SCIENTIA PLENA **VOL. 9, NUM. 1** **2013**
www.scientiaplena.org.br

Dragonflies (Odonata) in Subtropical Atlantic Forest fragments in Rio Grande do Sul, Brazil: seasonal diversity and composition

Libélulas (Odonata) em subtropicais fragmentos de Mata Atlântica no Rio Grande do Sul, Brasil: diversidade sazonal e composição

S. Renner[1]; E. Périco[1]; G. Sahlén[2]

[1]*Ecologia e Sensoriamento Remoto, Centro Universitário Univates, 95900-000, Lajeado-RS, Brasil*

[2]*Ecology and Environmental Sciences, Halmstad University,30118, Halmstad, Suécia*

samuelrenner@hotmail.com

(Recebido em 15 de agosto de 2012; aceito em 16 de janeiro de 2013)

One of the most endangered ecosystems in America is the Atlantic Forest, which demands emergency actions to protect its remnants as well its biodiversity. In this situation the species inventory can develop a management role for the future, determining specific areas that should be preserved as well the species composition and richness can be used as an indicator of a healthy ecosystem. The use of dragonfly species composition has proven its potential indication of quality habitats. The Odonata species actually still poorly known in the Neotropical region and has never been used as a tool to analyze the actual conditions of aquatic environments particularly in the Subtropical Atlantic Forest, which occurs in south of Brazil. A systematic survey was carried out in aquatic systems located at remnants of forest from March 2011 to February 2012. A total of 565 specimens belonging to 34 species, distributed in 5 families were sampled. Libellulidae was dominant, with 14 species, followed by Coenagrionidae, Gomphidae, Lestidae and Aeshnidae. Through inventory survey we deepen the Odonata composition knowledge and performed a statistic analysis.
Keywords: Entomology; Ecology; species richness

A Floresta Atlântica é um dos mais ameaçados ecossistemas da América do Sul, o qual demanda ações emergenciais para a proteção de seus remanescentes bem como a sua biodiversidade. Nessa situação, inventariamentos de espécies podem desenvolver um importante papel para o futuro, determinando áreas específicas que devem ser protegidas, bem como a composição e riqueza de espécies pode ser usada como indicador de um sistema saudável. Atualmente as espécies da Ordem Odonata da região Neotropical continuam pouco conhecidas e jamais foram utilizadas como ferramenta de análise de ambientes aquáticos particularmente na Floresta Atlântica Subtropical, presente na região Sul do Brasil. Uma pesquisa sistemática foi realizada em sistemas aquáticos de fragmentos florestais entre Março de 2011 e Fevereiro de 2012. Um total de 565 espécimes, pertencendo a 34 espécies, distribuidas em 5 famílias foram amostrados. Libellulidae foi dominante, com 14 espécies, seguida de Coenagrionidae, Gomphidae, Lestidae e Aeshnidae. Através deste inventário foi aprofundado o conhecimento sobre a composição de Odonata e desenvolvida uma análise estatística.
Palavras-chave: Entomologia; Ecologia; riqueza de espécies

---

1. INTRODUCTION

As described by [31], the Atlantic Forest is the cradle of one the most rich ecosystems on the entire planet, and actually one of the most fragmented environments due to human activities. Less than 7% of the original Atlantic Forest remain in a highly fragmented system which originally covered approximately 15% of the total Brazilian area [14]. The aquatic resources situated in the remaining forests are under extreme pressure, as well the species which depends on them to survive [6].

Although aquatic resources are under particular threat today, the management of the aquatic habitats and watersheds requires the development of a comprehensive assessment and monitoring methods [20]. The effects of the forest fragmentation on the fauna of primary tropical forests has focused mainly on birds or mammals [8, 22], there being relatively few work on insects [23, 11].

The biggest problem for conservation in tropical forests is the scarce information allowing the establishment of priorities and concentration of efforts on practical actions. This is largely due to low availability of faunal inventories, which limits the knowledge of the distribution and abundance of species. Faunal surveys are an excellent tool for conservation, ecosystem management and environmental protection, not only as representations of biodiversity but also from organisms serving as indicators of environmental conditions. Unfortunately, only 29% of Brazilian territory presents data on Odonata species richness [7], although it is a well known for providing “flagships” within the field of conservation biology is the Odonata order [26], which has been used as source of indicator species by several authors [2, 3, 4, 19, 30].

