars within three time blocks: morning (0800 - 1100 h), midday (1100 - 1400 h), and afternoon (1400 - 1600 h). Each transect was surveyed only once during a period of 15 min in each time block. Odonata were grouped according to morphology and coloration pattern. I collected dead individuals and deposited them in the entomology collection of Museo de Historia Natural of Universidad Nacional Mayor de San Marcos (MUSM) (Table 1). Taxa were identified by comparing photographs and collected material with reference material from the MUSM collection. Odonata activity was also punctually recorded on rainy days.

In order to relate Odonata occurrence and abundance to a vegetation type, I used a multinomial species classification method (CLAM). It classifies species as generalists or specialists using their estimated relative abundances in two habitats (Chazdon *et al.* 2011). I considered a specialization value of 2/3 ("supermajority rule"; Chazdon *et al.* 2011), and the following adapted categories: mainly present in one vegetation type, present in both types, or too rare for classification. Fisher's exact tests were used to assess whether


**Figure 1.** Vegetation types found on the shores of Cocha Cashu (Manu National Park, Peru) during October and November 2017. A – shrubs; B – herbaceous vegetation. This figure is in color in the electronic version.

**Table 1.** Abundance of adult Odonata species observed along transects in shrubs and herbs along the shores of Cocha Cashu (Manu National Park, Peru) during October and November 2017. The P-value corresponds to Fisher's exact tests comparing the abundance in herbs and shrubs in the three time blocks (value in bold indicates significant difference).

| Taxon | Morning | | Midday | | Afternoon | | Total | P value |
|---|---|---|---|---|---|---|---|---|
| | Herb | Shrub | Herb | Shrub | Herb | Shrub | | |
| *Acanthagrion* spp. | 107 | 69 | 107 | 63 | 96 | 91 | 533 | - |
| Coenagrionidae | 22 | 2 | 18 | 5 | 17 | 1 | 65 | - |
| *Epipleoneura humeralis* (Selys, 1886)* | 4 | 5 | 1 | 11 | 2 | 3 | 26 | 0.119 |
| *Erythemis plebeja* (Burmeister, 1839) | 1 | 0 | 1 | 0 | 0 | 0 | 2 | - |
| *Erythemis peruviana* (Rambur, 1842)* | 16 | 0 | 19 | 0 | 4 | 0 | 39 | - |
| *Lestes* sp.* | 9 | 8 | 5 | 0 | 1 | 2 | 25 | 0.137 |
| *Brachymesia furcata* (Hagen, 1861) | 43 | 3 | 42 | 4 | 34 | 6 | 132 | 0.439 |
| *Micrathyria/Nephepeltia** | 60 | 16 | 54 | 12 | 48 | 22 | 212 | - |
| *Oligoclada pachystigma* Karsch, 1890* | 10 | 18 | 10 | 21 | 11 | 34 | 104 | 0.563 |
| *Perithemis lais* (Perty, 1834)* | 9 | 23 | 9 | 18 | 10 | 18 | 87 | 0.843 |
| *Protoneura paucinervis* Selys, 1886 | 4 | 16 | 2 | 17 | 2 | 12 | 53 | 0.887 |
| *Telebasis rubricauda* Bick & Bick, 1995 | 30 | 5 | 19 | 9 | 10 | 13 | 86 | **0.003** |
| *Telebasis* sp. | 5 | 0 | 10 | 0 | 5 | 1 | 21 | 0.524 |

*Voucher specimens deposited in MUSM.

vegetation use was independent of the time blocks. Analyses were performed with the packages *vegan* and *stats* in R 4.0.3 (Oksanen *et al.* 2020; R Core Team 2021).

Thirteen taxa were identified (Table 1, Figures 2 and 3). One was identified only to family level (Coenagrionidae), as it was not collected nor photographed. It had a green thorax with black longitudinal markings, and black abdomen with a blue tip (likely an *Ischnura*). *Micrathyria* and *Nephepeltia* are similar in external appearance, differing in the antenodal vein (Garrison *et al.* 2006), therefore they were grouped into a single taxon. *Acanthagrion* individuals were not identified to species level, as several species may coexist in the same area (Tennessen 2004). These three taxa were not included in the statistical analyses.

Five species were identified as occurring in both vegetation types (*Epipleoneura humeralis*, *Lestes* sp., *Olygoclada pachystigma*, *Perithemis lais*, *Telebasis rubricauda*), three mainly in herbs (*Brachymesia furcata*, *Erythemis peruviana*, and *Telebasis* sp.), one mainly in shrubs (*Protoneura paucinervis*), and one too rare for classification (*Erythemis plebeja*). Both *Erythemis* species were only recorded on herbs (Table 1), and were excluded from Fisher's exact tests. Vegetation use among taxa did not vary significantly among temporal blocks, except for *T. rubricauda* (Table 1).

