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EMERGENCE TRAP FOR THE COLLECTION OF EXUVIAE AND ADULT OF ODONATA

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Abstract: Odonates have aquatic larval stages and terrestrial adults. The extreme change in habitat occupation during their life cycle means that combined collection methods, capable of providing data for both larvae and adults, are scarce and are often inefficient. Given this, we applied a method for the collection of specimens of both life phases using emergence traps. During fieldwork, 78 emergence events were recorded for 15 species. We also briefly discuss the emergence pattern of the recorded species. We believe the information obtained here provide an important contribution to the understanding of the ecology and basic biology of Neotropical odonate species, as well as helping to solve the taxonomic problems associated with the identification of larvae.

Keywords: Cerrado; damselflies; dragonflies; stream; collection method.

Damselflies and dragonflies (Insecta, Odonata) are amphibiotic organisms, with aquatic larvae and terrestrial adults. The transition from the immature aquatic phase to the terrestrial adult occurs through the emergence of the larvae, which attach themselves to fixed structures, such as trunks, branches, roots, rocks and/or macrophytes to reach their final stage of development (Neiss & Hamada 2014). The exuvia discarded after the molt remains fixed to the substrate following the emergence of the adult. Following this transformation, the adult is ready to inhabit an environment totally distinct from that in which it lived during its first life stages (Corbet 1999). The transition process may be influenced by a number of factors including habitat complexity, interactions with predators, and even resource availability, which may either accelerate or delay emergence (Tavares *et al.* 2017, Moore *et al.* 2018).

One of the main obstacles to studies on odonate larvae is species identification, since it is necessary to rear the larva until emergence to ensure its reliable identification in most cases. This is an extremely complicated process, especially when the species inhabits lotic environments and requires well-oxygenated running waters to develop adequately (Carvalho & Nessimian 1998). This problem is highlighted by the fact that no description of the larva is available for approximately 60 % of the odonate species that occur in Brazil (Miguel *et al.* 2017). The exuviae is essential for a reliable description of the stage larval, however most studies with exuvia are neglected (Bried & Samways 2015), representing only 1 % of the articles analyzed in a scientometric study (Miguel *et al.* 2017). This low percentage of studies may be related to difficulties in diagnosing the species of exuvia, because although they may be collected during traditional Odonata sampling, it is rarely possible to determine the species to which they belong due to the lack of the adult specimen. Furthermore, the combination of adult and exuvian data is important not only for solving taxonomic problems related to larval identification, but also for understanding the ontogeny of different species, ecological and phylogenetic aspects.

In order to solve the difficulties encountered in sampling the aquatic/terrestrial transition of insects, Needham (1908) published one of the first recorded emergency traps. Such a device basically consists of an armed net over the water body, resembling a small tent. Faced with the success of capture, several models of traps have been proposed and used since then (David 1984). Given the overall lack of data on the larva-adult transition and the taxonomic problems related to the identification of the larvae, we used an emergence trap to collect data on both odonate life stages.

The base of the trap is formed by a 26” bicycle wheel (Figure 1A), with tire and inner tube (Figure 1B). The inner tube is essential to guarantee the flotation of the trap, while the tire protects the tube against damage from branches and other organisms. Four 50 cm iron rods were fixed to the wheel to form a cone-shaped structure (Figure 1C). The apex of this cone is formed by a ring (100 mm in diameter), and is covered with thick tulle net, which provides a substrate to allow the larvae to climb up the trap to emerge. An elbow joint of a 100 mm PVC pipe was attached to the ring at the top of the trap (Figure 1D), with the external opening covered with fine net, to capture the emerging adults and to allow the maturation of the cuticle of the tenerals (Figure 1E).

