NEW DISTRIBUTION AND SPECIES RECORDS OF TRICHOPTERA FROM SOUTHERN AND SOUTHEASTERN BRAZIL

Roger J. Blahnik, Henrique Paprocki, and Ralph W. Holzenthal

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Department of Entomology, University of Minnesota
1980 Folwell Ave, Saint Paul, MN, 55108, USA
email: blah003@umn.edu

Abstract

We provide here a list of new species records of Trichoptera (Insecta) collected in Southern and Southeastern Brazil. We report 21 new distribution records for the country of Brazil. We also provide new distribution records for 92 species of Trichoptera for the states of Minas Gerais, São Paulo, Rio de Janeiro, Paraná and Santa Catarina.

Key words: *Trichoptera, Caddisflies, Checklist, Aquatic Insects, Neotropical, Brazil, Distribution, New records*

Resumo

Apresenta-se aqui uma lista de novos registros de Trichoptera (Insecta) para estados do Sul e Sudeste do Brasil. O número de novos registros de espécies de Trichoptera apresentados aqui é de 92, sendo que 21 são novos registros também para país.

Palavras-chave:*Trichoptera, Fauna, Lista de espécies, Brasil, Insetos aquáticos, Distribuição*

Introduction

The diversity and distribution of Trichoptera from the Neotropical region is still very incompletely known; many new species remain to be discovered and described and most described species are known only from fragmentary distribution records. Although several regions in the Neotropics have been reasonably well surveyed (e.g., the Caribbean, Costa Rica, Chile), most distribution records of species of Trichoptera outside these regions are still represented by incidental collections. Many species are still only known from the site from which the species was originally described. The accompanying list was compiled from recent collections made during a United States National Science Foundation funded project, conducted in coordination with the Museu de Zoologia, Universidade de São Paulo, to inventory and describe the Trichoptera diversity of southeastern Brazil. It represents new distribution records of Trichoptera by state for the collection survey area. To date, however, no collecting has been done in the state of Espírito Santo. Records from the states of Santa Catarina and Paraná in southern Brazil resulted from collecting done by Ralph Holzenthal during a sabbatical prior to the initiation of the research project. For a complete list of the taxa currently known from Brazil, including state records, the reader is referred to the accompanying article by Paprocki et al. (2004). In addition to these records of previously described species, many species (about half of the total collected) represent new and undescribed species. Taxonomic and systematic work on these are in progress and descriptions will be reported in subsequent papers. The primary purpose of this paper is to list new species and distribution records by state from the inventory survey project. Although, the primary value of the list is to add to the knowledge of the Trichoptera fauna of southern and southeastern Brazil itself, the list has the further value of helping to fill continent-wide gaps in our knowledge of Trichoptera distribution in South America.

Collecting Methods

Collections of insects result from the juxtaposition of three elements: time, place, and opportunity. In order for a species of insect to be collected, a collector must be in the right place, at the right time, and s/he must also have or take the opportunity to collect. Needless to say, the inventory discussed here and in the accompanying article by Paprocki et al. (2004) allowed for the juxtaposition of these elements for only some fraction of the Trichoptera fauna actually present in southern and southeastern Brazil. Undoubtedly, many additional species remain to be collected**.** The following description of collecting methods is given both to record the methods used during the inventory and as an aid to students interesting in documenting the fauna.

A standard method of collecting Trichoptera is the use of a blacklight (ultra-violet light) and bed sheet erected near a stream. Primary flight time of caddisflies begins about sunset and continues for several hours after dark, but rapidly tapers off in the later evening. A second flight period occurs near dawn for some species. A 12 volt automobile battery, which can be recharged as necessary, provides enough energy to run a blacklight for several nights. However, use of a portable generator allows the possibility of also running a mercury vapor light, which gives off a much brighter light. Simultaneous use of both a mercury vapor light and blacklight maximizes their effectiveness. A tarp suspended over the sheet will provide essential protection from rain and keep the sheet dry. With such a precaution, flight of caddisflies to the sheet will continue during mild or even moderate rainfall, and it is possible to continue collecting. The best and most effective way to collect caddisflies is directly from the sheet with use of cyanide jars. If tissue paper is placed in the bottom of the jar and the jar is not allowed to become too full of insects, the hairs on the wings of the specimens, which are easily removed using general collection techniques or by rough or careless handling, will be retained. The hairs on the wings, much like the scales on the wings of Lepidoptera, are very useful diagnostic characters (Holzenthal and Blahnik 1995). Because the specimens are fragile and desiccate quickly, it is important that they be pinned promptly. Usually all of the specimens collected during a single night can be easily pinned the following morning, using stainless steel pins or minutens. Fortunately, it is not necessary to spread the wings of Trichoptera. While requiring extra effort in the field compared to collecting specimens in ethanol, specimens collected this way are also the most valuable for systematic work. When it is considered that some percentage of specimens collected will likely also constitute type series, the value of carefully pinning them should be evident.

It is also valuable to augment collecting at a sheet with other collecting techniques, including ethanol pan traps, malaise traps suspended across a stream, and day collecting by net. The method we use for ethanol pan traps is simply to place a blacklight horizontally over a shallow white pan, with a small amount of ethanol in the bottom. The trap can be run for several hours after sunset, or all night if conservation of battery power is not an issue. It must be admitted that collecting specimens in ethanol is the preferred method by some (perhaps most) Trichoptera taxonomists. However, while it is possible to do systematic work on specimens stored in ethanol, and even some advantages (more pliability, less shrinkage), they lose their color more rapidly than specimens on pins and their overall condition in ethanol deteriorates over time. Ideally, both methods of preservation should be used. Use of ethanol collecting as an adjunct method is especially important for species in the family Hydroptilidae (the so-called microcaddisflies), especially at a site where they are very abundant. This is because "micros" usually appear at a sheet in a pulse shortly after sunset and time limits the number of specimens that can be manually collected at a sheet. Use of an ethanol pan trap guarantees that species that may have been missed at the sheet are still collected. Also, if the traps are run all night they may collect species with unusual flight periods. Although it is necessary to collect hydroptilids in ethanol to capture total diversity, every effort should still be made to collect and pin as many specimens as possible. Malaise traps and day collecting (sweeping) with a net, are useful adjunct collecting methods, especially for collecting day-active species and those not readily attracted to lights. Some day-active species may be common, but are only rarely or incidentally (or never) collected at lights.

It is important also to collect larval specimens from a site for eventual association with adult material. This is especially true if species-level identifications of larvae are ever to be used for biomonitoring purposes. A traditional method for associating larval and adult material is by use of a "metamorphotype" (Vorhies 1909, Ross 1934, Milne 1938, Ross 1944, Wiggins 1996). It requires the fortuitous collection of a mature pupa, or pharate adult, in which the genitalic characters are already formed. Larval sclerites for most species are retained within the pupal case and form the basis for making associations. Rearing of larvae is also useful, but usually requires controlled laboratory conditions. DNA sequencing techniques also hold the promise of being useful for associating larvae and adults, but limited use of the method has been made so far in Trichoptera. Specimens that are either pinned or collected in ethanol can be directly used for DNA sequencing, but efforts should also be made to collect specimens in fluids especially designed for their suitability for preserving DNA, if the eventual goal is to use the material for this purpose. Whatever method is used to associate larvae and adults, once the identity of a larva is determined, it is likely that morphological characters will continue to be important for making species identifications and constructing keys. Taxonomic progress on larvae will inevitably lag behind that of adults, on which species taxonomy is based.

Results and Discussion

Twenty-one records are of species previously unreported from Brazil. These are indicated in Table 1 by an asterisk. As might be anticipated, of the 92 species for which new state distribution records are given, the majority were either already known from nearby states in Brazil, or from the neighboring countries of Uruguay, Paraguay, or Argentina. Others, however, were previously only reported from countries distant from the collection area or from very distant areas of Brazil, as for example *Oxyethira espinada* Holzenthal and Harris and *Polyplectropus alleni* (Yamamoto), previously only known from Costa Rica, *Smicridea palifera* Flint, previously only recorded from Venezuela, and *Chimarra adamsae* Blahnik, previously only known from southern Peru and the Rio Xingu region of Brazil. Previous distribution records would have inferred these species to be restricted and endemic in distribution, but obviously this is not the case. Undoubtedly, many species of Trichoptera *will* prove to be regionally restricted and endemic, but it is still premature to make these kinds of assessments at this time.

Despite the fact that the region of southern and southeastern Brazil has a long history of occupation and includes the largest cities, universities, and museums in the country, the Trichoptera of the area have remained very poorly known and incompletely documented. Fritz Müller, was one early worker on Trichoptera of the region (with publications during 1879-1921), but there has been no recent tradition of Trichoptera research. This absence of workers largely explains why such a large percentage of the fauna has remained unknown. However, a number of Brazilian students have recently become interested in Trichoptera, in part because of the value of studying the fauna in order to do water quality assessment. They are beginning a new tradition in systematic work on Trichoptera within Brazil and it is anticipated that the fauna will soon be much better known.

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	Taxon	New state records				
	Ecnomidae					
*	*Austrotinodes uruguayensis* Angrisano 1994				PR	
	Glossossomatidae					
	Mexitrichia albolineata (Ulmer) 1907		SP			
	Mexitrichia teutona Mosely 1939			RJ		
*	*Protoptila cora* Flint 1983	MG				
	Helicopsychidae					
	Helicopsyche (*Cochliopsyche*) *clara* (Ulmer) 1905	MG				
	Helicopsyche (*Cochliopsyche*) *opalescens* Flint 1972	MG	SP			
*	*Helicopsyche (Cochliopsyche) lobata* Flint 1983	MG				SC
	Helicopsyche (*Feropsyche*) *monda* Flint 1983	MG	SP		PR	
	Hydrobiosidae					
	Atopsyche (*Atopsaura*) *acahuana* Schmid 1989	MG		RJ		
	Atopsyche (*Atopsaura*) *huanapu* Schmid 1989			RJ		
	Atopsyche (*Atopsaura*) *huarcu* Schmid 1989		SP			
	Atopsyche (*Atopsaura*) *plancki* Marlier 1964	MG		RJ		
	Atopsyche (*Atopsaura*) *sanctipauli* Flint 1983	MG		RJ	PR	SC
	Atopsyche (*Atopsaura*) *zernyi* Flint 1974	MG		RJ		SC
*	*Atopsyche* (*Atopsyche*) *chirihuana* Schmid 1989	MG				
*	*Atopsyche* (*Atopsyche*) *erigia* Ross 1947	MG				
	Hydropsychidae					
	Blepharopus diaphanus Kolenati 1859	MG				
	Centromacronema obscurum (Ulmer) 1905	MG				SC
	Leptonema bifurcatum Flint et al. 1987	MG				
	Leptonema sparsum (Ulmer) 1905	MG				
	Leptonema tridens Mosely 1933	MG	SP			
	Leptonema trispicatum Flint et al. 1987		SP		PR	
	Leptonema viridianum Navás 1916		SP			
	Macronema hageni Banks 1924	MG				
	Macrostemum ulmeri (Banks) 1913	MG				
	Smicridea (*Rhyacophylax*) *appendiculata* Flint 1972	MG				
*	*Smicridea* (*Rhyacophylax*) *dentifera*Flint 1983a		SP			
	Smicridea (*Rhyacophylax*) *discalis* Flint 1972	MG				
*	*Smicridea* (*Rhyacophylax*) *forcipata* Flint 1983					SC
	Smicridea (*Rhyacophylax*) *iguazu* Flint 1983	MG				
	Smicridea (*Rhyacophylax*) *piraya* Flint 1983	MG				
*	*Smicridea* (*Rhyacophylax*) *radula* Flint 1974	MG	SP	RJ	PR	
	Smicridea (*Rhyacophylax*) *scutellaris* Flint 1974	MG				
	Smicridea (*Rhyacophylax*) *spinulosa* Flint 1972		SP			SC
	Smicridea (*Rhyacophylax*) *unguiculata* Flint 1983	MG				
	Smicridea (*Rhyacophylax*) *vermiculata* Flint 1978	MG				
	Smicridea (*Smicridea*) *albosignata* Ulmer 1907	MG		RJ		
	Smicridea (*Smicridea*) *bivittata* (Hagen) 1861	MG				
*	*Smicridea* (*Smicridea*) *palifera* Flint 1981			RJ		
	Smicridea (*Smicridea*) *paranensis* Flint 1983	MG		RJ		
	Synoestroposis grisoli Navás 1924	MG				
	Synoestroposis pedicillata Ulmer 1905	MG				
	Hydroptilidae					
	Abtrichia antennata Mosely 1939	MG				
	Abtrichia squamosa Mosely 1939	MG		RJ		
	Anchitrichia duplifurcata Flint 1983	MG				
	Byrsopteryx abrelata Harris and Holzenthal 1994				PR	

	Hydroptila argentinica Flint 1983				PR	
*	*Neotrichia filifera* Flint 1983a	MG				
*	*Oxyethira espinada* Holzenthal and Harris 1992	MG				
*	*Oxyethira parce* (Edwards and Arnold) 1961	MG				
	Oxyethira tica Holzenthal and Harris 1992	MG				
	Oxyethira zilaba (Mosely) 1939	MG	SP		PR	
	Leptoceridae					
	Achoropsyche duodecimpunctata (Navás) 1916	MG	SP			
	Grumichella aequiunguis Flint 1983	MG			PR	
	Grumichella rostrata Thienemann 1905					
	Nectopsyche aureovittata Flint 1983	MG	SP			
*	*Nectopsyche acutiloba* Flint 1974	MG				
	Nectopsyche bruchi (Navás) 1920	MG			PR	
*	*Nectopsyche brunneofascia* Flint 1983a		SP			SC
	Nectopsyche flavofasciata (Ulmer) 1907	MG	SP			
	Nectopsyche fuscomaculata Flint 1983	MG	SP			
	Nectopsyche muhni (Navás) 1916	MG				
*	*Nectopsyche navasi* Holzenthal 1999					SC
	Nectopsyche ortizi Holzenthal 1995	MG	SP	RJ		
	Nectopsyche pantosticta Flint 1983			RJ		
	Nectopsyche punctata (Ulmer) 1905	MG	SP			
	Nectopsyche separata (Banks) 1920	MG	SP			
*	*Oecetis inconspicua* (Walker) 1852	MG			PR	
	Oecetis iguazu Flint 1983	MG	SP			
*	*Triplectides neotropicus* Holzenthal 1988	MG				
*	*Triplectides misionensis* Holzenthal 1988		SP	RJ	PR	SC
	Odontoceridae					
*	*Marilia elongata* Martynov 1912	MG				
	Marilia major Müller 1880	MG			PR	
	Marilia minor Müller 1880	MG		RJ		
*	*Marilia truncata* Flint 1983a	MG				
	Philopotamidae					
	Chimarra (*Chimarra*) *adamsae* Blahnik 1998	MG	SP		PR	
	Chimarra (*Chimarrita*) *camella* Blahnik 1997		SP	RJ		
	Chimarra (*Chimarrita*) *camura* Blahnik 1997		SP			
	Chimarra (*Curgia*) *conica* Flint 1983			RJ		
	Chimarra (*Curgia*) *froehlichi* Flint 1998	MG				
	Chimarra (*Chimarrita*) *kontilos* Blahnik 1997	MG	SP			
	Chimarra (*Chimarrita*) *majuscula* Blahnik 1997		SP			
	Chimarra (*Curgia*) *teresae* Flint 1998	MG	SP	RJ		
	Chimarra (*Chimarra*) *uara* Flint 1971	MG				
	Polycentropodidae					
	Cernotina cacha Flint 1971	MG				
	Cernotina perpendicularis Flint 1971	MG				
	Cyrnellus fraternus (Banks) 1905	MG			PR	SC
	Cyrnellus mammillatus Flint 1971	MG	SP		PR	
	Cyrnellus risi (Ulmer) 1907	MG				
	Nyctiophylax neotropicalis Flint 1971	MG		RJ	PR	
*	*Polyplectropus alleni* (Yamamoto) 1967	MG				
	Sericostomatidae					
	Grumicha grumicha (Vallot) 1855		SP			
	Total	**69**	**29**	**19**	**17**	**10**

Table 1: New records of Trichoptera Species for the Brazilian States of Minas Gerais, São Paulo, Rio de Janeiro, Paraná and Santa Catarina.

