

Monomachus (Hymenoptera, Monomachidae) from Atlantic rainforests in São Paulo State, Brazil

Monomachus (Hymenoptera, Monomachidae) del bosque lluvioso Atlántico del Estado de São Paulo, Brasil

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Abstract: A survey of *Monomachus* (Hymenoptera, Monomachidae) was carried out with five Malaise traps/area in five areas of Atlantic Rainforest in São Paulo State, Brazil. The sampling effort in all localities amounted to 9,900 traps-day. Data were obtained from a total of 304 exemplars of *Monomachus*: 66 females and 238 males. The highest occurrence of *Monomachus* was observed between June and September with a frequency peak in July, and they were most frequent in Parque Estadual Morro do Diabo (PEMD) (350 m above sea level), where the sampling effort to catch each exemplar was 65.1 traps-day. From the sample of females of *Monomachus* captured in the Parque Estadual Intervalles, Parque Estadual da Serra do Mar/Núcleo Santa Virgínia (PESM/NSV), PEMD and Estação Ecológica Juréia Itatins, between December 2009 and December 2010, two species were recognized: *M. fuscator* (N = 58 / 87.9 %) and *M. cubiceps* (8 / 12.1 %). In additional samplings in 2011 at PESM/NSV two exemplars of *M. klugii* recorded only from Rio de Janeiro State, Brazil were obtained, showing that its distribution has extended to São Paulo State.

Key words: Chiromyzinae. Diaprioidea. Malaise trap. Neotropical. Parasitoids.

Resumen: Se realizó un estudio de *Monomachus* (Hymenoptera, Monomachidae) con cinco trampas Malaise por área, en cinco áreas del bosque lluvioso Atlántico en el Estado de São Paulo, Brasil, entre octubre de 2009 y diciembre de 2011. El esfuerzo de muestreo en todas las localidades ascendió a 9.900 trampas-día. Se obtuvo un total de 304 ejemplares de *Monomachus*: 66 hembras y 238 machos. La mayor ocurrencia de *Monomachus* fue entre junio y septiembre, con pico de frecuencia en julio, siendo más frecuentes en el Parque Estadual Morro do Diabo (PEMD) (350 m sobre el nivel del mar), donde el esfuerzo de muestreo para capturar cada ejemplar fue de 65,1 trampas-día. Del total de hembras de *Monomachus* capturadas del Parque Estadual Intervalles, Parque Estadual da Serra do Mar/Núcleo Santa Virgínia (PESM/NSV), PEMD y Estação Ecológica Juréia Itatins entre diciembre 2009 y diciembre 2010 se reconocieron dos especies: *M. fuscator* (N = 58 / 87,9 %) y *M. cubiceps* (8,0 / 12,1 %). En muestreos adicionales en 2011 en PESM/NSV se obtuvieron dos ejemplares de *M. klugii* sólo registrada para el Estado de Río de Janeiro, y ahora su distribución se extiende al Estado de São Paulo.

Palabras clave: Chiromyzinae. Diaprioidea. Trampa Malaise. Neotropical. Parasitoides.

Introduction

Monomachidae (Hymenoptera: Diaprioidea) is a small family of parasitoid wasps with two recognized genera: *Monomachus* Klug, 1841, which have an Austral disjunct distribution with species recorded from Australia, New Guinea and New World, and *Chasca* Johnson and Musetti, 2012, known only from South America (Musetti and Johnson 2004; Johnson and Musetti 2012); they are sexually dimorphic, with females possessing a long sickle-shaped metasoma, and very short ovipositor hidden inside the segment VIII; whereas males have a pedunculate metasoma (Masner 2006).

There are 23 species of *Monomachus* known from New World and five from Australia/New Guinea (Johnson and Musetti 2012). Seventeen species are recorded for Brazil, six of them in the State of São Paulo (Musetti and Johnson 2004; Johnson and Musetti 2012). Most species of *Monomachus*

appear to be rare, with limited geographic distributions; the greatest diversity of species is found in the Atlantic rainforest of southeastern Brazil (Musetti and Johnson 2004).