According to [29] and [32], Odonate communities in disturbed habitats will often be less species rich and consist of many widespread generalists. Another example from the tropics, the study carried by [18] in Brazil, where species with a wide geographical range, i.e. the common species, were predominant in open savannah, while those with a more restricted distribution were predominant in forests. The presence or absence of determined species, can mirror the human activities in the surrounding of the water bodies [24, 25] as well the structural components of the forest remnants surveyed.

The order Odonata in general are among the most significant organisms in the systems that are under threat [25], being an important focal organisms in contemporary conservation. Dragonflies are particularly abundant in warmer waters as those in lowlands of tropical and subtropical regions. Along the last thirty years this order has been one of the most studied groups around the world, but these studies still scarce in the Neotropical region [13].

[10] states that dragonflies are one of the most visible indicators of wetland diversity and health, and their species composition allows to monitoring environmental changes. Due to the species-specific variation for tolerances that insects have for a wide range of environmental circumstances, insects are also widely used as indicators, being a reliable tool for environment monitoring [1].

Despite the larval stage be a better indicator than the adults, we opted to run this investigation using adults due to the lack of larvae information, i.e. identification keys, most of Neotropical dragonfly species can only be identified through adults instead larvae, which still poorly known [12, 25]. [28] declared that a species restricted to a narrower range of conditions is a better indicator than a generalist species and must not just be selective to where to breed, but being also common enough to be easily detected in a brief survey.

Developing an inventory survey is possible to analyze statistically the regional species composition and to produce a overview of the distribution patterns along the year seasons and to select and discuss from a complete species list, which species can be considered as potential species richness indicators. Our focus area is located in the extreme south of Brazil, the state of Rio Grande do Sul, which is covered by the southernmost portion of Atlantic Forest, in a Subtropical climate.

2. MATERIALS AND METHODS

During this survey project we sampled for adult dragonflies on 15 aquatic habitats that were selected in a random way, mixing lakes, bogs, streams and other wetlands, in the way to have a general perception of the Odonata species richness. Those localities were visited once per season between the year of 2011 and 2012, summer, autumn and spring, excluding winter due to the low activity of adults in the cold season.

All sampled areas are located into small fragments of Subtropical Atlantic Forest in southernmost part of Brazil, State of Rio Grande do Sul (RS) (Figure 1), among the coordinates 29°30’ N and 52°0’ E. Those areas are in a completely fragmented situation due to human activities mainly to agricultural zones and urban development.

All the sampling areas are located in the municipality of Cruzeiro do Sul (RS) (Figure 1), which is inserted in the Taquari River Valley [9]. Altitudes varying between 100 and 200m, the climate is Temperate Subtropical with average temperatures varying between 15°C and 18°C and the precipitation average varies between 1.300 mm and 1.800 mm [17].