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CHECKLIST OF THE TRICHOPTERA (INSECTA) OF BRAZIL I

Henrique Paprocki, Ralph W. Holzenthal and Roger J. Blahnik

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Department of Entomology, University of Minnesota
1980 Folwell Ave, Saint Paul, MN, 55108, USA
email: papr0002@umn.edu
or hpaprocki@ig.com.br

Abstract

We present here a list of Trichoptera species recorded in the literature from Brazil as of September 2003. The total number of species recorded for Brazil is 378. The most diverse family is Hydropsychidae with 103 species; the second most diverse is Hydroptilidae with 50 species, followed by Leptoceridae and Philopotamidae with 41 each. Distributions by state and additional literature relevant to Brazilian Trichoptera are also presented.

Key words: *Trichoptera, Caddisflies, Checklist, Aquatic Insects, Neotropical, Brazil, Distribution, New records*

Resumo

Apresenta-se aqui uma lista de Trichoptera (Insecta) para o Brasil com registros de espécies publicados na literatura até Setembro de 2003. O número de espécies registradas para o Brasil é de 378. A família mais diversa é Hydropsychidae com 107 espécies, seguida por Hydroptilidae com 50, Leptoceridae e Philopotamidae com 41 cada. Também são fornecidas a distribuição por estado e a literatura adicional relevante a ordem Trichoptera no Brasil.

Palavras-chave:*Trichoptera, Fauna, Lista de espécies, Brasil, Insetos aquáticos, Distribuição*

Introduction

Caddisflies (Trichoptera) constitute the most abundant and diverse order of insects whose members are exclusively aquatic. They reach their highest diversity in pristine mountain streams and rivers where they exploit a variety of microhabitats. Some are grazers, feeding on the algae that grow on submerged rocks, others are collectors of tiny bits of organic matter or are filter feeders that strain drifting organic matter. Many shred larger pieces of organic matter, mostly wood and leaves, ingesting the resulting pieces. There are also predators and species that pierce aquatic macrophytes to ingest the cell cytoplasm (Merritt and Cummins 1996).

The immature stages of caddisflies develop in water, where they build portable cases or fashion fixed retreats that are amazing for their intricate engineering. The larvae, like caterpillars, produce silk from modified salivary glands. In some families, this silk is used to build nets that filter the water to capture food items. In others the silk is used as glue to build portable cases in which the larvae reside. Cases are constructed of a wide variety of materials, including sand, rock fragments, leaves, twigs, abandoned snail shells or entirely of silk in some species (Wiggins 1996).

Adult caddisflies resemble small moths (Figures 1-4), but they have their wings covered with hairs, while moth and butterfly wings are covered with scales. Adult caddisflies live for only a few days to 2 or 3 weeks. While adults don't feed, they perform the essential life functions of mating and egg laying. From the taxonomic perspective, adults are very important because species identification is based almost solely on characters of the adult male genitalia (Morse 2003).

Caddisfly larvae have very distinct responses to pollution and other environmental impacts. Knowledge of the species and their natural history has great value for the development of water quality monitoring programs. Together with other aquatic organisms, they are used in a number of important water quality indexes or metrics. Some of these indexes require identification only at the family level, but species level identification allows for more precise water quality assessment (Resh and Unzicker 1975, Resh 1995). It is not possible though, to determine the species of an immature without knowing the adult. In this case, adult taxonomy has to be established first, followed by larval/adult associations.

A great part of the fauna of the Neotropical region has not yet been described. The accelerated loss of species in many threatened Neotropical areas is tragic. Describing unknown biodiversity is one of the most important aids to conservation efforts. Highly sensitive freshwater ecosystems, such as tropical rivers, are suffering major losses of species before they are known to science. Major efforts should be made to collect and describe this fauna, which represents a major source of genetic diversity.

We present here a list of Brazilian Trichoptera recorded in the scientific literature as of September 2003. We hope that this list will be a useful resource for the emerging trichopterologist community in Brazil, as well as to other aquatic insect researchers. For complete taxonomical information on the taxa presented here, we suggest consulting the "Catalog of Neotropical Caddisflies (Insecta: Trichoptera)" (Flint et al 1999b) and the Fisher *Tricopterorum Catalogus* (1962-1973). For more information on the order Trichoptera and the history of Trichoptera taxonomy in Brazil we suggest an article published in Ciência Hoje (Paprocki 2003), which can be downloaded from the web site http://www2.uol.com.br/cienciahoje/chmais/pass/ch190/primeira.pdf.

Methods

The literature search prior to 1999 was performed using the catalog of Flint et al (1999b). Another valuable source for compiling these data was the Trichoptera World Checklist web site http://entweb.clemson.edu/database/trichopt/search.htm maintained by Dr. John C. Morse at Clemson University, USA. Zoological Records was another source used to search for Brazilian Trichoptera literature. We did not present all literature available for Trichoptera, but only the references relevant to taxonomic studies, such as species descriptions, new distribution records, and the most recent revisions of genera. Codes used for the Brazilian states are RO (Roraima), AC (Acre), AM (Amazonas), RR (Roraima), RN (Rondonia), PA (Pará), AP (Amapá), TO (Tocantins), MA (Maranhão), PI (Piauí), CE (Ceará), RN (Rio Grande do Norte), PB (Paraíba), PE (Pernambuco), AL (Alagoas), SE (Sergipe), BA (Bahia), MG (Minas Gerais), ES (Espírito Santo), RJ (Rio de Janeiro), SP, (São Paulo), PR (Paraná), SC (Santa Catarina), RS (Rio Grande do Sul), MS (Mato Grosso do Sul), MT (Mato Grosso), GO (Goiás), DF (Distrito Federal). In Table 1, when there is no specific information about the state in Brazil where the species was collected, only "Brazil" is indicated. The number in parentheses after the taxon name represents the number of species for that taxon. We also present references for the most recent taxonomic revision for each genus, when available. Table 2 presents the number of species records per state in Brazil.

Results and Discussion

The total number of Trichoptera species recorded for Brazil is 378 (Table 1). The total number of genera recorded

Figure 1 - Polycentropus sp. mating Family Polycentropodidae

Figure 2- Macronema *sp. Family Hydropsychidae.*

Figure 3- Trichoptera of the family Philopotamidae mating.

Figure 4- Leptonema *sp. Family Hydropsychidae.*

Taxon (Number of species: 378)	Bibliography	Distribution by state
Anomalopsychidae (1)		
Contulma Flint 1969 (1)	Flint 1969, Holzenthal and Flint 1995	
Contulma tijuca Holzenthal and Flint 1995	Holzenthal and Flint 1995	RJ
Atriplectididae (1)		
Neoatriplectides Holzenthal 1997 (1)	Holzenthal 1997	
Neoatriplectides sp Holzenthal 1997	Holzenthal 1997	SP
Calamoceratidae (17)		
Phylloicus Müller 1880 (17)	Müller 1880, Prather 2003	
Phylloicus abdominalis (Ulmer) 1905	Ulmer 1905b, Prather 2003	SC, MG, RJ, SP, PR
Phylloicus amazonas Prather 2003	Prather 2003	AM
Phylloicus angustior Ulmer 1905	Ulmer 1905a, Prather 2003	RS, GO, MG, PR, SC
Phylloicus auratus Prather 2003	Prather 2003	AM
Phylloicus bertioga Prather 2003	Prather 2003	SP
Phylloicus bidigitatus Prather 2003	Prather 2003	RJ
Phylloicus bromeliarum Müller 1880	Müller 1880, Prather 2003	SC, SP
Phylloicus brevior Banks 1915	Banks 1915, Prather 2003	PR, RO
Phylloicus fenestratus Flint 1974	Flint 1974b, Prather 2003	AM, PB, PR, RO
Phylloicus flinti Prather 2003	Prather 2003	RO
Phylloicus major Müller 1880	Müller 1880, Prather 2003	RJ, SC, SP
Phylloicus medius Müller 1880	Müller 1880, Prather 2003	SC
Phylloicus obliquus Navás 1931	Navás 1931, Prather 2003	MG, RJ, SC
Phylloicus paprockii Prather 2003	Prather 2003	MG
Phylloicus plaumanni Flint 1983	Flint 1983a, Prather 2003	SC
Phylloicus quadridigitatus Prather 2003	Prather 2003	SP
Phylloicus tricalcaratus (Ulmer) 1905	Ulmer 1905b, Prather 2003	BA
Phylloicus yolandae Prather 2003	Prather 2003	PR
Ecnomidae (6)		
AustrotinodesSchmid 1955 (6)	Schmid 1955, Flint 1973, Flint and Denning 1989	
Austrotinodes amazonensis Flint and Denning 1989	Flint and Denning 1989	AM
Austrotinodes ariasi Flint and Denning 1989	Flint and Denning 1989	AM
Austrotinodes bracteatus Flint and Denning 1989	Flint and Denning 1989	SP
Austrotinodes paraguayensis Flint 1983	Flint 1983a	MG
Austrotinodes prolixus Flint and Denning 1989	Flint and Denning 1989	MG
Austrotinodes uruguayensis Angrisano 1994	Angrisano 1994, Blahnik et al 2004	PR
Glossosomatidae (21)		
Canoptila Mosely 1939 (1)	Mosely 1939	

Canoptila bifida Mosely 1939	Mosely 1939	SC
Itauara Müller 1888 (3)	Müller 1888, Flint et al 1999a	
Itauara amazonica (Flint) 1971	Flint 1971	AM
*Itauara brasiliana (*Mosely) 1939	Mosely 1939	SC
Itauara plaumanni (Flint) 1974	Flint 1974a	SC
Mexitrichia Mosely 1937 (5)	Mosely 1937, Flint et al 1999a	
Mexitrichia albolineata (Ulmer) 1907	Ulmer 1907a, Blahnik et al 2004	SC, SP
Mexitrichia catarinensis Flint 1974	Flint 1974a	SC
Mexitrichia ormina Mosely 1939	Mosely 1939	SC
Mexitrichia teutona Mosely 1939	Mosely 1939, Flint 1972, Blahnik et al 2004	SC, MG, RJ
Mexitrichia unota Mosely 1939	Mosely 1939	SC
Protoptila Banks 1904 (12)	Banks 1904, Flint 1971, Flint 1996	
Protoptila cora Flint 1983	Flint 1983a, Blahnik et al 2004	MG
Protoptila condylifera Flint 1971	Flint 1971	AM
Protoptila disticha Flint 1971	Flint 1971	AM, PA
Protoptila dubitans Mosely 1939	Mosely 1939	SC
Protoptila ensifera Flint 1971	Flint 1971	AM
Protoptila flexispina Flint 1971	Flint 1971	AM
Protoptila macilenta Flint 1971	Flint 1971	PA
Protoptila mara Flint 1971	Flint 1971	AM
Protoptila simplex Flint 1971	Flint 1971	AM, PA
Protoptila ternatia Flint 1971	Flint 1971	AM
Protoptila tetravittata Flint 1971	Flint 1971	AM
Protoptila trispicata Flint 1971	Flint 1971	AM
Helicopsychidae (11)		
Helicopsyche Siebold 1856 (11)	Siebold 1856, Müller 1885, Johanson 1998	
Helicopsyche (*Cochliopsyche*) *clara* (Ulmer) 1905	Ulmer 1905a, Flint 1996, , Blahnik et al 2004	SC, MG
Helicopsyche (*Cochliopsyche*) *opalescens* Flint 1972	Flint 1972, Flint 1996, Blahnik et al 2004	RR, RJ, SP
Helicopsyche (Cochliopsyche) lobata Flint 1983	Flint 1983a, Blahnik et al 2004	MG, SC
Helicopsyche (*Feropsyche*) *braziliensis* (Swainson) 1840	Swainson 1840	Brazil
Helicopsyche (*Feropsyche*) *flinti* Johanson 1999	Johanson 1999	SC
Helicopsyche (*Feropsyche*) *helicoidella* (Vallot)1855	Vallot 1855	BA
Helicopsyche (*Feropsyche*) *monda* Flint 1983	Flint 1983a, Blahnik et al 2004	SC, MG, SP, PR
Helicopsyche (*Feropsyche*) *muelleri* Banks 1920	Banks 1920	SC
Helicopsyche (*Feropsyche*) *planorboides* Machado 1957	Machado 1957	MG
Helicopsyche (*Feropsyche*) *valligera* Flint 1983	Flint 1983a	SC
Helicopsyche (*Feropsyche*) *vergelana* Ross 1956	Ross 1956b	Brazil
Hydrobiosidae (19)		
Atopsyche Banks 1905 (19)	Banks 1905, Schmid 1989	