Temperature, relative humidity and shade determine the presence of Odonata in an area (May 1979). Due to their constant exposure to the sun, herbs provide a drier and warmer microhabitat than shrubs. Half of the recorded species were observed in both vegetation types and three mainly in herbs in all time blocks, indicating that species in the lake are adapted to unshaded areas.

Zygoptera are usually associated with dense canopy cover and shade (Alves-Martins *et al.* 2019), but only one species, a Protoneurinae, was recorded primarily in shrubs. Members of that subfamily are expected to prefer shaded environments due to their vulnerability to desiccation and overheating (Paulson 2006). However, other protoneurine, *E. humeralis*, was recorded equally on herbs and shrubs. Notably, both *Telebasis* species differed in their vegetation preference, as has been recorded previously for different closely related species of the same genus (May 1977). *Lestes* species are known to adapt their body temperature through behavior (Lambret and Stoquert 2011), which explains why *Lestes* sp. was found in both vegetation types.

As in my results, the Anisoptera *B. furcata* and *E. peruviana* were found to prefer herbaceous areas of a lake in Brazil (De Marco *et al.* 2005). *Perithermis lais* was reported to avoid open areas (Calvão *et al.* 2003) and their similar abundance in herbs and shrubs in my survey could be owed to the presence of the substrate where they roost (branches; Garrison *et al.* 2006) in herbaceous areas. Similarly, *O. pachystigma* was reported


**Figure 2.** Anisoptera species recorded along transects on the shores of Cocha Cashu (Manu National Park, Peru) during October and November 2017. A – *Brachymesia furcata*; B – *Erythemis plebeja*; C – *Erythemis peruviana*; D – *Micrathyria/ Nephepeltia*; E – *Oligoclada pachystima*; F – *Perithemis lais*. This figure is in color in the electronic version.

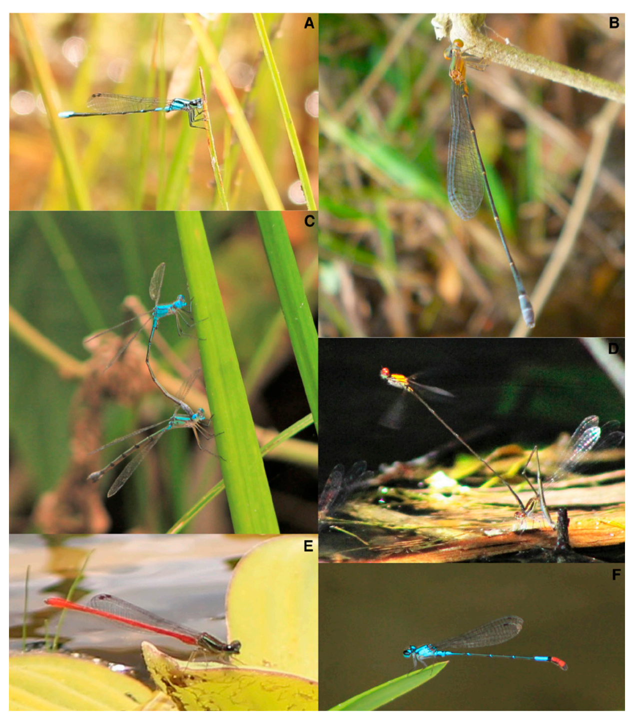


**Figure 3.** Zygoptera species recorded along transects on the shores of Cocha Cashu (Manu National Park, Peru) during October and November 2017. A – *Acanthagrion* sp.; B – *Epipleoeura humeralis*; C – *Lestes* sp.; D – *Protoneura paucinervis*; E – *Telebasis* sp.; F – *Telebasis rubricauda*. This figure is in color in the electronic version.

resting on macrophyte leaves (Bota-Sierra *et al*. 2015) in herbaceous areas and on broad leaves in shrubs (personal observation).

All taxa, except *Erythemis* and *Telebasis* sp., were also observed being active during overcast days with light rain performing activities such as patrolling, ovipositing and fighting. In the Neotropics, some genera do not require sunlight for their daily activity (Paulson 2006). This was the first record of *Brachymesia*, *Epipleoneura*, *Lestes*, *Protoneura*, and *Telebasis* having little dependence on sunlight for their activity in the Neotropics The long rainy season in the study area may explain this adaptation to sub-optimal weather conditions. Future studies should expand on these aspects of odonate activity patterns.

My results highlight the importance of vegetation heterogeneity for Odonata in Amazonian wetlands. Since only one species was found to be more associated with shrubs, it is possible that most Odonata in this area have adapted to living in unshaded habitat, unlike along streams, where Zygoptera species are usually associated with canopy cover (Carvalho *et al*. 2018).

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