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Short Communication

Association of *Anagrus amazonensis* Triapitsyn, Querino & Feitosa (Hymenoptera, Mymaridae) with aquatic insects in upland streams and floodplain lakes in central Amazonia, Brazil

Malu Christine Barbosa Feitosa[a,*], Ranyse Barbosa Querino[b], Neusa Hamada[a]

[a] *Instituto Nacional de Pesquisas da Amazônia, Coordenação de Biodiversidade, Curso de pós-graduação em Entomologia, Manaus, AM, Brazil*
[b] *Embrapa Meio-Norte, Teresina, PI, Brazil*

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ABSTRACT

Anagrus amazonensis Triapitsyn, Querino & Feitosa (Hymenoptera, Mymaridae) is a parasitoid that uses aquatic insect eggs as a host for the development of its immature stages. The objectives of this study are to record the interaction between *A. amazonensis* and its hosts and the aquatic plants used by these hosts to lay their eggs. Field work was conducted in floodplain lakes and upland (*terra firme*) streams, in four municipalities in Amazonas State, Brazil, where aquatic plants were scanned for the presence of aquatic insect eggs. In the laboratory, eggs were maintained in plastic containers with water until the emergence of the parasitoid or of the first instar insect. A total of 1223 adults of *A. amazonensis* emerged from eggs of Hemiptera, Lepidoptera and Odonata; these eggs were collected on 12 species of aquatic plants.

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Among parasitoid hymenopterans, a small group has one or more life stages associated with aquatic environments (Bennett, 2008) where they oviposit on the eggs, larvae or pupae of a large range of host insects (Williams and Feltmate, 1992). Most are endoparasitoids of immature insects that are actually embedded partly or almost completely inside the host plant tissue or other submersed substrates or on floating substrates (Querino, 2012). In Brazil there are currently seven families (Braconidae, Diapriidae, Eulophidae, Figitidae, Mymaridae, Platygastridae, and Trichogrammatidae) and eight genera of Hymenoptera known to be associated with aquatic hosts (Querino and Hamada, 2014). In Central Amazonia, the riparian vegetation and aquatic macrophytes in streams and floodplain lakes are the preferred substrates for aquatic insects to oviposit (Bentes et al., 2014) but few records exist of the interaction between parasitoid, aquatic host, and plant used for oviposition by the insect host. *Hydrophylita neusae* Querino and Pinto (Hymenoptera: Trichogrammatidae) was found associated to Odonata eggs deposited on leaves of *Thurnia sphaerocephala* Hook. (Thurniaceae) (Querino and Pinto, 2007). *Pseudoligosita longifrangiata* (Viggiani) (Hymenoptera, Trichogrammatidae) was recorded for the first time in Brazil parasitizing eggs of *Argia insipida* Hagen in Selys (Odonata, Coenagrionidae) deposited on *Tonina fluviatilis* Aublet (Eriocaulacea) (Querino and Hamada, 2009). *Anagrus amazonensis* Triapitsyn, Querino and Feitosa (Hymenoptera, Mymaridae) was observed parasitizing Odonata (Zygoptera) eggs deposited on *Rhynchospora pubera* (Vahl) Bockeler (Cyperaceae) (Triapitsyn et al., 2008).

Knowledge of the parasitoid host fauna and their habitats is important for studies of population dynamics because these organisms act as a natural population control of their hosts. The aim of the present study is to document the aquatic insect hosts of *A. amazonensis* and the plants on which host eggs are laid in Central Amazonia. Eggs were randomly collected in 2004, 2005, and 2006 in three floodplain lakes (lentic environments) and eight upland (*terra firme*) forest streams (lotic environments) in four municipalities (Iranduba, Manaus, Presidente Figueiredo, and Rio Preto da Eva) in Amazonas State, Brazil (Fig. 1). Aquatic plants and vegetation trailing from stream banks were scanned for aquatic insect eggs, and, when present, eggs were collected and placed in plastic bags to be transported to the laboratory in Styrofoam boxes. In the laboratory, each aquatic insect egg batch was placed in a plastic container with water treated with fungicide in order to inhibit fungal growth, and was inspected daily until the emergence of parasitoids or immature insect hosts. Identification of aquatic insect egg was based on Bentes et al. (2014) and of *A. amazonensis* was based on the original description (Triapitsyn et al., 2008). Specimens obtained in this study are deposited in the Invertebrate Collection of the National Institute of Amazonian Research, Manaus, Brazil.

* Corresponding author.
E-mail: malu_chris@yahoo.com.br (M.C.B. Feitosa).