Atopsyche (*Atopsaura*) *acahuana* Schmid 1989	Schmid 1989, Blahnik et al 2004	ES, RJ
Atopsyche (*Atopsaura*) *antisuya* Schmid 1989	Schmid 1989	MG
Atopsyche (*Atopsaura*) *apurimac* Schmid 1989	Schmid 1989	RJ
Atopsyche (*Atopsaura*) *hamata* Ross and King 1952	Ross and King 1952	RR
Atopsyche (*Atopsaura*) *hatunpuna* Schmid 1989	Schmid 1989	SP
Atopsyche (*Atopsaura*) *huacachaca* Schmid 1989	Schmid 1989	RJ
Atopsyche (*Atopsaura*) *huamachucu* Schmid 1989	Schmid 1989	RJ
Atopsyche (*Atopsaura*) *huanapu* Schmid 1989	Schmid 1989, Blahnik et al 2004	SP, RJ
Atopsyche (*Atopsaura*) *huarcu* Schmid 1989	Schmid 1989, Blahnik et al 2004	MG, RJ, SP
Atopsyche (*Atopsaura*) *longipennis* (Ulmer) 1905	Ulmer 1905a	SC
Atopsyche (*Atopsaura*) *plancki* Marlier 1964	Marlier 1964a, Blahnik et al 2004	SP, RJ
Atopsyche (*Atopsaura*) *sanctipauli* Flint 1983	Flint 1983a, Blahnik et al 2004	SP, RJ, PR, SC
Atopsyche (*Atopsaura*) *serica* Ross 1953	Ross 1953	SC
Atopsyche (*Atopsaura*) *siolii* Flint 1971	Flint 1971	AM
Atopsyche (*Atopsaura*) *usingeri* Denning and Sykora 1968	Denning and Sykora 1968	RJ
Atopsyche (*Atopsaura*) *zernyi* Flint 1974	Flint 1974a, Blahnik et al 2004	SP, MG, RJ, SC
Atopsyche (*Atopsyche*) *chirihuana* Schmid 1989	Schmid 1989, Blahnik et al 2004	MG
Atopsyche (*Atopsyche*) *erigia* Ross 1947	Ross 1947, Blahnik et al 2004	MG
Atopsyche (*Atopsyche*) *urumarca* Schmid 1989	Schmid 1989	MG
Hydropsychidae (107)		
Blepharopus Kolenati 1859 (1)	Kolenati 1859	
Blepharopus diaphanus Kolenati 1859	Kolenati 1859, Marinoni and Almeida 2000, Blahnik et al 2004	RJ, SC, PR, MG
Centromacronema Ulmer 1905 (2)	Ulmer 1905a, Fischer 1963	
Centromacronema auripenne (Rambur) 1842	Rambur 1842	Brazil
Centromacronema obscurum (Ulmer) 1905	Ulmer 1905a, Blahnik et al 2004	SP, MG, SC
Leptonema Guérin 1843 (23)	Guérin 1843, Flint et al 1987	
Leptonema agraphum (Kolenati) 1859	Kolenati 1859	RJ
Leptonema amazonense Flint 1978	Flint 1978	RR
Leptonema aspersum (Ulmer) 1907	Ulmer 1907b	BA, MS
Leptonema aterrimum Mosely 1933	Mosely 1933	PA
Leptonema bifurcatum Flint et al. 1987	Flint et al. 1987, Blahnik et al 2004	ES, MG
Leptonema boraceia Flint et al. 1987	Flint et al. 1987	RJ,SP
Leptonema columbianum Ulmer 1905	Ulmer 1905a	RO, AM, PA, BA, MG, SP, MS, GO, DF
Leptonema crassum Ulmer 1905	Ulmer 1905a	RR, MG, ES, SP, MT, GO
Leptonema eugnathum (Müller) 1921	Müller 1921	SC
Leptonema lacuniferum Flint 1978	Flint 1978	AM
Leptonema lunatum Flint et al 1987	Flint et al 1987	SC
Leptonema maculatum Mosely 1933	Mosely 1933	AM, PA
Leptonema pallidum Guerin 1834	Guérin 1843	MG, ES, RJ, SP, GO, DF
Leptonema rostratum Flint et al. 1987	Schmid 1964	AM, RR, PA, MT

Leptonema serranum Navás 1933	Flint et al. 1987	SP
Leptonema sparsum (Ulmer) 1905	Flint et al. 1987, Marinoni and Almeida 2000, Blahnik et al 2004	RO, AM, PA, RJ, SP, SC, MT, GO, DF, PR, MG
Leptonema speciosum (Burmeister) 1839	Burmeister 1839	RJ
Leptonema spinulum Flint et al. 1987	Flint et al. 1987	MT, DF
Leptonema stigmaticum Navás 1916	Burmeister 1839	RJ
Leptonema tholloni Navás 1923	Flint et al. 1987	RJ
Leptonema tridens Mosely 1933	Mosely 1933, Blahnik et al 2004	RJ, PR, MG, SP
Leptonema trispicatum Flint et al. 1987	Flint et al. 1987, Blahnik et al 2004	SP, PR
Leptonema viridianum Navás 1916	Mosely 1933, Blahnik et al 2004	MG, RJ, GO, DF
Macronema Pictet 1836 (18)	Pictet 1836, Flint and Bueno 1832	
Macronema amazonense Flint 1978	Flint 1978	AM
Macronema argentilineatum Ulmer 1905	Ulmer 1905a	AM, PA
Macronema bicolor Ulmer 1905	Ulmer 1905a	MG, SC
Macronema burmeisteri Banks 1924	Banks 1924	AM
Macronema exophtalmum Flint 1978	Flint 1978	AM
Macronema fragile Banks 1915	Banks 1915	AM
Macronema fulvum Ulmer 1905	Ulmer 1905a	RJ
Macronema hageni Banks 1924	Banks 1924, Blahnik et al 2004	AM, PA, MG
Macronema immaculatum Mosely 1934	Mosely 1934a	SP, PR
Macronema lachlani Banks 1924	Banks 1924	AM
Macronema lineatum Pictet 1836	Pictet 1836	BA
Macronema muelleri Banks 1924	Banks 1924	AM
Macronema partitum Navás 1932	Navás 1932b	RJ
Macronema parvum Ulmer 1905	Ulmer 1905a	AM
Macronema pennyi Flint 1978	Flint 1978	AM
Macronema percitans Walker 1860	Walker 1860	AM, PA, MT
Macronema pertyi Banks 1924	Banks 1924	MT
Macronema rubiginosum Guérin 1843	Guérin 1843	Brazil
Macrostemum Kolenati 1859 (14)	Kolenati 1859, Flint and Bueno 1982	
Macrostemum arcuatum (Erichson) 1848	Erichson 1848	AM, PA
Macrostemum braueri (Banks) 1924	Banks 1924	AM
Macrostemum digramma (McLachlan) 1871	McLachlan 1871	MG
Macrostemum erichsoni (Banks) 1920	Banks 1920	AM
Macrostemum hyalinum (Pictet) 1836	Pictet 1836, Marinoni and Almeida 2000	PA, PR
Macrostemum maculatum (Perty) 1833	Perty 1833	BA, SP
Macrostemum negrense (Flint) 1978	Flint 1978	AM, PA
Macrostemum par (Navás) 1930	Navás 1930	SP
Macrostemum ramosum (Navás) 1916	Navás 1916b	RJ
Macrostemum santaeritae (Ulmer) 1905	Ulmer 1905b	AM, PA
Macrostemum surinamense (Flint) 1974	Flint 1974c	AM
Macrostemum trigramma (Navás) 1916	Navás 1916b	RJ
Macrostemum triste (Navás) 1916	Navás 1916b	RJ
Macrostemum ulmeri (Banks) 1913	Banks 1913, Blahnik et al 2004	AM, RR, PA, MG

Plectromacronema Ulmer 1906 (2)	Ulmer 1906, Flint 1967, Flint 1983b	
Plectromacronema comptum Ulmer 1906	Ulmer 1906	AM, PA
Plectromacronema subfuscum (Banks) 1920	Banks 1920	SC
Pseudomacronema Ulmer 1905 (1)	Ulmer 1905a	
Pseudomacronema vittatum Ulmer 1905	Ulmer 1905a	AM, PA
Smicridea McLachlan 1871 (40)	McLachlan 1871, Flint 1974b, Flint 1989	
Smicridea (*Rhyacophylax*) *abrupta* Flint 1974	Flint 1974c	A M
Smicridea (*Rhyacophylax*) *appendiculata* Flint 1972	Flint 1972, Blahnik et al 2004	AM, MG
Smicridea (*Rhyacophylax*) *atrobasis* Flint 1983	Flint 1983a	SC
Smicridea (*Rhyacophylax*) *brasiliana* (Ulmer) 1905	Ulmer 1905a	SC
Smicridea (*Rhyacophylax*) *caligata* Flint 1974	Flint 1974c	A M
Smicridea (*Rhyacophylax*) *columbiana* (Ulmer) 1905	Ulmer 1905a	A M
Smicridea (*Rhyacophylax*) *coronata* Flint 1980	Flint 1980	MG, SP
Smicridea (*Rhyacophylax*) *dentifera* Flint 1983a	Flint 1983a, Blahnik et al 2004	SP
Smicridea (*Rhyacophylax*) *discalis* Flint 1972	Flint 1972, Marinoni and Almeida 2000, Blahnik et al 2004	PR, MG
Smicridea (*Rhyacophylax*) *ephippifer* Flint 1978	Flint 1978	PA
Smicridea (*Rhyacophylax*) *forcipata* Flint 1983	Flint 1983a, Blahnik et al 2004	SC
Smicridea (*Rhyacophylax*) *froehlichi* Almeida and Flint 2002	Almeida and Flint 2002	RJ
Smicridea (*Rhyacophylax*) *gladiator* Flint 1978	Flint 1978	A M
Smicridea (*Rhyacophylax*) *iguazu* Flint 1983	Flint 1983a, Marinoni and Almeida 2000	RJ, SC, PR, MG
Smicridea (*Rhyacophylax*) *jundiai* Almeida and Flint 2002	Almeida and Flint 2002, Blahnik et al 2004	ES, RJ, PR
Smicridea (*Rhyacophylax*) *mangaratiba* Almeida and Flint 2002	Almeida and Flint 2002	RJ
Smicridea (*Rhyacophylax*) *marlieri* Flint 1978	Flint 1978	AM, PA
Smicridea (*Rhyacophylax*) *marua* Flint 1978	Flint 1978	A M
Smicridea (*Rhyacophylax*) *piraya* Flint 1983	Flint 1983a, Marinoni and Almeida 2000, Blahnik et al 2004	SP, SC, PR, MG
Smicridea (*Rhyacophylax*) *pseudolobata* Flint 1978	Flint 1978	A M
Smicridea (*Rhyacophylax*) *radula* Flint 1974b	Flint 1974b, Blahnik et al 2004	MG, SP, RJ, PR
Smicridea (*Rhyacophylax*) *ralphi* Almeida and Flint 2002	Almeida and Flint 2002	RJ, ES, SP, PR
Smicridea (*Rhyacophylax*) *scutellaris* Flint 1974	Flint 1974c, Blahnik et al 2004	AM, PA, MG
Smicridea (*Rhyacophylax*) *spinulosa* Flint1972	Flint 1972, Marinoni and Almeida 2000, Blahnik et al 2004	AM, PA, PR, SP, SC
Smicridea (*Rhyacophylax*) *unguiculata* Flint1983	Flint 1983a, Marinoni and Almeida 2000, Blahnik et al 2004	SP, SC, GO, PR, MG
Smicridea (*Rhyacophylax*) *vermiculata* Flint1978	Flint 1978, Marinoni and Almeida 2000, Blahnik et al 2004	PA, SC, PR, MG
Smicridea (*Rhyacophylax*) *vilela* Flint 1978	Flint 1978	AM, PA
Smicridea (*Rhyacophylax*) *voluta* Flint 1978	Flint 1978	AM, PA
Smicridea (*Rhyacophylax*) *weidneri* Flint 1972	Flint 1972, Marinoni and Almeida 2000	SC, PR

Smicridea (*Smicridea*) *aequalis* Banks 1920	Banks 1920	PA
Smicridea (*Smicridea*) *albosignata* Ulmer 1907	Ulmer 1907a, Marinoni and Almeida 2000, Blahnik et al 2004	SP, PR, RJ, MG, RJ
Smicridea (*Smicridea*) *bivittata* (Hagen) 1861	Hagen 1861, Blahnik et al 2004	PA, MG
Smicridea (*Smicridea*) *mirnae* Almeida and Flint 2002	Almeida and Flint 2002	PR
Smicridea (*Smicridea*) *obliqua* Ulmer 1905	Ulmer 1985	A M
Smicridea (*Smicridea*) *palifera* Flint 1981	Flint 1981, Blahnik et al 2004	RJ
Smicridea (*Smicridea*) *paranensis* Flint 1983	Flint 1983a, Marinoni and Almeida 2000, Blahnik et al 2004	PR, MG, RJ
Smicridea (*Smicridea*) *reinerti* Flint 1978	Flint 1978	PA
Smicridea (*Smicridea*) *sattleri* Denning and Sykora 1968	Denning and Sykora 1968	SP
Smicridea (*Smicridea*) *sexspinosa* Flint 1978	Flint 1978	A M
Smicridea (*Smicridea*) *truncata* Flint 1974	Flint 1974c	AM, PA
Synoestroposis Ulmer 1905 (6)	Ulmer 1905a, Flint et al 1999a	
Synoestroposis furcata Flint 1974	Flint 1974c	PA
Synoestroposis grisoli Navás 1924	Navás 1924, Blahnik et al 2004	AM, PA, MG
Synoestroposis obliqua Ulmer 1905	Ulmer 1905a	RS
Synoestroposis pedicillata Ulmer 1905	Ulmer 1905a, Blahnik et al 2004	SC, MG
Synoestroposis punctipennis Ulmer 1905	Ulmer 1905a	A M
Synoestroposis stictonota Navás 1932	Navás 1932a	SC
Hydroptilidae (50)		
Abtrichia Mosely 1939 (2)	Mosely 1939	
Abtrichia antennata Mosely 1939	Mosely 1939, Blahnik et al 2004	SC, MG
Abtrichia squamosa Mosely 1939	Mosely 1939, Blahnik et al 2004	SC, MG, RJ
Acostatrichia Mosely 1939 (3)	Mosely 1939	
Acostatrichia brevipenis Flint 1974	Flint 1974c	RR
Acostatrichia plaumanni Mosely 1939	Mosely 1939	SC
Acostatrichia simulans Mosely 1939	Mosely 1939	SC
Alisotrichia Flint 1964 (1)	Flint 1964	
Alisotrichia cacaulandia	Harris and Flint 2002	RO
Anchitrichia Flint 1970 (1)	Flint 1970	
Anchitrichia duplifurcata Flint 1983	Flint 1983a, Guahyba 1991, Blahnik et al 2004	RJ, MG
Ascotrichia Flint 1983 (1)	Flint 1983a	
Ascotrichia frontalis Flint 1983	Flint 1983a	ES, RJ
Betrichia Mosely 1939 (2)	Mosely 1939	
Betrichia longistyla Flint 1983	Flint 1983a	SC
Betrichia zilbra Mosely 1939	Mosely 1939	SC