Little is known about the hosts of Monomachidae: the Australian species *M. antipodalis* Westwood, 1874 acts as egg-larval or egg-pupal parasitoid of *Boreoides* spp. (Diptera: Stratiomyidae, Chiromyzinae) (Riek 1970; Naumann 1985, 1991); Lima *et al.* (2001) reared *Monomachus* sp. from puparia of *Chiromyza vittata* Wiedemann, 1820 (Diptera: Stratiomyidae, Chiromyzinae) a pest of coffee root in Brazil. The present study derives from the activities developed during the course "Systematic and bionomics of parasitoid Hymenoptera" presented by N. W. Perioto, R. I. R. Lara and D. R. R. Fernandes in the winter of 2013 to students of the Post Graduate program in Agronomy (Agricultural Entomology), Universidade Estadual Paulista "Júlio de Mesquita Filho", Jaboticabal campus, São Paulo State.

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Our main goal was to identify and obtain distributional information for the species of Monomachidae from five localities in Atlantic rainforests in São Paulo State.

Material and methods

Monomachidae from five localities of Atlantic rainforests in São Paulo State (Fig. 1) were sampled, i.e., Estação Ecológica Juréia-Itatins (EEJI) (24°31'14.6"S, 47°12'5.7"W), Iguape County; Parque Estadual Intervalos (PEI) (24°16'28.0"S, 48°25'14.8"W), Ribeirão Grande County; Parque Estadual Morro do Diabo (PEMD) (22°36'17.0"S, 52°18'05.8"W), Teodoro Sampaio County; Parque Estadual da Serra do Mar, Núcleo Picinguaba (PESM/NP) (23°19'59.3"S, 44°49'57.8"W), Ubatuba County, and Núcleo Santa Virgínia (PESM/NSV) (23°19'24.8"S, 45°05'40.1"W), São Luiz do Paraitinga County, between December 2009 and December 2010. At PESM/NSV the samplings extended until December 2011, this additional collection period was not considered for the calculation of sampling effort. The surveys were authorized by the Sistema de Autorização e Informação em Biodiversidade (SISBIO), license #10632-1. In each area five Malaise traps (Townes 1972) were operated continuously, placed 50 meters apart using Dietrich solution as a preservative; the samples were removed monthly. The total sampling effort over all localities amounted to 9,900 traps-day.

Identifications were made using the key to genera of Monomachidae proposed by Johnson and Musetti (2012) and, the key to females of species of the New World proposed by Musetti and Johnson (2004) that stated “Males of *Monomachus* spp. generally have the diagnostic characters of the mandibles and clypeus only weakly expressed. They

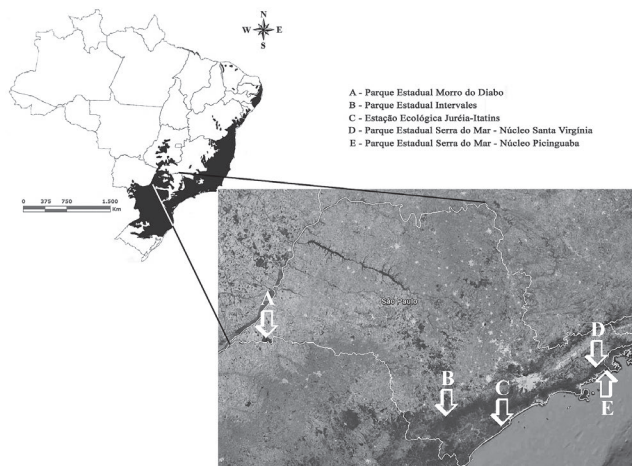


Figure 1. Collect sites in Atlantic Rainforest at São Paulo State, Brazil. Image sources: www.wwf.org.br and Google Earth.

are, therefore, often difficult or impossible to identify and are not included in [the] key”.

The specimens are deposited in the Coleção Entomológica do Laboratório de Sistemática e Bioecologia de Parasitoides e Predadores (LRRP) of the APTA Ribeirão Preto, Ribeirão Preto, São Paulo State, Brazil (N.W. Perioto, curator).