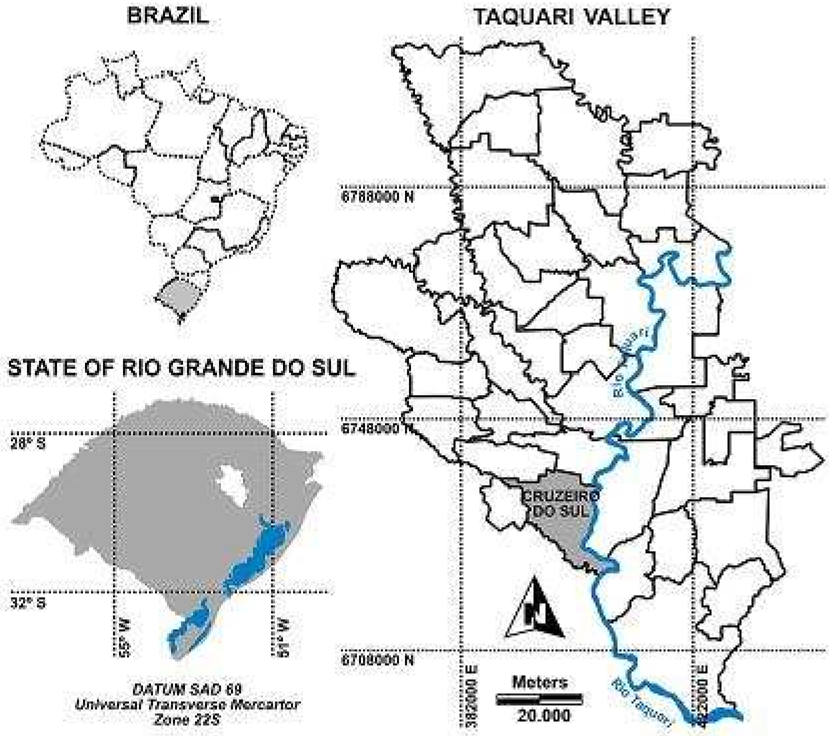


Figure 1: Brazilian map, Rio Grande do Sul and the sampling zone, Cruzeiro do Sul, RS.

The sampling method used standard insect nets, each locality was sampled once per season during sunny days, in the peak time of the Odonata activity (between 9 a.m. and 16 p.m.), catching specimens in the surroundings of the water source and marsh zone.

As some species are quite difficult to catch due to its fast flying and agility, i.e. big Aeshnids, those were registered only by sight (using binoculars), for the final specimens accounting. Each locality was visited by a field team composed by two persons, and the sampling occurred until the field team concluded that at least one specimen from each species occurring there was sampled, except for the fast flying ones, that were only registered by sight. Using field sheets, all the GIS data, weather, biological and water conditions encountered in each locality was taken as field information, for the later comparison between species richness and particular local conditions. Particular aquatic vegetation notes were taken for each sampling point according to the occurrence and density of the aquatic plants.

All the specimens sampled were preserved in 96% ethanol, separated by locality and sampling season, and later determined according [12, 13, 15, 16] until the level of species. The determination work took place at the Ecology Laboratory, at UNIVATES, Lajeado (RS), Brazil, where all the specimens collected during this survey are deposited in the Invertebrate Collection of the Natural History Museum (MCNU).

The identified specimen data was analyzed statistically using the software Estimates 8.0 to estimate the collector curve, Shannon, Jacknife 2nd order and Jaccard indexes, PAST 2.16 to the seriation and MVSP 3.1 to the UPGMA analysis. The dates for richness, singletons, doubletons, uniques and duplicates are collected data.