Bredinia Flint 1968 (1)	Flint 1981	
Bredinia espinosa Harris, Holzenthal and Flint 2002	Harris, Holzenthal and Flint 2002	MT, RO
Byrsopteryx Flint 1981 (2)	Flint 1981	
Byrsopteryx abrelata Harris and Holzenthal 1994	Harris and Holzenthal 1994, Blahnik et al 2004	RJ, PR
Byrsopteryx espinhosa Harris and Holzenthal 1994	Harris and Holzenthal 1994	RJ
Dicaminus Müller 1879 (1)	Müller 1879b, Botosaneanu and Flint 1982	
Dicaminus ladislavii Müller 1879	Müller 1879b	SC
Eutonella Müller 1921 (1)	Müller 1921, Flint et al 1999a	
Eutonella peltopsychodes Müller 1921	Müller 1921	SC
Flintiella Angrisano 1995 (1)	Angrisano 1995	
Flintiella boraceia Harris, Flint and Holzenthal 2002	Harris, Flint and Holzenthal 2002	SP
Hydroptila Dalman 1819 (2)	Dalman 1819, Bueno 1984, Harris and Holzenthal 1999	
Hydroptila argentinica Flint 1983	Flint 1983a, Blahnik et al 2004	SP, PR
Hydroptila producta Mosely 1939	Mosely 1939	SC
Leucotrichia Mosely 1934 (1)	Mosely 1934, Flint 1970	
Leucotrichia brasiliana Sattler and Sykora 1977	Sattler and Sykora 1977	AM
Neotrichia Morton 1905 (12)	Morton 1905	
Neotrichia abbreviata Flint 1983	Flint 1983a	SC
Neotrichia dubitans (Mosely) 1939	Mosely 1939	SC
Neotrichia durior Flint 1983	Flint 1983a	SC
Neotrichia filifera Flint 1983a	Flint 1983a, Blahnik et al 2004	MG
Neotrichia longissima Flint 1983	Flint 1983a	SC
Neotrichia noteuna (Mosely) 1939	Mosely 1939	SC
Neotrichia novara (Mosely) 1939	Mosely 1939	SC
Neotrichia ovona (Mosely) 1939	Mosely 1939	SC
Neotrichia rotundata Flint 1974	Flint 1974c	RR
Neotrichia sicilicula Flint 1983	Flint 1983a	SC
Neotrichia tertia (Mosely) 1939	Mosely 1939	SC
Neotrichia teutonia Flint 1983	Flint 1983a	SC
Nothotrichia Flint 1967 (1)	Flint 1967, Harris and Armitage 1997	
Nothotrichia tupi Holzenthal and Harris 2002	Holzenthal and Harris 2002	
Ochrotrichia Mosely 1934 (1)	Mosely 1934b	
Ochrotrichia concha Bueno and Santiago 1992	Bueno and Santiago 1992	AM
Oxyethira Eaton 1873 (13)	Eaton 1873	
Oxyethira bicornuta Kelley 1983	Kelley 1983	AM
Oxyethira brasiliensis Kelley 1983	Kelley 1983	PA
Oxyethira discaelata Kelley 1983	Kelley 1983	AM

Oxyethira espinada Holzenthal and Harris 1992	Holzenthal and Harris 1992, Blahnik et al 2004	MG
Oxyethira hyalina Müller 1879	Müller 1879b	SC
Oxyethira lagunita Flint 1983	Flint 1983a	PR
Oxyethira merga Kelley 1983	Kelley 1983	RR
Oxyethira parce (Edwards and Arnold) 1961	Edwards and Arnold 1961, Blahnik et al 2004	MG
Oxyethira santiagensis Flint 1982	Flint 1982a	Brazil
Oxyethira spirogyrae Müller 1879	Müller 1879b	SC
Oxyethira spissa Kelley 1983	Kelley 1983	AM, PA
Oxyethira tica Holzenthal and Harris 1992	Holzenthal and Harris 1992, Blahnik et al 2004	MG
Oxyethira zilaba (Mosely) 1939	Mosely 1939, Blahnik et al 2004	SC, MG, SP, PR
Peltopsyche Müller 1879 (2)	Müller 1879b, Flint 1971	
Peltopsyche maclachlani Müller 1879	Müller 1879b	SC
Peltopsyche sieboldii Müller 1879	Müller 1879b	SC
Rhyacopsyche Müller 1879 (1)	Müller 1879b	
Rhyacopsyche hagenii Müller 1879	Müller 1879b	SC
Tricholeiochiton Kloet and Hincks 1944 (1)	Kloet and Hincks 1944	
Tricholeiochiton neotropicalis Flint 1992	Flint 1992	RR
Leptoceridae (41)		
Achoropsyche Holzenthal 1984 (1)	Holzenthal 1984	
Achoropsyche duodecimpunctata (Navás) 1916	Navás 1916a, Almeida and Marinoni 2000, Blahnik et al 2004	AM, RR, PA, ES, SC, PR, MG, SP
Atanatolica Mosely 1936 (2)	Mosely 1936, Holzenthal 1988b	
Atanatolica brasiliana (Brauer) 1865	Brauer 1865	RJ
Atanatolica flinti Holzenthal 1988	Holzenthal 1988b	RJ
Grumichella Müller 1879 (2)	Müller 1879a, Holzenthal 1988b	
Grumichella aequiunguis Flint 1983	Flint 1983a, Blahnik et al 2004	SC, MG, PR
Grumichella rostrata Thienemann 1905	Thienemann 1905, Holzenthal 1988b	MG, RJ, SP, SC
Nectopsyche Müller 1879 (19)	Müller 1879a	
Nectopsyche aureovittata Flint 1983	Flint 1983a, Almeida and Marinoni 2000, Blahnik et al 2004	RJ, SC, PR, MG, SP
Nectopsyche acutiloba Flint 1974	Flint 1974c, Blahnik et al 2004	MG
Nectopsyche bella (Müller) 1921	Müller 1921	SC
Nectopsyche bruchi (Navás) 1920	Navás 1920	MG, PR
Nectopsyche brunneofascia Flint 1983a	Flint 1983a, Blahnik et al 2004	SP, SC
Nectopsyche diminuta (Banks) 1920	Banks 1920, Flint 1991	AM, RR, PA
Nectopsyche flavofasciata (Ulmer) 1907	Ulmer 1907a, Blahnik et al 2004	SC
Nectopsyche fuscomaculata Flint 1983	Flint 1983a, Almeida and Marinoni 2000, Blahnik et al 2004	RJ, SC, PR
Nectopsyche gemma (Müller) 1880	Müller 1880	SC

Nectopsyche jenseni (Ulmer) 1905	Ulmer 1905b	AM
Nectopsyche modesta Müller 1921	Müller 1921	SC
Nectopsyche muelleri (Ulmer) 1905	Ulmer 1905a	SC
Nectopsyche muhni (Navás) 1916	Navás 1916b, Blahnik et al 2004	Brazil, MG
Nectopsyche navasi Holzenthal 1999	Flint et al 1999a	SC
Nectopsyche ortizi Holzenthal 1995	Holzenthal 1995, Almeida and Marinoni 2000, Blahnik et al 2004	PA, PR, MG, SP, RJ
Nectopsyche pantosticta Flint 1983	Flint 1983a, Blahnik et al 2004	RS, RJ
Nectopsyche punctata (Ulmer) 1905	Ulmer 1905b, Blahnik et al 2004	PA, MG, SP
Nectopsyche separata (Banks) 1920	Banks1920, Almeida and Marinoni 2000, Blahnik et al 2004	RJ, SC, PR, MG, SP
Nectopsyche splendida (Navás) 1917	Navás 1917, Almeida and Marinoni 2000, Blahnik et al 2004	Brazil, PR, MG
Neoathripsodes Holzenthal 1989 (1)	Holzenthal 1989	
Neoathripsodes anomalus Holzenthal 1989	Holzenthal 1989, Blahnik et al 2004	RJ, MG
Notalina Mosely 1936 (4)	Mosely 1936, Holzenthal 1986b	
Notalina brasiliana Holzenthal 1986	Holzenthal 1986b	MG
Notalina cipo Holzenthal 1986	Holzenthal 1986b	MG
Notalina hamiltoni Holzenthal 1986	Holzenthal 1986b	SP
Notalina morsei Holzenthal 1986	Holzenthal 1986b	MG
Oecetis McLachlan 1877 (6)	McLachlan 1877	
Oecetis amazonica (Banks) 1924	Banks 1924	AM
Oecetis excisa Ulmer 1907	Ulmer 1907a	BR
Oecetis inconspicua (Walker) 1852	Walker 1852, Blahnik et al 2004	MG, PR
Oecetis iguazu Flint 1983	Flint 1983a, Blahnik et al 2004	ES, RJ, SC, SP
Oecetis paranensis Flint 1982	Flint 1982b, Blahnik et al 2004	Brazil, MG
Oecetis punctipennis (Ulmer) 1905	Ulmer 1905b, Blahnik et al 2004	BA, MG
Oecetis rafaeli Flint 1992	Flint 1992	RR
Triplectides Kolenati 1859 (3)	Kolenati 1859, Holzenthal 1988a	
Triplectides egleri Sattler 1963	Sattler 1963	AM, PA
Triplectides neotropicus Holzenthal 1988	Holzenthal 1988a, Blahnik et al 2004	MG
Triplectides gracilis (Burmeister) 1839	Burmeister 1839, Holzenthal 1988a, Almeida and Marinoni 2000	MG, ES, RJ, SP, SC, PR
Triplectides misionensis Holzenthal 1988	Holzenthal 1988a, Blahnik et al 2004	SP, RJ, PR, SC
Triplectides ultimus Holzenthal 1988	Holzenthal 1988a	RJ
Limnephilidae (1)		
Antarctoecia Ulmer 1907 (1)	Ulmer 1907c	
Antarctoecia brasiliensis Huamantinco and Nessimian 2003	Huamantinco and Nessimian 2003	MG
Odontoceridae (12)		
Barypenthus Burmeister 1839 (1)	Burmeister 1839, Flint 1969, Paprocki and Holzenthal 2001	

Barypenthus concolor Burmeister 1839	Burmeister 1839, Paprocki and Holzenthal 2001	MG, RJ, SP
Marilia Müller 1880 (11)	Müller 1880	
Marilia albicornis (Burmeister) 1839	Burmeister 1839	Brazil
Marilia elongata Martynov 1912	Martynov 1912, Blahnik et al 2004	MG
Marilia fasiculata Banks 1913	Banks 1913	RO
Marilia flexuosa Ulmer 1905	Ulmer 1905b	Brazil
Marilia guaira Flint 1983	Flint 1983a	GO
Marilia infundibulum Flint 1983	Flint 1983a	SC
Marilia lateralis Flint 1983	Flint 1983a	MS
Marilia major Müller 1880	Müller 1880, Blahnik et al 2004	SC, MG, PR
Marilia minor Müller 1880	Müller 1880, Blahnik et al 2004	SC, MG, RJ
Marilia sioli Marlier 1964	Marlier 1964b	AM
Marilia truncata Flint 1983a	Flint 1983a, Blahnik et al 2004	MG
Philopotamidae (41)		
Chimarra Stephens 1829 (39)	Stephens 1829, Flint 1998, Blahnik 1998	
Chimarra (*Chimarra*) *adamsae* Blahnik 1998	Blahnik 1998, Blahnik et al 2004	PA, MG, SP, PR
Chimarra (*Chimarra*) *uara* Flint 1971	Flint 1971, Blahnik 1998, Blahnik et al 2004	RO, AM, DF, MG
Chimarra (*Chimarrita*) *akantha* Blahnik 1997	Blahnik 1997	AM
Chimarra (*Chimarrita*) *camella* Blahnik 1997	Blahnik 1997, Blahnik et al 2004	MG, SP, RJ
Chimarra (*Chimarrita*) *camura* Blahnik 1997	Blahnik 1997, Blahnik et al 2004	RJ, SP
Chimarra (*Chimarrita*) *heligma* Blahnik 1997	Blahnik 1997	MG
Chimarra (*Chimarrita*) *majuscula* Blahnik 1997	Blahnik 1997, Blahnik et al 2004	RJ, SP
Chimarra (*Chimarrita*) *kontilos* Blahnik 1997	Blahnik 1997, Blahnik et al 2004	ES, RJ, MG, SP
Chimarra (*Chimarrita*) *tortuosa* Blahnik 1997	Blahnik 1997	AM
Chimarra (*Chimarrita*) *simpliciforma* Flint 1971	Flint 1971	AM
Chimarra (*Chimarrita*) *xingu* Blahnik 1997	Blahnik 1997	PA
Chimarra (*Curgia*) *aurivittata* Flint 1971	Flint 1971, Flint 1998	RO, AM
Chimarra (*Curgia*) *beckeri* Flint 1998	Flint 1998	RJ
Chimarra (*Curgia*) *boraceia* Flint 1998	Flint 1998	SP
Chimarra (*Curgia*) *brasiliana* (Ulmer) 1905	Ulmer 1905, Almeida and Marinoni 2001	SC, PR
Chimarra (*Curgia*) *burmeisteri* Flint 1998	Flint 1998	RJ
Chimarra (*Curgia*) *camposae* Flint 1998	Flint 1998	MG
Chimarra (*Curgia*) *centrispina* Flint 1998	Flint 1998	MG
Chimarra (*Curgia*) *cipoensis* Flint 1998	Flint 1998	MG
Chimarra (*Curgia*) *conica* Flint 1983	Flint 1983a, Flint 1998, Blahnik et al 2004	RO, CE, MG, SC, MT, GO, RJ
Chimarra (*Curgia*) *cultellata* Flint 1983	Flint 1983a, Flint 1998	RO, MG, SC, DF
Chimarra (*Curgia*) *donamariae* Denning and Sykora 1968	Denning and Sykora 1968	PA
Chimarra (*Curgia*) *fittkaui* Flint 1971	Flint 1971	AM
Chimarra (*Curgia*) *froehlichi* Flint 1998	Flint 1998, Blahnik et al 2004	ES, RJ, SP, MG
Chimarra (*Curgia*) *hyoeides* Flint 1983	Flint 1983a, Flint 1998	PA, SP, SC
Chimarra (*Curgia*) *medioloba* Flint 1971	Flint 1971	AM
Chimarra (*Curgia*) *morio* Burmeister 1839	Burmeister 1839, Flint 1998	BA, RJ, SP, PR, SC
Chimarra (*Otarrha*) *odonta* Blahnik 2002	Blahnik 2002	SP, RJ