Results and discussion

Data were obtained from a total of 304 exemplars of *Monomachus*, which 152 exemplars (50.0 % of the total collected) at PEMD, 85 (28.0 %) at PEI, 56 (18.4 %) at PESM-NSV, 9 (3.0 %) at EEJI and, 2 (0.7%) PESM-NP (Table 1).

Table 1. Females and males of *Monomachus* Klug, 1841 (Hymenoptera: Diaprioidea) collected with Malaise traps in areas of Atlantic Rainforest of the São Paulo State at Estação Ecológica Juréia-Itatins (EEJI), Parque Estadual Intervalos (PEI), Parque Estadual do Morro do Diabo (PEMD), Parque Estadual da Serra do Mar, Núcleo Santa Virgínia (PESM/NSV), and Núcleo Picinguaba (PESM/NP) between December 2009 and December 2010.

	<i>Monomachus fuscator</i> (Perty, 1833), females						<i>Monomachus cubiceps</i> Schroettky, 1911, females						Females		<i>Monomachus</i> (males)							
	PEI	EEJI	PESM/NSV	PESM/NP	PEMD	total	PEI	EEJI	PESM/NSV	PESM/NP	PEMD	total	total	%	PEI	EEJI	PESM/NSV	PESM/NP	PEMD	total	%	
Dec-09																						
Jan-10																		2		2	0.8	
Feb-10																	10		10	4.2		
Mar-10																	22		22	9.2		
Apr-10													7			3			10	4.2		
May-10	1		1			2						2	2.7	6					6	2.5		
Jun-10	2		1		4	7	1			2	3	10	13.7	10	3	11		11	35	14.7		
Jul-10			2		24	26	2			1	3	29	39.7	19	1	2		48	70	29.4		
Aug-10		2			15	17	1			1	2	19	26.0	7	1			29	37	15.5		
Sep-10					6	6						6	8.2	10	2	4		11	27	11.3		
Oct-10														6					6	2.5		
Nov-10														12					12	5.0		
Dec-10														1					1	0.4		
Total	3	2	4		49	58	4			4	8	66	100.0	78	7	52	2	99	238	100.0		
%	5.2	3.4	6.9		84.5	100.0	50.0			50.0	100.0			32.8	2.9	21.8	0.8	41.6	100.0			

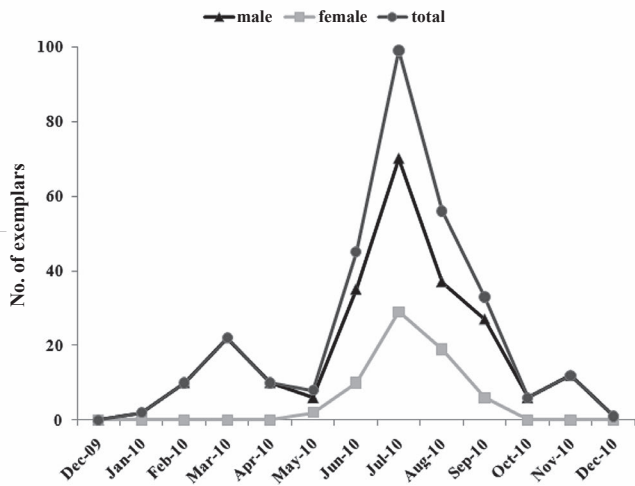


Figure 2. *Monomachus* Klug, 1841 (Hymenoptera: Diapriodea) collected with Malaise traps in five areas of Atlantic Rainforest of the São Paulo State, Brazil, between December 2009 and December 2010.

In this study a strong deviation towards males was observed: 238 males (78.3 % of the total collected) and 66 females (21.7 %) were caught, resulting in 3.6 males for each female (Table 1). These data corroborate those of Musetti and Johnson (2004), who reported that only 17.2 % of the specimens in collections were females, suggesting that the two sexes occupy different habitats as adults: the males fly in search of females, perhaps even forming swarms while females fly closer to the soil and leaf litter searching their hosts (*opus cit.*). Azevedo and Santos (2001) collected only males of *Monomachus*: 100 exemplars of *M. eurycephalus* Schletterer, 1890 and 22 of *M. fuscator* (Perty, 1833) in an Atlantic rainforest in the Reserva Biológica de Duas Bocas, Espírito Santo State.