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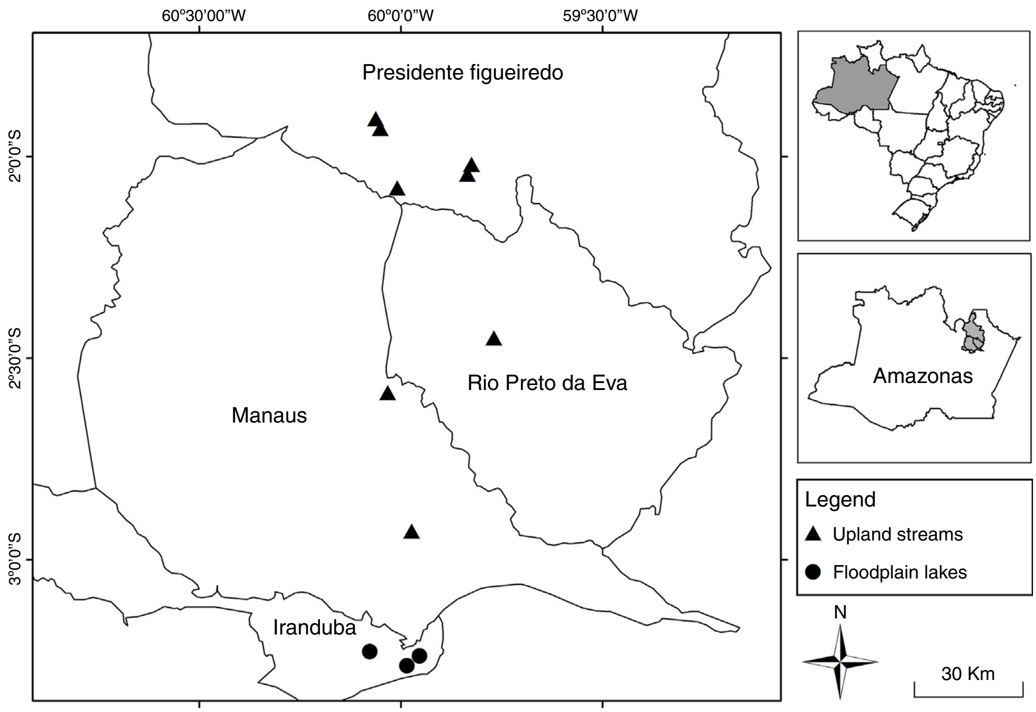

Fig. 1. Sites where *Anagrus amazonensis* (Hymenoptera, Mymaridae), its hosts, and their associated plants were collected in Amazonas State, Brazil.

A total of 1223 individuals of *A. amazonensis* were obtained, of which 1128 were female and 95 were male. Many factors can be influencing the sex ratio and result in a higher prevalence of females in the samples, such as reproduction habits and host characteristics. These factors may be explored in future studies.

A. amazonensis emerged from eggs of Hemiptera, Lepidoptera, and Odonata. *A. amazonensis* parasitized eggs placed on the underside of the macrophyte's leaves, with the exception of lepidopteran eggs, which were placed on the upper surfaces of the leaves. The higher rate of parasitism in Odonata eggs is most likely due to the fact that they are more easily found in the sampled locations. The host range of *A. amazonensis* appears to be exceptionally wide (encompassing three insect orders) even for a taxon (Mymaridae) where there seems to be a tendency for species not to be host-species specific; many mymarid species present host specificity at the genus level, while others are known to parasitize hosts of a wide range of families in a single insect order (Huber, 1997). The habitat range also appeared to be exceptionally wide. Although most aquatic Hymenoptera are recorded in lentic environments, at least 1/3 of the species are associated with lotic environments (Bennett, 2008). *A. amazonensis* did not show any preference, occurring in both lotic (upland streams) and lentic (floodplain lakes) environments (Fig. 1).

A. amazonensis emerged from aquatic insect eggs laid on 12 species of aquatic plants (Table 1). Of these, only *Eichhornia crassipes* (Mart.) Solms., *Salvinia* sp., *Pistia stratiotes* L., *T. fluviatilis* Aublet, *Thurnia* sp., and Ciperaceae had been previously associated with oviposition of aquatic insect eggs in the Amazon region (Bentes et al., 2014).

Huber (1986) reported *Anagrus* as one of the three most-abundant genera of Mymaridae in faunal surveys. However, of the eight species of *Anagrus* recorded in Brazil, as far as it is known, only

Table 1
Anagrus amazonensis Triapitsyn, Querino & Feitosa (Hymenoptera, Mymaridae) associations with aquatic plants and aquatic insect hosts sampled from upland streams and floodplain lakes during the years 2004, 2005, and 2006 in Amazonas State.

Aquatic plants		Insect hosts	*Anagrus amazonensis*		
Family	Species		♀	♂	Subtotal
Thurniaceae[a]	*Thurnia sphaerocephala* (Rudge) Hook.	Odonata	645	3	648
Araceae[a]	*Philodendron* sp.	Odonata	92	1	93
	Urospatha sagittifolia (Rudge) Schott	Lepidoptera	51	1	52
		Odonata	42	0	42
	Spathiphyllum maguirei Bunting	Odonata	16	0	16
Cyperaceae[a]	*Rhynchospora pubera* (Vahl) Boeck.	Odonata	83	23	106
Eriocaulaceae[a]	*Tonina fluviatilis* Aublet	Odonata	25	0	25
Parkeriaceae[b]	*Ceratopteris pteridoides* (Hook.) Hieron	Odonata	14	1	15
Poaceae[a]	*Panicum laxum* Sw.	Odonata	45	0	45
	Poaceae not identified	Odonata	4	0	4
Pontederiaceae[b]	*Eichhornia crassipes* (Mart.) Solms.	Hemiptera	52	39	91
		Odonata	15	6	21
	Pontederia rotundifolia L.f.	Hemiptera	28	21	49
Xyridaceae[a]	*Xyris caroliniana* Walt.	Odonata	25	2	27
Total			1137	97	1234

[a] Upland stream plants.
[b] Floodplain lake plants.

A. amazonensis is associated with aquatic environments (Triapitsyn et al., 2008). Host records are only known for 7 of these 8 species; only *A. brasiliensis* Triapitsyn does not have a confirmed host.

The results of this study therefore contribute to current understanding of this parasitoid, including its natural history, host interactions, and geographic distribution, especially for aquatic environments.

Conflicts of interest

The authors declare no conflicts of interest.

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