Chimarra (*Curgia*) *parana* Flint 1972	Flint 1972, Flint 1998	MG, RJ, SP, SC, GO, DF
Chimarra (*Curgia*) *petersorum* Flint 1998	Flint 1998	PR
Chimarra (*Curgia*) *petricola* Flint 1998	Flint 1998	RJ
Chimarra (*Curgia*) *plaumanni* Flint 1983	Flint 1983a	SC
Chimarra (*Curgia*) *quaternaria* Flint 1971	Flint 1971	AM
Chimarra (*Curgia*) *scopuloides* Flint 1974	Flint 1974c, Flint 1998	RO, RR, PA, SC, GO
Chimarra (*Curgia*) *teresae* Flint 1998	Flint 1998, Blahnik et al 2004	SC, MG, SP, RJ
Chimarra (*Curgia*) *tucuna* Flint 1998	Flint 1998	AM
Chimarra (*Curgia*) *ypsilon* Flint 1983	Flint 1983a, Almeida and Marinoni 2001 Female	RJ, SC, PR
Chimarra (*Otarrha*) *diaksis* Flint 1971	Flint 1971	AM
Chimarra (undetermined) *usitatissima* Flint 1971	Flint 1971, Flint 1974c, Blahnik 1997	RO, AM, PA, MG
Dolophilodes Ulmer 1909 (1)	Ulmer 1909	
Dolophilodes (*Sortosa*) *sanctipauli* Flint 1971	Flint 1971	SP
Wormaldia McLachlan 1865 (1)		
Wormaldia planae Ross and King 1956	Ross 1956a, Flint 1999	Brazil
Polycentropodidae (46)		
Cernotina Ross 1938 (26)	Ross 1938, Flint 1971	
Cernotina abbreviata Flint 1971	Flint 1971	PA
Cernotina acalyptera Flint 1971	Flint 1971	AM
Cernotina antonina Holzenthal and Almeida 2003	Holzenthal and Almeida 2003	PR,MG
Cernotina attenuata Flint 1971	Flint 1971	AM
Cernotina bibrachiata Flint 1971	Flint 1971	AM
Cernotina cacha Flint 1971	Flint 1971, Blahnik et al 2004	AM, MG
Cernotina cingulata Flint 1971	Flint 1971	AM
Cernotina compressa Flint 1971	Flint 1971	AM
Cernotina cygnea Flint 1971	Flint 1971	AM
Cernotina cystophora Flint 1971	Flint 1971	AM
Cernotina declinata Flint 1971	Flint 1971	PA
Cernotina decumbens Flint 1971	Flint 1971	AM
Cernotina ecotura Sykora 1998	Sykora 1998	RR
Cernotina encrypta Flint 1971	Flint 1971	AM
Cernotina filiformis Flint 1971	Flint 1971	AM
Cernotina lazzarii Holzenthal and Almeida 2003	Holzenthal and Almeida 2003	PR
Cernotina obliqua Flint 1971	Flint 1971	AM
Cernotina perpendicularis Flint 1971	Flint 1971, Blahnik et al 2004	AM, PA, MG
Cernotina sexspinosa Flint 1983	Flint 1983a	SC
Cernotina spinigera Flint 1971	Flint 1971	RR, PA
Cernotina spinosior Flint 1992	Flint 1992	RR
Cernotina subapicalis Flint 1971	Flint 1971	AM
Cernotina trispina Flint 1971	Flint 1971	AM
Cernotina uara Flint 1971	Flint 1971	AM
Cernotina unguiculata Flint 1971	Flint 1971	PA
Cernotina verticalis Flint 1971	Flint 1971	AM

Cyrnellus Banks 1913 (7)	Banks 1913, Flint 1971	
Cyrnellus arotron Flint 1971	Flint 1971	AM, PA
Cyrnellus bifidus Flint 1971	Flint 1971	AM
Cyrnellus collaris Flint 1971	Flint 1971	AM
Cyrnellus fraternus (Banks) 1905	Banks 1905, Blahnik et al 2004	AM, PA, MG, PR, SC
Cyrnellus mammillatus Flint 1971	Flint 1971, Blahnik et al 2004	AM, PA, MG, PR, SP
Cyrnellus risi (Ulmer) 1907	Ulmer 1907a, Blahnik et al 2004	AM, PA, MG
Cyrnellus ulmeri Flint 1971	Flint 1971	AM, PA
Nyctiophylax Brauer 1865 (1)	Brauer 1865, Neboiss 1993	
Nyctiophylax neotropicalis Flint 1971	Flint 1971, Blahnik et al 2004	AM, MG, RJ, PR
Polycentropus Curtis 1835 (1)		
Polycentropus urubici Holzenthal and Almeida 2003	Holzenthal and Almeida 2003	SC, PR
Polyplectropus Ulmer 1905 (11)	Ulmer 1905a, Flint 1968, Bueno 1990	
Polyplectropus alleni (Yamamoto) 1967	Yamamoto 1967, Blahnik et al 2004	MG
Polyplectropus annulicornis Ulmer 1905	Ulmer 1905b	RS
Polyplectropus banksianus Flint 1971	Flint 1971	AM
Polyplectropus brachyscolus Flint 1971	Flint 1971	AM
Polyplectropus dubitatus Flint 1983	Flint 1983a	SC
Polyplectropus flavicornis Ulmer 1905	Ulmer 1905a	SC
Polyplectropus fuscatus Flint 1983	Flint 1983a	SC
Polyplectropus inarmatus Flint 1971	Flint 1971	AM
Polyplectropus spiculifer Flint 1971	Flint 1971	AM
Polyplectropus ulmeriana Flint 1983	Flint 1983a	SC
Polyplectropus profaupar Holzenthal and Almeida 2003	Holzenthal and Almeida 2003	SC, PR
Sericostomatidae (1)		
Grumicha Müller 1879 (1)	Müller 1879b, Flint et al 1999a	
Grumicha grumicha (Vallot) 1855	Vallot 1855, Blahnik et al 2004	SC, SP
Xiphocentronidae (3)		
Xiphocentron Brauer 1870 (3)	Brauer 1870, Schmid 1982	
Xiphocentron ilionea Schmid 1982	Schmid 1982	SP
Xiphocentron saltuum Müller 1921	Müller 1921	Brazil
Xiphocentron steffeni (Marlier) 1964	Marlier 1964a	SP

Table 1- Species of Trichoptera recorded for Brazil in the literature.

RO	**AC**	**AM**	**RR**	**PA**	**AP**	**TO**	**MA**	**PI**	**CE**	**RN**	**PB**	**PE**	**AL**
14	0	109	17	54	0	0	0	0	1	0	1	0	0
SE	**BA**	**MG**	**ES**	**RJ**	**SP**	**PR**	**SC**	**RS**	**MS**	**MT**	**GO**	**DF**	**Brazil**
0	8	101	12	76	69	55	97	4	3	8	11	8	378

Table 2- Number of Trichoptera species recorded per state in Brazil.

for the country is 61, distributed in 16 families. Hydropsychidae is the family with the largest number of records, with 107 species, followed by Hydroptilidae with 50 species, Polycentropodidae with 46, and Philopotamidae with 41. We also present here the number of species per family and genus for Brazil in Table 1. The number of Trichoptera species per state is presented in Table 2. The Trichoptera fauna of many states is practically unknown. Nine states (AC, AP, TO, MA, PI, RN, PE, AL and SE) do not have any record for the order Trichoptera and another 10 states have less than 15 species records (RO, CE, PB, BA, ES, RS, MS, MT, GO and DF). The total number of known Trichoptera species for the world is 11,638 (Morse 2003). Flint et al. (1999b) recorded 2,196 Trichoptera species for the Neotropical region, distributed in 24 families and 153 genera.

There has been no historical tradition of Trichoptera research in Brazil. It is not surprising that the contribution of Brazilian researchers to the knowledge of Trichoptera biodiversity has been limited to date, but this scenario has been changing in recent years. Increasing numbers of Brazilian researchers and students are developing an interest in the taxonomy of Trichoptera. We hope, they will contribute to the description of Trichoptera diversity in the next years. Knowledge of aquatic fauna biodiversity is important as an aid for policy-makers, water quality, conservation practices, ecological studies and much more. The study of Trichoptera diversity in Brazil is incipient. We expect that the number of species recorded for Brazil will at least double in the next decade. The senior author recorded with co-workers, 91 species of Trichoptera during an aquatic insect biodiversity study conducted in the Ouro Preto (Minas Gerais) region. Thirty-five of the 96 species recorded were unknown to science (Paprocki et al 2002). This study in Ouro Preto is a small sample of the immense Trichoptera biodiversity that Brazilian streams and rivers can support. Known Brazilian biodiversity, as currently reported, is vastly underestimated, considering the country's large area and the complexity of its ecosystems (Migotto et al 2002).

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Authors: Henrique Paprocki, Ralph W. Holzenthal and Roger J. Blahnik

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HOW MANY SPECIES OF *DROSOPHILA* (DIPTERA, DROSOPHILIDAE) REMAIN TO BE DESCRIBED IN THE FORESTS OF SÃO PAULO, BRAZIL? SPECIES LISTS OF THREE FOREST REMNANTS.

Hermes Fonsêca de Medeiros, Louis Bernard Klaczko

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Curso de Pós-Graduação em Ecologia, Departamento de Genética e Evolução, Instituto de Biologia, Universidade Estadual de Campinas (UNICAMP), Campinas, SP, Cx. Postal 6109, C.E.P.: 13083-970, Brazil.
e-mail: hermes@unicamp.br (corresponding author)

Curso de Pós-Graduação em Ecologia, Departamento de Genética e Evolução, Instituto de Biologia, Universidade Estadual de Campinas (UNICAMP), Campinas, SP, Cx. Postal 6109, C.E.P.: 13083-970, Brazil.
e-mail: lbk@unicamp.br

Abstract

This paper describes the composition and abundance of *Drosophila* species found in three forest remnants in the State of São Paulo. A well-standardized sampling procedure applied on four collecting trips to the same sites on four areas resulted on 944 samples. All males collected were identified by analyses of the genitalia, this being the only data set used. One hundred and twenty five species were detected amongst the 29,289 males analyzed. From them 57,6% could be identified as described species. Thirteen of the species found were absent from the previous species list for the state of São Paulo State, thus represent an increase of 13% on the number known. We argue that the majority of the 53 unidentified species are in fact undescribed. The sites studied did not differ significantly in the proportion of identified species. On average identified species were almost seven times more abundant than unidentified ones, and this difference was significant. Rarefaction curve analysis confirmed that the proportion of unidentified species increase with sample size, and did not reach a plateau with our data set. These results illustrate the large richness of *Drosophila* species in forest remnants of São Paulo State. It also indicates that about half of the species in this region remain to be described. This conclusion is particularly important when one considers that this is a well studied genus of Diptera, on the best sampled region of Brazil.

Key words: *composition; diversity; richness; inventory; atlantic forest; neotropical region.*

Resumo

Este trabalho descreve a composição e a abundância de espécies de *Drosophila* encontradas em três remanescentes florestais do estado de São Paulo. Um procedimento de coletas bem padronizado aplicado em quatro coletas nos mesmos sítios em três áreas resultou em 944 amostras. Todos os machos coletados foram identificados pela análise da genitália, e apenas os dados destes foram analisados. Cento e vinte e cinco espécies foram detectadas entre os 29.289 machos analisados. Destas 57,6% puderam ser identificadas como espécies já descritas. Treze das espécies encontradas estavam ausentes da lista prévia de espécies do estado de São Paulo, resultado em um aumento de 13% nesta lista. A maioria das 53 espécies não identificadas são, provavelmente, não descritas. Os sítios estudados não diferem significativamente na proporção de espécies identificadas. Em média as espécies identificadas foram quase sete vezes mais abundantes do que as não identificadas, e esta diferença foi significativa. Uma análise de curvas de rarefação confirmou que a proporção de espécies não identificadas aumenta com o tamanho amostral, e não atinge um platô em nosso conjunto de dados. Estes resultados ilustram a grande riqueza de espécies de *Drosophila* nos remanescentes florestais do estado de São Paulo. Eles também indicam que cerca de metade das espécies desta região ainda não foram descritas. Esta conclusão mostra-se particularmente importante considerando que este é um gênero de Diptera bem estudado, na região mais bem amostrada do Brasil.

Palavras-chave:*: composição; diversidade; riqueza; inventário; mata atlântica, região neotropical.*

Introduction

With more than 1700 species (Tidon-Sklorz & Sene 1999), the *Drosophila* genus has been historically explored by geneticists. Nowadays there is increasing interest on applying these well studied and easily manipulated animals on the study of the distribution of biological diversity and its causes (e.g. Sevenster & Alphen 1993; Shorrocks & Sevenster 1995; Worthen *et al.* 1998). This new application for *Drosophila* makes the publication of faunistic inventories of this taxon particularly relevant.

A series of local inventories of *Drosophila* faunas has been provided for South America (Dobzhansky & Pavan 1943; Pavan & Cunha 1947; Malogolowkin 1951; Pavan 1959; Vilela *et al.* 1980; Val & Kaneshiro 1988; Tidon-Sklorz *et al.* 1994; De Toni & Hofmann 1995; Tidon-Sklorz & Sene 1995; Val & Marques 1996; Goñi *et al.* 1998; Vilela & Mori 1999). Data on the distribution of species has also been provided by papers dealing primarily with other questions. Some reviews about the theme have also been published (Sene *et al.* 1980; Val *et al.* 1981; Vilela *et al.* 1983; Tidon-Sklorz & Sene 1999; Vilela *et al.*.002).

The *Drosophila* fauna of the neotropical region is highly diversified (Val *et al.* 1981), with numerous species remaining to be described. Many of these species can be distinguished only by analysis of the male genitalia (Vilela 1992). Male genitalia, especially the aedeagus, is the most important character used by taxonomists to recognize, describe and synonymize species (see Vilela & Bächli 1990). Indeed differentiation on male genitalia can be presented as a gross description for the species concept most frequently applied in this taxon. This also occurs with other animal taxa and results from the common and widespread pattern of faster and divergent morphological evolution of these structures (Eberhard 1985).

The practice of using this character in *Drosophila* taxonomy is also based on other evidences. Geneticists have carried out tests of reproductive isolation in the lab, and on the field with the application of genetic markers. In many cases, when sibling species are detected on basis of genetic markers or reproductive isolation, differentiation of the male genitalia is observed (eg. Spassky 1957). Thus the male genitalia are the tool of choice for identifying species in neotropical *Drosophila* communities.

In this paper we provide species lists for three sites, which represent the three major types of forest found in the state of São Paulo, southeastern Brazil. These lists are the first inventories in Brazil we have notice, with a defined sampling design and standardized collecting method, in which ***all*** collected individuals were identified by analyzing the male genitalia. Our results show an increase of 13% in the number of species compared to the previous species list for this State.

Material and Methods

Collecting Methods - *Drosophila* were caught using a trap developed to minimize bias in capturing different species of flies attracted to banana baits (Medeiros & Klaczko 1999). This trap showed better results compared to others tested, especially for capturing species that resist entering traps, such as those of the *tripunctata* group. Traps were baited with peeled, ripe bananas fermented with dried baker yeast (*Saccharomyces cerevisiae)* for 36 h (50 g of yeast per 5 kg of banana). Each trap received 100-150 ml of bait and was hung at 10 cm from the forest floor for 24 h, after which the animals caught were removed. The baits, and the parts of the trap that had been in contact with it, were then changed for a new collecting turn. On each collecting trip, traps were set on three consecutive days to provide a total of 72 h of sampling. The traps were hung close to the forest floor to mimic naturally decaying fruits. The bait was replaced daily with fresh fermented banana, to allow the comparison of the results from consecutive days without the confounding effect of bait aging.

The sampling design was aimed primarily at studying the association between the taxocenosis and a gradient of humidity. Thirty points were sampled at each site, equally distributed between 10 classes of distance from a stream: 1; 2.5; 5; 10; 20; 40; 60; 80; 120; and 160 m. These collecting points were not distributed in lines, but on a design that allows a minimal distance of 40 m between adjacent traps. The resulting sampling area was a rectangle of 9.6 hectares (600 m long, bordering the stream, and 160 m wide, perpendicular to the stream). No traps were set at less than 3 m from glades.