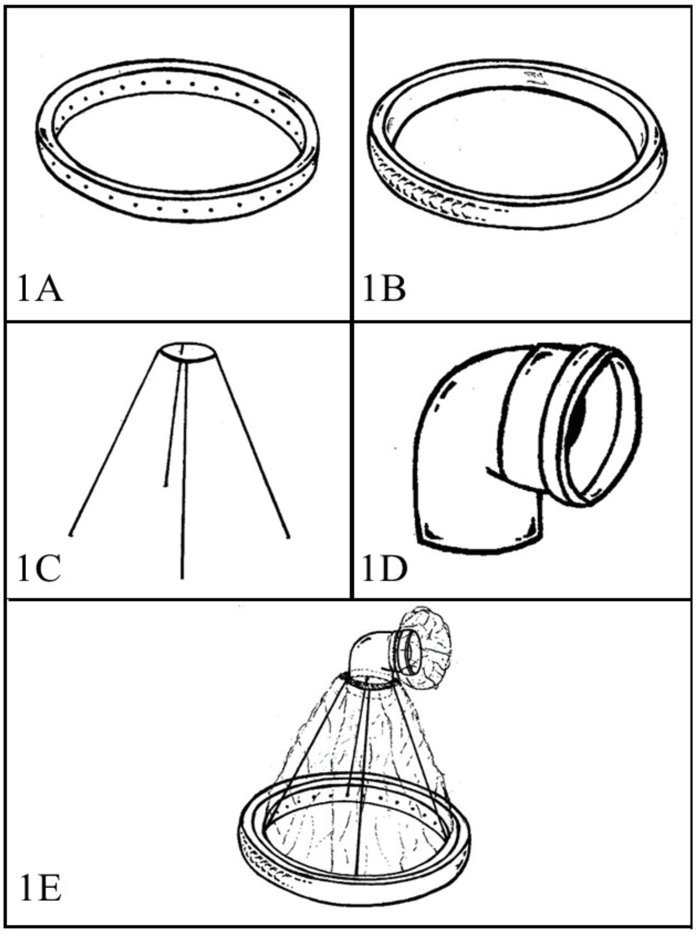

Figure 1. Illustration of the emergence trap: (1A) 26” bicycle wheel; (1B) 26” bicycle tire and inner tube; (1C) conical support made of 50 cm iron rods and 100 mm diameter ring; (1D) elbow joint of a 100 mm PVC pipe; (1E) complete trap covered with thick tulle and mosquito net.

The trap was tested in two streams of the Cerrado savanna, Bacaba (14º43"3.5'S, 52º21"48.3'W) and Salgadinho (14º41"30'S, 52º 22"10'W), both located in the municipality of Nova Xavantina, Mato Grosso state, Brazil. Twelve traps were installed and anchored to the vegetation near the margin of the stream with a nylon thread (Figure 2A and 2B). The traps were checked twice a week between August 2016 and September 2017. At the beginning of the experiment, the traps were distributed at intervals of approximately 10 m along the stream, although we adjusted the distribution of the traps at the peak of the dry season, placing with an average distance of 30 m between them in the pools when the streams became more intermittent. All biological material was collected under the license SISBIO 14.457-1 and deposited in the Alexander James Ratter Zoobotany collection, Mato Grosso State University, Nova Xavantina *campus*.

A total of 78 emergence events (larvae and adult insects) were recorded during the study period. However, we identified only 51 species-level individuals because some specimens were female or/and newly emerged, therefore, their structures were not in adequate condition for identification. These insects represented 15 species, including seven species of Zygoptera (damselflies), *Acanthagrion aepiolum* Tennessen 2004, *Acanthagrion ascendens* Calvert 1909, *Argia croceipennis* Selys 1865, *Acanthagrion phallicorne* Leonard 1977, *Hetaerina rosea* Selys 1853, *Neoneura sylvatica* Hagen in Selys 1886, and *Protoneura tennuis* Selys 1860, and eight species of the suborder Anisoptera (dragonflies), *Dythemis multipunctata* Kirby 1894, *Elga leptostyla* Ris 1911, *Oligoclada borrori* Santos 1945, *Perithemis mooma* Kirby 1889, *Perithemis lais* Perty 1834, and *Perithemis thais* Kirby 1889, *Phyllocycla* sp. Calvert 1948 e *Tramea* sp. Hagen 1861 (Table 1). Species such as *O. borrori* and *A. aepiolum* are unprecedented for the state of Mato Grosso.