In this study were necessary 32.6 traps-day, in average, to collect one exemplar of *Monomachus*. Exemplars of this genus are generally rare in collections (Musetti and Johnson 2004). The observed abundance of female of *Monomachus* spp. was low, but this may be a reflection of the sampling method employed. In contrast, Azevedo and Santos (2001) captured 0.42 specimens per minute employing sweeping nets.

The highest abundance of *Monomachus* (233 exemplars, 76.6 % of the total collected) was observed between June and September with frequency peak in July (99 / 32.6 %) (Fig. 2); the increase of the populations of this genus coincides with early winter in the southern hemisphere. As males and females had similar population fluctuations it is plausible to assume that their flight activities are concomitant in the studied areas, which corroborates the observations of Azevedo and Santos (2001), Perioto and Lara (2003) and Perioto *et al.* (2005) who did not capture Monomachidae in studies carried out at PESM-NP and EEJI in January and May, respectively.

Although the PEMD is located in a region of São Paulo State where temperatures are high throughout the year, they usually decrease between May and September, the period that corresponded to highest abundance of *Monomachus* in the area; *Monomachus* was more abundant at PEMD (350 m above sea level - asl) where the sampling effort to catch one exemplar was 65.1 traps-day, followed by PEI (880 m

asl) with 116.0 traps-day/exemplar, PESM-NSV (1030 m asl) with 177.0 traps-day/exemplar, EEJI (16 m asl) with 1,100.0 traps-day/exemplar and PESM-NP (215 m asl) with 4,950.0 traps-day/exemplar.

Like Monomachidae, Chiromyzinae, their hosts, also have disjunct distribution in the southern hemisphere. They are also found in the Neotropical and Australasian regions and, in general, the greater abundance of *Monomachus* in the dry season and in areas of higher altitude seems to be related to the temporal and geographic abundance of their hosts (Woodley 2001; 2011). In a survey in areas of Atlantic rainforest in Minas Gerais State Fontenelle *et al.* (2009) obtained exemplars of Chiromyzinae only in the dry season. From females of *Monomachus* were identified *M. fuscator* (58 / 87.9 % of the total of females of *Monomachus* captured) and *M. cubiceps* Schrottky, 1911 (8 / 12.1 %) (Table 1).

M. fuscator, with its distinctive green color, is one of the most common species of the genus and, together with *M. cubiceps*, predominate in samplings in southeastern Brazil (Musetti and Johnson 2004). *M. fuscator* has a wide distribution in Brazil, with reports of its occurrence in the states of Pernambuco, Bahia, Minas Gerais, Espírito Santo, Rio de Janeiro, São Paulo, Paraná, Santa Catarina and Rio