Study areas - Samples were obtained from three sites at different forest remnants in the state of São Paulo, southeastern Brazil. These localities which differ clearly in their climatic and geomorphological conditions, as well as on their respective vegetation, represent the three major types of forest formations in these state (Salis *et al*. 1995), namely, the interior plateau forests, represented by Barreiro Rico farm; forests on the western slopes of the Serra do Mar mountains and those of the the Serra da Mantiqueira mountains, represented by Serra do Japi at over 1000 m (Leitão-Filho 1992; Rodrigues & Shepherd 1992); and forests of the eastern slopes of the Serra do Mar mountains, represented by Ilha Bela.

Throughout this region the climate can be divided in two main seasons: a cold and dry from April to September, and a hot and humid from October to March (Cezar & Leitão Filho 1990; Morellato 1992).

Barreiro Rico farm (B. Rico in the rest of this paper) includes three fragments of well preserved semideciduous forest (total of 2,200 ha). The sample fragment was about 336 ha. The topography is plane, with an average altitude of about 500 m. The average annual precipitation is 1,339 mm, and the average temperature 21.5°C. The maximum average mothly temperature occurs in February (31.3° C) and the minimum in July (11.7°C) (Cezar & Leitão Filho 1990).

The Serra do Japi (Japi in the rest of this paper) includes a group of mountains belonging to the Mantiqueira complex. The Serra do Japi park has an area of 19,170 ha. The altitude within it ranges from 700 to 1300 m, and the climate (Pinto 1992), soil (Rodrigues & Shepherd 1992) and vegetation (Leitão-Filho 1992; Rodrigues & Shepherd 1992) vary markedly with the altitude. The average annual temperature at higher sites is around 15.7° C, with the maximum average monthly temperature occurring in January (between 18.4° C and 22.2° C), and the minimum in July (between 11.8° C and 15.3° C). The rainfall varies considerably over short distances, with an overall estimate of about 1500 mm per year.

The Parque Estadual de Ilha Bela (I. Bela in the rest of this paper) is located on an island off the northern coast of São Paulo State (23°47' S and 45°24'W). The topography is mountainous, with 73% of the island between 100 and 900 m above the sea-level (maximum of 1379 m) (França 1951). The park covers an area of 27,025 ha which corresponds to about 80% of the island. The maximum monthly precipitation occurs in December (2000 mm), and the minimum in August (79 mm). The average monthly temperature varies from 19.5°C in the winter to 24°C in the summer (Tommasi 1985 apud Belúcio 1995). The vegetation is included in the region of the "Floresta Ombrófila Densa" (IBGE 1983).

The sampling area in B. Rico was on the southern margin of a section of a stream located between 48°05'11"W - 22°41'15"S and 48°04'52"W - 22°41'26"S. In Japi and I. Bela, the sampling areas were on the northern margins of streams. The coordinates of the sections of the streams used were: Japi - between 46°57'48"W - 23°14'06"S and 46°57'33"W - 23°14'12"S; I. Bela - between 45°20'49"W - 23°50'48"S and 45°20'30"W - 23°50'47"S.

Four collecting trips were made to each site — two in the hot/humid season and two in the dry/cold season. At B. Rico, the sampling periods were January 6-9, March 2-5, June 13-16, July 23-26, in 1998. At Japi they were February 21-24, March 18-21, July 7-10, and August 12-15, in 1998. At I. Bela, the periods were December 19-22 1997, January 15-18, June 22-25, and September 2-5, in 1998.

Identification of Samples - Each collected male was identified by analyzing the genitalia, the only reliable method for recognizing many neotropical *Drosophila* as pointed out by Vilela (1992) in the case of the *tripunctata* group. The fresh aedeagus (the intromittent organ, and the most useful part of male genitalia for species identification) of at least one individual of each species found was observed under a microscope and drawn with the help of a camera lucida. This drawing facilitated the identification of the species, which was based on figures of male genitalia available in the taxonomic literature. Species for which no corresponding aedeagus could be found in the literature received a code, and the other individuals found from these species were identified by comparing them with our drawings and/or with the first collected specimens. Nevertheless, in most cases the genitalia were analyzed under a stereomicroscope with no need for removal, as proposed by Spassky (1957). In two cases, the identification was not based on the shape of aedeagus: the distinction between *D. melanogaster* Meigen 1830 and *D. simulans* Sturtevant 1919 was based on the shape of the posterior salience of the genital arch (Salles 1948), the shape of the hypandrium was used to distinguish between the species of the *willistoni* complex (Burla *et al.* 1949; Malogolowkin 1952; Spassky 1957). Since the identification of most species was not based on original descriptions, we have indicated the published figures of male genitalia used for the identification (see table 1).

The flies were analyzed fresh on a film of water in a petri dish. Since the external characters were not analyzed, and since no preparation of genitalia parts was necessary, considerable velocity compatible with identification of big samples was possible. Specimens are preserved in our laboratory.

Data Analysis - The proportions of species that could be identified in each of the three sites were compared using a chi square contingency test. To assess whether the unidentified species corresponded to less abundant species, the abundances of identified and unidentified species were compared in each area using a two-tailed Mann-Whitney test, with correction for continuity and for presence of tied ranks (Zarr 1999). To describe the effect of sample size on the proportion of unidentified species, two species accumulation curves were produced, using the "EstimateS" program (Colwell 1997). One curve included all species and the other excluded the identified species. Each point on the curves represented the average number of species in 50 subsamples of a specific size taken at random, without replacement. The curve corresponding to the proportion of unidentified species was calculated by dividing the results of the curve of unidentified species by that of all species together. In this analysis, a sample unit was defined as the flies caught in one trap on one day. A total of 944 units was examined.

Results and Discussion

A total of 29,289 *Drosophila* males were collected and identified. One hundred and twenty five species were found: 57 from Japi, 76 from I. Bela, and 90 from B. Rico. Seventy two of these were identified as described species, based on figures of the male genitalia found in the literature, and/or with the help of Professor Carlos R. Vilela. Table 1 shows the total number of males per species and the locality, as well as the references used for identification. Eight

Table 1. Total number of males per species and locality. The numbers following the name of the each species corresponds to the references used in identification. In the numbers underlined the figure used represented a specimen from the type series. “Vilela, personal com.”, means that the identification was made by the first author based on drawings and explanations kindly provided by Prof. Carlos Vilela. The species underlined were not included in a previous list from São Paulo state.

Subgenus	Group	Species	Japi	B. Rico	I. Bela	Total
Drosophila	*annulimana*	*D. ararama* Pavan & Cunha (2)		2		2
		D. annulimana Duda (2, 26)	38	1	55	94
		D. arapuan Cunha & Pavan (2)	1		2	3
		D. aragua Vilela & Pereira (24)		12		12
	calloptera	*D. atrata* Burla & Pavan (22)		265	13	278
		D. quadrum Wiedemann (22)	1	8		9
		D. schildi Malloch (22)		2		2
	canalinea	*D. canalinea* Patterson & Mainland (22)		5		5
		D. albomarginata Duda (22)			7	7
		D. sp5	51			51
		D. sp7	28	696	11	735
		D. sp42	1	39	6	46
		D. sp73		1		1
		D. sp81		1		1
		D. spb3			4	4
		D. spb11			3	3
		D. spb30			1	1
		D. spb35			1	1
	cardini	*D. cardini* Sturtevant (11, 28)		11		11
		D. neocardini Streisinger (11, 28)		25	116	141
		D. polymorpha Dobzhansky & Pavan (11, 28)	22	127	7	156
	coffeata	*D. fuscolineata* Duda (22, 16 as *D. fumosa*)	1	27	22	50
		D. sp52 aff. *D. coffeata* Williston (19)		2	205	207
	dreyfusi	*D. briegeri* Pavan & Breuer (3)	59	43	159	261
		D. dreyfusi Dobzhansky & Pavan (3)	41	1	34	76
		D. krugi Pavan & Breuer (3)	6		48	54
	guarani	*D. griseolineata* Duda (22)	48	2033	9	2090
		D. guaru Dobzhansky & Pavan (22)		151	2	153
		D. maculifrons Duda (22)	23	189		212
		D. ornatifrons Duda (22, 16 as *D. guarani*)	60	20		80
		D. sp31	6	1	11	18
		D. sp67		1		1
	immigrans	*D. immigrans* Sturtevant (external morphology)	3	7		10
	mesophragmatica	*D.* sp61		2	7	9
		D. spb26			1	1

Table 1 (cont.)

Subgenus	Group	Species	Japi	B. Rico	I. Bela	Total
	pallidipennis	*D. pallidipennis* Dobzhansky & Pavan (11, 22)		2	12	14
	repleta	*D. buzzatii* Patterson & Wheeler (18, 4)		1		1
		D. fascioloides Dobzhansky & Pavan (18)	5	1	11	17
		D. ivai Vilela (18)		1		1
		D. mercatorum Patterson & Wheeler (18, 4)		3		3
		D. nigricruria Patterson & Mainland (18)		1		1
		D. onca Dobzhansky & Pavan (18)	16	544	166	726
		D. paranaensis Dreyfus & Barros (18, 4)		19		19
		D. pictilis Wasserman (18)			5	5
		D. pictura Wasserman (18)			9	9
		D. querubimae Vilela (18)		2		2
		D. repleta Wollaston (18)		1	3	4
		D. senei Vilela (18)	5	1		6
		D. sp8	10	110	17	137
		D. sp70 aff. *D. vicentinae* Vilela (18)		1		1
		D. sp74 aff. *D. aldrichi* Patterson & Crow (18, 7, 4)		1		1
		D. sp79 aff. *D. ivai* (18)		1	2	3
		D. spb5			91	91
		D. spb6			156	156
		D. spb32			3	3
		D. spb38			2	2
	tripunctata	*D. bandeirantorum* Dobzhansky & Pavan (20)	23	40	14	77
		D. bifilum Frota-Pessoa (Vilela, personal com.)	6	127	6	139
		D. cuaso Bächli, Vilela & Ratcov (1)	47	12	99	158
		D. frotapessoai Vilela & Bächli (22)		1		1
		D. medioimpressa Frota-Pessoa (20, 8)	4	3		7
		D. mediopicta Frota-Pessoa (20, 8)	120	13	6	139
		D. mediopunctata Dobzhansky & Pavan (4, 8)	177	356	7	540
		D. mediosignata Dobzhansky & Pavan (1)	44	2		46
		D. mediostriata Duda (22, 4 as *D. crocina*)	25	107	1	133
		D. mesostigma Frota-Pessoa (16, 20)		1		1
		D. neoguaramunu Frydenberg (22)		2	4	6
		D. nigricincta Frota-Pessoa (16)			4	4
		D. paraguayensis Duda (1)	926	3656	4	4586
		D. paramediostriata Townsend & Wheeler (25)	3	384		387
		D. roehrae Pipkin & Heed (20, 13)	51	42	1	94
		D. setula Heed & Wheeler (27)	1		1	2
		D. spinatermina Heed & Wheeler (27)		90		90
		D. trapeza Heed & Wheeler (27, 12 as *D. mirassolensis*)	3	64		67
		D. trifilum Frota-Pessoa (8)	23	539	6	568

Table 1 (cont.)

Subgenus	Group	Species	Japi	B. Rico	I. Bela	Total
		D. sp.1 *D. angustibucca* sensu Frota-Pessoa, 1954; non Duda, 1925 (8, Vilela, personal com.)	105	92		197
		D. sp17	3			3
		D. sp18	1		4	5
		D. sp22 aff. *D.* sp1	29	7	1	37
		D. sp28	11	797	11	819
		D. sp33	3	25	3	31
		D. sp37	8		1	9
		D. sp38	1			1
		D. sp50		4	177	181
		D. sp76		1		1
		D. spb12			13	13
		D. spb16			1	1
		D. spb25			2	2
		D. spb27			2	2
		D. spb36		1	1	2
		D. spb37			1	1
	ungrouped	*D. caponei* Pavan & Cunha (16, 21)		39	52	91
		D. sticta Wheeler (Vilela, personal com.)		1		1
		D. spb13 aff. *D. caponei*			2	2
Siphlodora	ungrouped	*D. flexa* Loew (24)		1		1
Sophophora	*melanogaster*	*D. malerkotliana* Parshad & Paika (17)	11	258	68	337
		D. melanogaster Meigan (14)		4		4
		D. simulans Sturtevant (14)	6	171	28	205
	saltans	*D. austrosaltans* Spassky (9)		4		4
		D. neoelliptica Pavan &Magalhães (9)	1		28	29
		D. neosaltans Pavan & Magalhães (9)			22	22
		D. prosaltans Duda (9)		226	23	249
		D. sturtevanti Duda (9)	151	2160	116	2427
	willistoni	*D. bocainensis* Pavan & Cunha (10, 29)	19	9		28
		D. bocainoides Carson (29)		2		2
		D. capricorni Dobzhanzky & Pavan (10)	495	84	422	1001
		D. changuinolae Wheeler & Magalhães (29)		3		3
		D. fumipennis Duda (10, 22)	35	112	324	471
		D. nebulosa Sturtevant (10)	14	137		151
		D. paulistorum Dobzhanzky & Pavan (5, 10, 6, 15)	309	804	1707	2820
		D. willistoni Sturtevant (5, 10, 15, 22)	925	5632	479	7036
unidentified		*D.* sp10	5		19	24
		D. sp12	1			1
		D. sp26	4	2	7	13
		D. sp34	2	1		3
		D. sp41	1			1
		D. sp53		3		3
		D. sp55		1		1
		D. sp64		3		3
		D. sp66		3	7	10
		D. sp77		1		1

Table 1 (cont.)

Subgenus	Group	Specie	Japi	B. Rico	I. Bela	Total
		D. sp82		1		1
		D. spb1			5	5
		D. spb21			1	1
		D. spb34			1	1
		Total of individuals	4018	20389	4882	29289

1. Bächli *et al*., 2000; 2. Breuer & Pavan, 1950; 3. Breuer & Pavan, 1954; 4. Breuer & Rocha, 1971; 5. Burla, *et al*., 1949; 6. Cordeiro, 1952; 7. Fontedevila *et al*., 1990; 8. Frota-Pessoa, 1954; 9. Magalhães & Björnberg, 1957; 10. Malogolowkin, 1952; 11. Malogolowkin, 1953; 12. Mourão & Gallo, 1967; 13. Pipkin & Heed, 1964; 14. Salles, 1948; 15. Spassky, 1957; 16. Val, 1982; 17. Val & Sene, 1980; 18. Vilela, 1983; 19. Vilela, 1984[a]; 20. Vilela, 1992; 21. Vilela, 2001; 22. Vilela, & Bächli, 1990; 23. Vilela, & Bächli, 2000; 24. Vilela & Pereira, 1982; 25. Vilela & Pereira, 1985; 26. Vilela & Val, 1983; 27. Vilela & Val, 1985; 28. Vilela *et al*., 2002; 29. Wheeler & Magalhães, 1962.

males of *D. latifasciaeformis* Duda 1940 were caught at B. Rico, but this species was not included in the list because, as recommended by Grimaldi (1990), the subgenus *Scaptodrosophila* (which includes this species) should be given the status of genus.