Considering the categorization in periods of the year according to regional climate variation: rainy (January, February and March), ebb (period after the rainy season in which the water level declines) (April, May and June), dry (July, August and September), and early rainy (October, November and December) seasons (Giehl *et al.* 2015), we recorded more emergencies in the early rain season and fewer records during the rainy and ebb season, which was also found in other studies (Salvarina *et al.* 2017, Trapero-Quintana & Reyes-Tur 2017). This result can be explained by two phenomena

Figure 2. The emergence of an adult odonate (A) in the emergence trap (B) in streams of the Cerrado savanna in the municipality of Nova Xavantina in Mato Grosso state, central Brazil.

Table 1. List of the odonate species captured in the emergence traps tested on the Bacaba and Salgadinho streams in the municipality of Nova Xavantina in Mato Grosso state, Brazil.

Species	Rainy	Early rainy	Dry	Ebb
Anisoptera				
Dythemis multipunctata Kirby 1894	0	2	0	0
Elga leptostyla Ris 1911	0	0	2	0
Oligoclada borrori Santos 1945	0	2	0	0
Perithemis lais Perty 1834	0	2	0	0
P. mooma Kirby 1889	0	0	2	0
P. thais Kirby 1889	0	4	0	0
Phyllocycla sp. Calvert 1948	0	1	0	0
Tramea sp. Hagen 1861	0	1	0	0
Zygoptera				
Acanthagrion aepiolum Tennessen 2004	0	0	1	0
A. ascendens Calvert 1909	0	1	0	0
A. phallicorne Leonard 1977	0	3	2	0
Argia croceipennis Selys 1865	0	0	1	1
Hetaerina rosea Selys 1853	0	0	0	1
Neoneura sylvatica Hagen in Selys 1886	0	24	0	0
Protoneura tennuis Selys 1860	0	1	0	0
Total	**0**	**41**	**8**	**2**

that cause severe seasonal fluctuations: increased precipitation and resource limitation. Increasing rainfall increases the amount of water in the aquatic environment, causing changes in the physicochemical parameters of water and flooding that can influence larval habits as well as drag them to unwanted locations (Gonçalves & Aranha 2004, Bispo *et al.* 2006). Moreover, resources such as food and microhabitats become scarcer in the rainy season, since part of the aquatic substrate (e.g. leaves, roots and sand) is modified as a result of these runaways caused by excess water in the canals (Suhaila *et al.* 2017, Verheyen *et al.* 2018). Therefore, both phenomena may be causing a synchrony of larval emergence (especially univoltines), probably in an attempt to escape these hydrological fluctuations caused by the rainy season (Hayden & Clifford, 1974, Gibbs & Mingo, 1986).

Although most of the registered odonates present a univoltine life cycles (Table 1), we also observed genera with bivoltine cycles (*Argia* and *Perithemis*) that emerged in only two periods of the year, or even multivoltine (*Acanthagrion*), emerging in all periods. However, Odonata larvae do not always present well-defined patterns in their emergence periods, for example, studies conducted in Cuba have found asynchronous emergence, contrasting to our results (Trapero-Quintana & Reyes-Tur 2011, 2017).

Despite the low capture rate of our trap when compared to other traditional methods applied in the same site (Calvão *et al.* 2014), the information obtained here provide an important contribution to the understanding of the basic biology of odonate species, as well as help to solve the taxonomic problems associated with the identification of larval species. Moreover, the exuviae captured by our method were found in excellent condition, allowing their taxonomic identification and even obtaining morphometric measurements. Regarding the periods of the year our results were more satisfactory in the early rain, since during the rainy season torrential downpours dislodged the traps. Thus, we suggest that this method be used in periods with lower water level fluctuations, as well as complement information obtained through traditional methods.

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