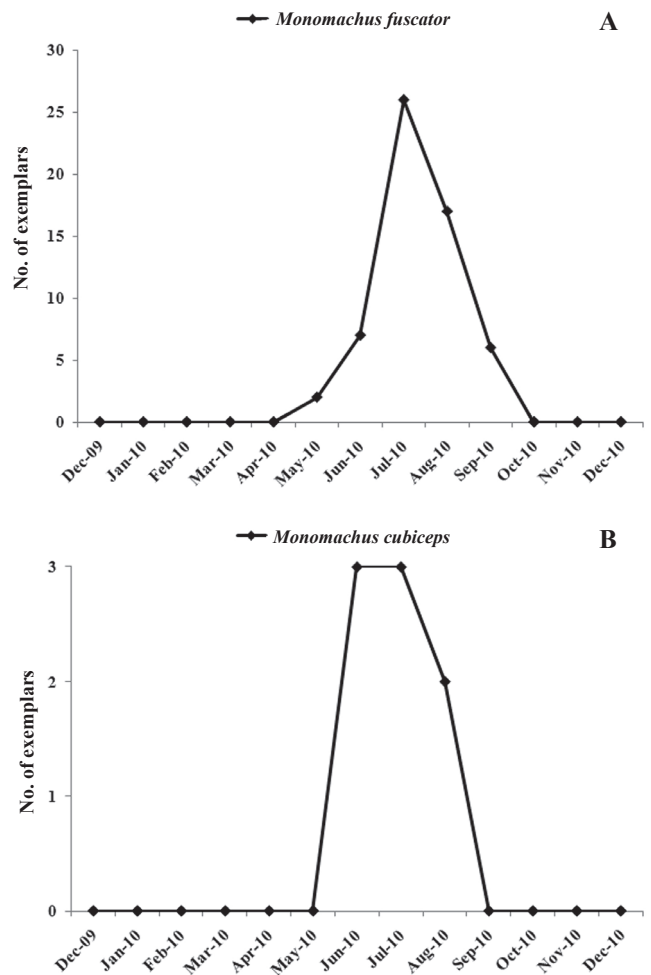


Figure 3. Species of *Monomachus* Klug, 1841 (Hymenoptera: Diapriodea) collected with Malaise traps in five areas of Atlantic Rainforest of the São Paulo State, Brazil, between December 2009 and December 2010. **A.** *Monomachus fuscator*. **B.** *Monomachus cubiceps*.

Grande do Sul and, *M. cubiceps* is limited to southwestern and southern Brazil, Argentina and Paraguay (Musetti and Johnson 2004).

M. fuscator was more abundant at PEMD (49 exemplars/ 84.5 % of the total this species), followed by PESM-NSV with 4 (6.9 %), PEI with 3 (5.2 %), EEJI with 2 (3.4 %), and none exemplar was captured in the PESM-NP (Table 1). The highest abundance of *M. fuscator* (43 exemplars, 74.1 % of the total this species) was observed in July and August with population peak in July (26 / 44.8 %) (Table 1, Fig. 3A). Due to the small number of specimens of *M. cubiceps* captured, the analyzed data were restricted to *M. fuscator* (Table 1, Fig. 3). *M. cubiceps* were collected only between June and August in the PEI and PEMD.

It is important to highlight that several authors have reported the inability of Malaise traps in capturing the Hymenoptera fauna in a certain environment when used as a single method of capture (Noyes 1989; García 2003; Campbell and Hanula 2007, Aguiar and Santos 2010). Further, Masner (1995) noted that Monomachidae are only occasionally captured with Malaise traps. The results obtained in this study indicate that *Monomachus* can be collected in great number with Malaise traps in high-altitude areas, if used for long periods with multiple replications.

In the additional collection period at PESM/NSV, in November and March (late spring and late summer in south hemisphere), were obtained two exemplars of *M. klugii* Westwood, 1841 that is readily separated from other South American species by its darkened wing tips and by the relatively flat and apically expanded mandibles. *M. klugii* was known only from Rio de Janeiro State, Brazil (Musetti and Johnson 2004) and now its distribution is extended to São Paulo State.

Acknowledgements

To the Instituto Nacional de Ciência e Tecnologia dos Hymenoptera Parasitoides da Região Sudeste Brasileira (Hympar/Sudeste – CNPq/Fapesp/Capes) for the financial support.

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Suggested citation:

PERIOTO, N. W.; LARA, R. I. R.; FERNANDES, D. R. R.; DE BORTOLI, C. P.; SALAS, C.; CROSARIOL NETTO, J.; PEREZ, L. A.; TREVISAN, M.; KUBOTA M. M.; PEREIRA,

N. A.; AGUIRRE-GIL, O. J.; SANTOS, R. F.; JORGE S. J.; LAURENTIS V. L. 2016. *Monomachus* (Hymenoptera, Monomachidae) from Atlantic rainforests in São Paulo State, Brazil. *Revista Colombiana de Entomología* 42 (2): 171-175. Julio-Diciembre 2016. ISSN 0120-0488.