Besides the species shown in table 1, we also observed the occurrence of another species, *D. metzii* Sturtevant 1921 (*tripunctata* group), which has never been registered before in Brazil (Vilela 1984b). Several males of this species were collected over palm flowers and fruits in an urban park (Bosque dos Jequitibás) in Campinas city. The identification was based on a comparison with the drawing of the aedeagus of a holotype provided by Vilela (1984).

Tidon-Sklorz & Sene (1999) provided a list of 93 species recorded in São Paulo state. We found 15 species not cited in that list. Of these, one was described (*D. cuaso*) and one revalidated (*D. mediosignata*) by Bächli *et al.* (2000), who also reported the presence of these species in São Paulo after the publication of the paper by Tidon-Sklorz & Sene (1999).

One species in the previous list, *D. mirassolensis,* was synonymized with *D. trapeza* (also present in the list) by Vilela & Val (1985), and another one, *D. angustibucca*, in fact corresponds to a misidentification of an undescribed species (Goñi *et al.* 1998). If one accepts the elevation of the subgenus *Scaptodrosophila* to genus, them a total of 105 described species of *Drosophila* are registered in São Paulo state.

The numbers of species found in each site are among the highest in Brazilian inventories. This was an unexpected result, since previous inventories used procedures chosen to maximize the efficiency of species detection, without the limitation of the standardization of the collecting method or sampling design.

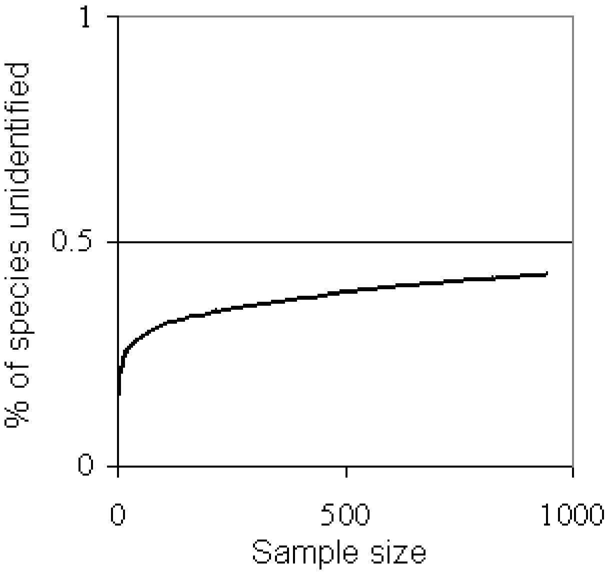
The main aim of this project was to study the spatial distribution of some species in response to an environmental gradient (manuscript in preparation). The restrictions necessary to study a spatial pattern, i.e., the use of only one type of bait, one kind of trap, and the inclusion of all sampling points to a homogeneous area (except for the studied gradient) could have limited the chance of detecting species. Consequently it could result on a smaller number of species in the lists than in lists produced with several collecting methods. On the contrary, our results indicate that samples obtained with a single well standardized collecting method can be used more efficiently in species inventories of *Drosophila*, with the additional advantage that it is possible to quantify sampling efforts.

The high number of species found probably reflected the sensitivity of our identification method. Large proportion of an inventory usually consists of rare species, and many species are detected on the basis of only a few or even a single individual (Magurran 1988). This was the case in this study, since the proportion of species detected with $\leq$ 5 individuals was 61% in B. Rico, 37% in Japi and 48% in I. Bela . The chance of detecting a species also diminishes as the list of species already detected increases, because of the increasing probability of it resembling a species detected before. Vilela & Mori (1999) reported some species that were not detected in a previous inventory of the same region (Tidon-Sklorz *et al.* 1994). These authors suggested that such species may have been overlooked because they were very similar to more abundant species already present in the list. Vilela (2001) also suggested that the low occurrence of *D. caponei* in previous inventories reflects its frequent inclusion in an unidentified group. Maximum sensitivity is therefore essential for the method used to detect species in an inventory project. Our results indicate that the concentration of the identification effort on the male genitalia provides better results than when this criterion is applied only when doubts appear during identification based on external morphology, as is usually done.

Overall, we identified 72 species (58% of the total) a result similar to that obtained by Val & Kaneshiro (1988), who identified 50% of the 82 species detected. The proportion of identified species did not differed significantly between sites (67% for Japi, 71% for B. Rico, and 54% for I. Bela; p=0.14). Thus we have no evidence that these forest types are different regarding the proportion of species remaining to be described.

Some of our unidentified species have probably already been described. These species may not have been recognized because of the lack of detailed representation of the aedeagus in the literature, but they are probably a minority. Recently, an effort has been made to produce detailed figures of the aedeagus of most neotropical *Drosophila* (e.g. references in Table 1), with the *tripunctata* group receiving special attention. Vilela (1992) pointed out that there are still four species in this group for which the male genitalia are incompletely illustrated in the literature. One of these was present in our samples and was identified in collaboration with Prof. Carlos R. Vilela. However, 16 species of this group could not be identified. Even if one assumes that the unidentified species include all three species with unillustrated genitalia, there are least 13 undescribed species in this group. We therefore believe that the majority of the unidentified species are in fact undescribed.

The average number of individuals per species at the three sites was significantly greater for identified species (Japi, $p < 0.05$; B. Rico, $p < 0.001$; I. Bela, $p < 0.001$). On the total of the three sites, identified species were on average almost seven times more abundant than the unidentified ones. A lower abundance of unidentified species was expected because species which are rarer and/or less attracted to traditional baits have a lower probability of being studied. The same factors obviously influenced the probability in figure 1, which illustrates how the proportion of unidentified species increases with sample size, without reaching a plateau in the sample studied. To this reasoning we must add that some *Drosophila* species are not attracted to banana baits at all, and these are the least studied taxonomicaly. Thus, it is reasonable to believe that a larger proportion of the total of described species has been detected, and suggests that our value of 58% of described species is an overestimate.



The combined use of standardized collecting procedures and a technique with a high and consistent sensitivity for species identification allows the use of methods to quantify biological diversity. This approach highlights the great diversity of *Drosophila* species in forest remnants in São Paulo state. Moreover, it indicates that at least about half of the species in this region remain to be described. The forests of southeastern Brazil, especially those of São Paulo state, are among the most studied ecosystems in this country (Lewinsohn & Prado 2002), including for *Drosophila* (Tidon-Sklorz & Sene 1999). *Drosophila* genus is also an exception between the mega diversified taxa of small forest dwelling invertebrates, by having received a significative taxonomic attention. Thus, our conclusions illustrate the actual state of knowledge about Brazilian biota, from which the proportion of described species is estimated as one tenth (Lewinsohn & Prado 2002). Moreover, it shows that *Drosophila* genus still needs intensive taxonomic effort as the most of our taxa. A conclusion that becomes more relevant considering that this is a well studied genus, on the best sampled region of Brazil.

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Authors: Hermes Fonsêca de Medeiros, Louis Bernard Klaczko

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HAWKSBILL TURTLES VISIT MOUSTACHED BARBERS: CLEANING SYMBIOSIS BETWEEN *ERETMOCHELYS IMBRICATA* AND THE SHRIMP *STENOPUS HISPIDUS*

Ivan Sazima[1], Alice Grossman[2], Cristina Sazima[1,3]*

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1- Departamento de Zoologia e Museu de História Natural, Caixa Postal 6109, Universidade Estadual de Campinas, 13083-970 Campinas, São Paulo, Brazil (http://www.unicamp.br)
*Corresponding author. Tel: + 55-19-3788 7292; fax: +55-19-3289 3124; e-mail: isazima@unicamp.br
2 - Projeto Tamar/Ibama, Alameda Boldró s/no, 53990-000 Fernando de Noronha, Pernambuco, Brazil
3 - Departamento de Zoologia, Caixa Postal 199, Universidade Estadual Paulista, 13506-900 Rio Claro, São Paulo, Brazil

Abstract

At the oceanic island of Fernando de Noronha, off northeast Brazil, we recorded the hawksbill turtle (*Eretmochelys imbricata*) visiting cleaning stations tended by the barber pole shrimp (*Stenopus hispidus*). This seems to be the first record of cleaning symbiosis between marine turtles and shrimps. During their foraging on the reef flat, the turtles regularly visited and posed at the stations. The same stations were visited by a few species of reef fishes, which posed and were cleaned by the shrimps. We suggest that cleaning symbiosis between turtles and shrimps is widespread and went unrecognised due to the superficial resemblance between a resting turtle and a posing and cleaned one. Additionally, we submit a putative origin for the cleaning symbiosis between marine turtles and cleaner shrimps following a few simple behavioural steps.

Key words: *Marine turtle-cleaner shrimp association, cleaning symbiosis, origin of turtle-shrimp association, reef environment, Equatorial West Atlantic*

Resumo

Nas ilhas oceânicas de Fernando de Noronha, ao largo da costa Nordeste do Brasil, registramos tartarugas-de-pente (*Eretmochelys imbricata*) visitando estações de limpeza mantidas pelo camarão-palhaço (*Stenopus hispidus*). Este parece ser o primeiro registro de simbiose de limpeza entre tartarugas marinhas e camarões. Durante o seu forrageamento na planície recifal, as tartarugas visitavam e posavam nas estações regularmente. As mesmas estações eram visitadas por algumas espécies de peixes recifais, que aí posavam e eram limpas pelos camarões. Sugerimos aqui que a simbiose de limpeza entre tartarugas marinhas e camarões seja comum e difundida, porém passa despercebida devido à semelhança superficial entre uma tartaruga que esteja descansando e aquela posando e sendo limpa. Além disso, apresentamos uma origem putativa para a simbiose de limpeza entre tartarugas marinhas e camarões-limpadores, que segue etapas comportamentais relativamente simples.

Palavras-chave:*Associação entre tartarugas marinhas e camarões-limpadores, Simbiose de limpeza, origem da associação tartaruga-camarão, ambiente recifal, Atlântico Equatorial Ocidental*

1. Introduction

Cleaning symbiosis between two species of marine turtles and several species of reef fishes has been recorded both from the Pacific and the Atlantic (Booth & Peters, 1972; Smith, 1988; Losey et al., 1994). In this kind of interaction, the cleaner fishes obtain food, and the turtles get rid of the organisms' growth on their shells and/or soft body parts (Smith, 1988; Losey et al., 1994). Cleaning interaction with reef fishes was only recently recorded for the green turtle (*Chelonia mydas*) at the oceanic islands of Fernando de Noronha Archipelago, Equatorial West Atlantic (Sazima et al., 2004).

To the best of our knowledge, however, no records of this type of interaction have been recorded between sea turtles and cleaner shrimps. This invertebrate cleaner type is known to interact with several reef fish species in the Mediterranean, the Atlantic, and the Pacific (reviews in Limbaugh et al., 1961; Criales & Corredor, 1977; Van Tassel et al, 1994; Côté, 2000). We report here on cleaning symbiosis between the hawksbill turtle (*Eretmochelys imbricata*) and the barber pole shrimp (*Stenopus hispidus*) at the Fernando de Noronha Archipelago, off North-eastern Brazil.

2. Material and Methods

The hawksbill turtle-cleaner shrimp symbiosis was recorded at the Fernando de Noronha Archipelago (03°50'S, 32°25'W), about 345 km off NE Brazil (see Maida & Ferreira, 1997 for map and description). Field study was conducted in November and December 2003 at the Baía do Sueste, on a reef flat composed of sandy bottom interspersed with rocky ledges sparsely to thickly covered by brown foliose algae, red coralline algae and stony corals (see description and illustrations in Maida et al., 1995, 1997; Sanches & Bellini, 1999). Depth at the observation site ranged up to 4 m at high tide, and 1.5-2.5 m at ebb tide.

Hawksbills' foraging and their cleaning by the barber pole shrimps were recorded in seven non-consecutive days while snorkelling (40-90 min each day). During observational sessions of 10-30 min (total observation time 185 min) we used focal animal samplings, in which all occurrences of specified actions were recorded (Altmann, 1974; Lehner, 1979). We focused on the postures assumed by the turtle while being cleaned, in order to infer to what body parts the shrimps were possibly nibbling at. Since barber pole shrimps attend their clients from within the recesses of coves or crevices (Limbaugh et al., 1961; Criales & Corredor, 1977; Humann, 1996), their cleaning behaviour is more difficult to observe than that of cleaner fishes. In all our observations, the turtle's body was partly wedged under rocky ledges on which the stations were located and thus prevented a clear view of the cleaner shrimps. Therefore, most of the cleaners' behaviour was inferred from the turtles' behaviour at the station and the more visible movements the shrimps did at their station while cleaning smaller clients such as reef fishes (Limbaugh et al., 1961 comment on similar hindrances for observing shrimps' cleaning behaviour).

3. Results

We found two barber pole shrimp cleaning stations being visited by hawksbill turtles on the reef flat. One of them was tended by an adult shrimp couple (Fig. 1), whereas the other was occupied by a single, supposedly juvenile shrimp. The two stations were on rocky outcrops densely covered by green algae, and adjacent to a sandy patch. The adult shrimps measured about 5 cm in body length and remained within large crevices under ledges, usually on the ceiling near the entrance (Fig. 2) from where they waved their long white antennae. The juvenile shrimp measured about 3 cm.

Hawksbill turtles spent 3-4 hours foraging and fed on mixed algal turf, an activity interspersed with periods of resting on the bottom or short breathing bouts on the water surface. Along their activity on the reef flat the turtles regularly sought the shrimps' cleaning stations.

The description below is a composite of the two most complete observations, and is representative of all our records of turtles (n= 7) on the two cleaning stations. In one of these records the turtle was already posing at the station and left on the observer's approach. The other record included approaching, posing, and leaving, but the view of the turtle's behaviour was somewhat hindered by the observer's position from behind the station.

After foraging for a while, the hawksbill turtle swam directly towards the cleaning station, landed in front of it and adjusted its position to accommodate the left or right portion of its hind-body and limbs under the rocky ledge. Its posture while at the station was very characteristic: its hind limbs were sprawled and the forelimbs were stretched holding its fore body and head elevated. The turtle held this posture for 50-60 sec after which it moved away. While at the shrimp station the turtle remained watchful and prone to flee at an observer's close approach.

Judging from the turtles' posture and their positioning under the ledge, they made available both the limbs (soft parts) and the carapace and plastron (hard parts) to the cleaner shrimps. From what we observed of the shrimps' behaviour while cleaning fishes and the use they make of their delicate, smaller chelae (claws), we presume that they nibbled at the turtles' soft parts, most probably the skin folds and the spaces between the limbs' scales (see Discussion).

Fig. 1. A cleaning station of the barber pole shrimp (*Stenopus hispidus*) under a rocky ledge on a reef flat at the Baía do Sueste, Fernando de Noronha Island, off NE Brazil. Two grunt clients (*Haemulon parra*) are lingering near the station.

Fig. 2. A couple of barber pole shrimps (*Stenopus hispidus*) at the cleaning station, the individual in the centre showing off the white long antennae and strong claws. The head of a moray (*Gymnothorax miliaris*) is visible in the left lower corner.

We recorded three turtle individuals at the two cleaning stations. The largest individual measured 63.5 cm CCL and was recorded twice at the station tended by the shrimp couple. The second one measured 61.5 cm CCL and was recorded four times at the same station. Both turtles are five-years residents at the study site, the first with 15 records and the second with 23 ones over the period (AG, pers. obs.). The smallest hawksbill measured about 40 cm CCL and was recorded only once at the juvenile shrimp cleaning station. We have no previous record of this individual.

After leaving a cleaning station all turtles followed the same path and were found foraging on the reef flat not far from the two cleaning stations. Additional hawksbills were found on the same feeding grounds, and possibly visited the shrimp stations as well.

Three species of reef fishes regularly visited the same stations used by the turtles and were cleaned by the barber pole shrimps: the surgeonfish *Acanthurus chirurgus*, the grunt *Haemulon parra*, and the parrotfish *Sparisoma axillare*.

4. Discussion

All hawksbill individuals recorded foraging on the reef flat and posing at the barber pole shrimp cleaning station were juveniles (see Witzell, 1983 for size of adults), although adult males were recorded at the reef flat occasionally (AG, pers. obs.). These findings agree with an 11-years study on occurrence of hawksbills and green turtles at the Fernando de Noronha Archipelago (Sanches & Bellini, 1999).

The posture assumed by the hawksbill turtle while on a cleaner shrimp station differed from the pose the green turtle assumes while being cleaned by small reef fishes (see Booth & Peters, 1972; Losey et al., 1994 for illustration and description), as the hawksbill rested on the bottom with its fore limbs stretched, the head and fore body elevated.

The narrow spaces between skin folds and limbs' scales probably are unavailable to a medium-sized or even a small cleaner fish (Sazima et al., 2004), as its mouth is larger and thus more 'clumsy' than the delicate lesser claws of a cleaner shrimp. We think this may be one cause for hawksbills seeking cleaning stations tended by barber pole shrimps and manoeuvring as that these body parts became available to the cleaners.

Three cleaner shrimp species are recorded cleaning reef fishes at the Fernando de Noronha Archipelago (Francini-Filho et al., 1999). The barber pole shrimp stands among the largest tropical West Atlantic cleaner shrimps (Limbaugh et al., 1961; Criales & Corredor, 1977; Humann, 1992) and thus its claws are larger than those of the other shrimps. We think that another cause for hawksbills seeking this shrimp is its large size (and thus its relative visibility), besides its large claws probably being able to deliver tactile stimuli perceptible even for the though hide of marine turtles (see Losey, 1993 for proximate causes of cleaning symbiosis).

To date the instances of cleaning symbiosis between marine turtles and cleaning fishes recorded at the Fernando de Noronha Archipelago involve fish species relatively unspecialised as cleaners (Sazima et al., 2004; pers. obs.). This indicates that marine turtles likely are unimportant clients for the relatively specialised fish cleaners such as the french angelfish *Pomacanthus paru* (Sazima et al., 1999) or the Noronha wrasse *Thalassoma noronhanum* (Francini-Filho et al., 2000). Indeed, cleaning stations tended by juvenile angelfish and wrasses were found close to the shrimp stations, but not a single cleaning interaction was recorded between turtles and these fish cleaners. This view remains to be tested as more data accumulate on cleaning symbiosis between marine turtles and reef fishes in the Southwest Atlantic (see below).

Although cleaning symbiosis between marine turtles and reef fishes or shrimps have been recorded only recently in the Southwest Atlantic (Sazima et al., 2004; pers. obs.), we believe that this is a widespread relationship that possibly went unrecognised as such by marine biologists. A turtle posing for a small cleaner near a rocky outcrop or under a ledge may well be regarded as a resting one (Fig. 3), as both the shelter and the turtle's postures in both situations are somewhat similar. Hawksbills commonly rest on the bottom and occasionally under ledges and in crevices both during the day and at night (per. obs.). However, a turtle being serviced at a cleaning station stretches its forelimbs and elevates its head and fore body. Thus, an attentive look may reveal that the turtle actually holds one of the characteristic postures assumed during cleaning interactions (Booth & Peters, 1972; Losey et al., 1994; Sazima et al., 2004; this study), and a brief inspection under the ledge or near the outcrop will likely disclose a cleaner shrimp and/or fish working on the turtle.

The putative origin of cleaning symbiosis between hawksbill turtles and cleaner shrimps may follow simple behavioural steps: (**1**) in the reef habitat hawksbills usually remain or rest near rocky ledges, sometimes in a crevice or under a ledge (Fig. 3; see also Meylan & Donnelly, 1999); (**2**) some of these rocks and ledges harbour stations tended by cleaning shrimps; (**3**) the shrimps treat the turtles as additional clients notwithstanding their differences in appearance and size when compared with fishes; (**4**) the turtles get rid of shed skin and epibionts, and receive tactile stimuli as well, both factors advantageous and/or pleasant for the turtles (Losey et al., 1994); (**5**) foraging turtles learn to seek the cleaning stations, and to pose for the shrimps to obtain the mentioned advantages. This scenario seems supported

Fig. 3. A hawksbill turtle (*Eretmochelys imbricata*) characteristically positioned under a rocky ledge, a behaviour that may either indicate a resting episode or a cleaning interaction with shrimps.

both by studies on cleaning symbiosis between fishes, and between fishes and marine turtles (e.g., Losey, 1979; Losey et al., 1994; Côté, 2000; Sazima et al., 2004), being reminiscent of the presumptive origin of cleaning between reef sharks and cleaner gobies presented by Sazima and Moura (2000). The barber pole cleaner shrimp seems active mostly at night (Criales & Corredor, 1977), and hawksbill turtles tend to wedge themselves in crevices and under ledges during night resting (AG and IS, pers. obs.), two additional events that lend further support to the above postulated origin.

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Title: Hawksbill turtles visit moustached barbers: cleaning symbiosis between ***Eretmochelys imbricata*** and the shrimp ***Stenopus hispidus***

Authors: Ivan Sazima, Alice Grossman, Cristina Sazima

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REGISTROS NOVOS DE OCORRÊNCIA DE SEIS ESPÉCIES DE SIMULIIDAE (DIPTERA) PARA O ESTADO DO RIO DE JANEIRO.

Leonardo H. Gil Azevedo; Marilza Maia Herzog

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Laboratório de Simulídeos e Oncocercose, Dept. Entomologia, IOC, FIOCRUZ (www.fiocruz.br).
Av. Brasil, 4365 – Manguinhos, Rio de Janeiro, RJ – Cx Postal 926 – CEP 21045-900.

Abstract

Six new records of Simuliidae for the state of Rio de Janeiro are described: *Simulium (Chirostilbia) empascae, S. (C.) subpallidum, S. (Hemicetha) brachycladum, S. (Inaequalium) inaequale, S. (Psaroniocompsa) auripellitum e S. (Trichodagmia) nigrimanum*.

Key words: *Simulium, new records, Rio de Janeiro.*

Resumo

Foram encontradas seis novas ocorrências de Simuliidae para o estado do Rio de Janeiro: *Simulium (Chirostilbia) empascae, S. (C.) subpallidum, S. (Hemicetha) brachycladum, S. (Inaequalium) inaequale, S. (Psaroniocompsa) auripellitum e S. (Trichodagmia) nigrimanum*.

Palavras-chave:: *Simulium, Distribuição, Rio de Janeiro.*

1.Introdução

Apesar dos trabalhos pioneiros sobre a diversidade dos simulídeos terem início na primeira metade do século XX no próprio Rio de Janeiro com os trabalhos de Lutz (1909, 1910), pouco se conhece sobre a distribuição do grupo no estado. Segundo Crosskey & Howard (1997) são listadas 75 espécies para o Brasil, sendo apenas 29 destas encontradas no estado do Rio de Janeiro.

Com base em exemplares identificados de diversas regiões do estado foram encontrados seis novos registros para o estado, aumentando para 35 o numero de espécies, um incremento na distribuição da família no Brasil.

2.Materiais e Métodos

Neste estudo foi utilizado material proveniente do estado do Rio de Janeiro, depositado na Coleção de Simulídeos do Departamento de Entomologia, IOC, FIOCRUZ (IOC) e na Coleção Entomológica do Departamento de Zoologia, IB, UFRJ (DZRJ). O material foi identificado através de observação em microscópio estereoscópio. Quando necessário foram realizadas dissecções e montagem em lâmina e lamínula, para observação em microscópio bacteriológico. A identificação foi feita através de comparação direta com exemplares depositados na Coleção de Simulídeos do IOC e do Museo Nacional de La Plata (MLP), com auxílio da bibliografia e utilizando o sistema taxonômico proposto por Crosskey & Howard, 1997. Foram utilizadas larvas de último instar, pupas e adultos com suas exúvias pupais.

3. Resultados e Discussão

Simulium (Chirostilbia) empascae Py-Daniel & Moreira, 1988.

Material utilizado: Município de Guapimirim, Rio Iconha (02/VIII/2001, A. Huamantinco e J. Nessimian Col.) [DZRJ]: 7 pupas. Município do Rio de Janeiro, Parque Nacional da Tijuca, Reserva dos Três Rios, Represa dos Ciganos (03/III/1982, M. Maia-Herzog & T. Leite Col.) [IOC – nº. 622-59]: 1 pupa (lâmina). (03/X/1983, M. Maia-Herzog & T. Carvalho Col.) [IOC]: 1 macho/exúvia pupal (lâmina). (26/III/1984, M. Maia-Herzog & R. Malaguti Col.) [IOC]: 1 fêmea/exúvia pupal (lâmina).

Distribuição: SC (Crosskey & Howard, 1997) e RJ (novo registro).

Discussão: Este registro amplia a área de distribuição desta espécie para o norte. Há poucos dados acerca da sua distribuição e provavelmente deve ocorrer em outros estados.

Simulium (Chirostilbia) subpallidum Lutz, 1910.

Material Utilizado: Município de Casimiro de Abreu, Ribeirão da Luz (05/VIII/200, A. Huamantinco e J. Nessimian Col.) [DZRJ]: 15 pupas. Município de Cachoeira de Macacu, Rio Boa Vista (03/VIII/2001, A. Huamantinco e J. Nessimian Col.) [DZRJ]: 16 pupas. Município de Guapimirim, Rio Iconha (02/VIII/2001, A. Huamantinco e J. Nessimian Col.) [DZRJ]: 4 pupas. Município de Valença, Conservatória, Cachoeira Municipal de Conservatória (15/IX/1994, A. Luna Dias & P. Garritano Col.) [IOC – nº. 1029]: 1 pupa. Município de Rio Claro, entroncamento das estradas Barra Mansa-Pouso Seco (Br494) com Getulândia-Santana do Bom Sucesso (Rj139), Córrego Pouso Seco (15/V/1979, A. Shelley & A. Luna Dias Col.) [IOC – nº. 450]: 2 fêmeas/exúvias pupais e 5 machos/exúvias pupais. Município de Itatiaia, Rio Campo Belo, abaixo do Sanatório Militar, Saída do Parque Nacional do Itatiaia (23/V/1979, A. Shelley & A. Luna Dias Col.) [IOC – n.º 483]: 1 macho/exúvia pupal.

Distribuição: Brasil (MG, BA, ES, GO, MS, PR, PA, SP, TO), Argentina (Misiones), Paraguai e Venezuela (Crosskey & Howard, 1997) e RJ (novo registro).

Discussão: É uma espécie que apresenta larga distribuição, principalmente no Brasil Central e parece estar relacionada a áreas com pouca cobertura vegetal. Encontra-se amplamente distribuída no estado.

Simulium (Hemicnetha) brachycladum Lutz & Pinto, 1932 [in Pinto, 1932].

Material Utilizado: Município do Rio de Janeiro, Parque Nacional da Tijuca, Estrada Grajaú-Jacarepaguá, Represa dos Ciganos (09/VIII/1983, M. Maia-Herzog, A. Luna Dias & T. Leite Col.) [IOC – nº. 660]: 1 pupa. Município de Itaguaí, Sitio Porangaba (10/XI/1983, A. Luna Dias Col.). [IOC – nº. 661]: 200 pupas.

Distribuição: PE, BA, ES, MG, PB, SP (Crosskey & Howard, 1997) e RJ (novo registro).

Discussão: A espécie apresenta-se amplamente distribuída nas regiões sudeste e nordeste brasileiras. No estado do Rio de Janeiro é encontrada em áreas de Baixada, próximo à costa.

Simulium (Inaequalium) inaequale (Paterson & Shannon, 1927).

Material Utilizado: Município de Rio Claro, entroncamento das estradas Barra Mansa-Pouso Seco (Br494) com Getulândia-Santana do Bom Sucesso (Rj139), Córrego Pouso Seco (15/V/1979, A. Shelley & A. Luna Dias Col.) [IOC – nº. 450]: 5 fêmeas/exúvias pupais e 2 machos/exúvias pupais.

Distribuição: Argentina (Misiones, Tucuman, Salta, Jujuy), Paraguai, Bolívia (La Paz), Brasil (AP, BA, ES, MG, MT, PR, PB, SC, SP) (Crosskey & Howard, 1997) e RJ (registro novo).

Discussão: A espécie apresenta larga distribuição na America do Sul.

Simulium (Psaroniocompsa) auripellitum Enderlein, 1933.

Matarial Utilizado: Município de Sumidouro, Murinelli (28/II/1980, A. Luna Dias & P. Garritano Col.) [IOC – nº. 510]: 1 fêmea/exúvia.

Distribuição: Uruguai, Argentina (Entre Rios, Corrientes, Misiones, Chaco, Santa Fé, Formosa), Paraguai, Brasil (DF, GO, MT, MS, PR, RS, SC e SP) (Crosskey & Howard, 1997) RJ (novo registro).

Discussão: A espécie apresenta larga distribuição na América do Sul. Este registro amplia a distribuição para o leste.

Simulium (Trichodagmia) nigrimanum Macquart, 1838.

Material Utilizado: Município de Sumidouro, Sitio Pamparrão (28/III/1980, A. Luna Dias & P. Garritano Col.) [IOC – nº. 512]: 8 pupas. Município de Guapimirim, Rio Iconha (27/VII/2001, A. Huamantinco e J. Nessimian Col.) [DZRJ]: 1 larva.

Distribuição: Venezuela, Paraguai, Brasil (SP, ES, MG, MT, MS, PR) (Crosskey & Howard, 1997) e RJ (novo registro).

Discussão: A espécie apresenta larga distribuição na América do Sul.

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Autores: Leonardo H. Gil Azevedo; Marilza Maia Herzog

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