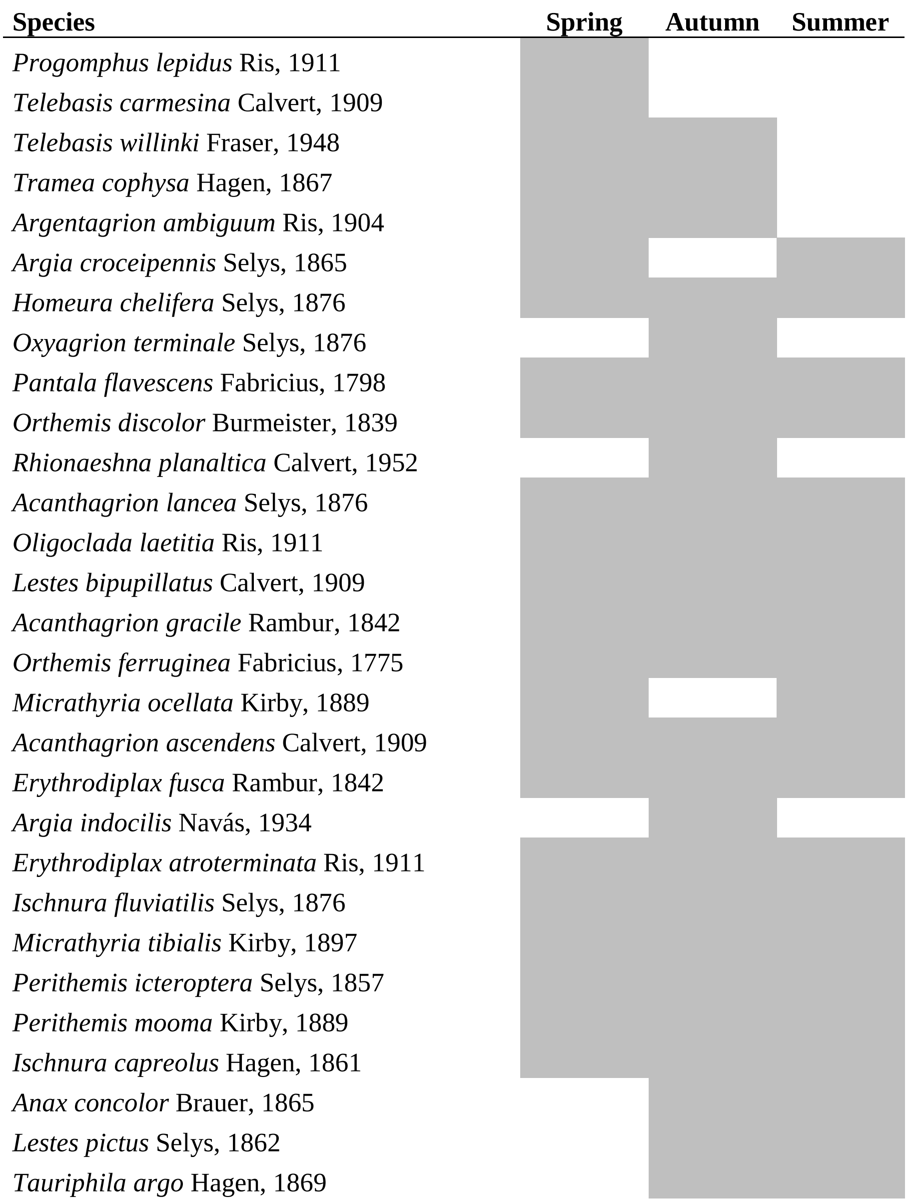
3. RESULTS AND DISCUSSION

The aquatic vegetation encountered at the sampling sites was composed mostly by *Eichhornia crassipes* (Mart.) (Pontederiaceae), *Lemna gibba* (L.) Araceae, *Pistia stratiotes* (L.) (Araceae), and *Salvinia auriculata* (Aubl.) (Salviniaceae) according [21], and also emergent vegetation, grasses and roots of the riparian shrubs and trees. The substrate of the sampling areas was basically composed by boulders, mud, silt, gravel, sand and decaying leaves.

Among the sampling sites we collected 565 specimens of 34 species, scattered in 5 families. Libellulidae and Coenagrionidae were the most dominant families, both with 14 species, followed by Lestidae (2 species), Aeshnidae (2 species) and Gomphidae (2 species). The most dominant genera was *Acanthagrion* Selys, followed by *Telebasis* Selys, and *Erythrodiplax* Brauer, with 3, 3 and 2 species, respectively (*Acanthagrion lancea* Selys 1876, *A. gracile* Rambur 1842, *A. ascendens* Calvert 1909, *Telebasis carmesina* Calvert 1909, *T. willinki* Fraser 1948, *T. theodorii* Navás 1934, *Erythrodiplax fusca* Rambur 1842 and *E. atroterminata* Ris, 1911).

The most abundant species was *Erythrodiplax fusca* (Libellulidae) (Δ = 144), followed by *Perithemis icteroptera* Selys 1857 (Libellulidae) (Δ = 62) and *Acanthagrion lancea* (Coenagrionidae) (Δ = 50).

The species seriation (Figure 2) shows how the species are distributed among the seasons. Five species were found just in the summer, three just in the autumn and two just in the spring. The other ones were found along two or three seasons. The Jaccard indexes among the seasons were: spring and autumn (0,655), spring and summer (0,581) and autumn and summer (0,594). This relation could be seen at the UPGMA analysis (Figure 3).



Erythemis peruviana Rambur, 1842
Oxyagrion sp. Selys, 1876
Telebasis sp. Selys, 1865
Dasythemis mincki mincki Karsch, 1890
Aphylla producta Selys, 1854

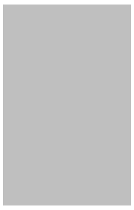


Figure 2: Species Seriation collected in Cruzeiro do Sul, RS, from March 2011 to February 2012 considering the seasons with constrained organization.

Grouping the abundance registering between the seasons and analyzing this data through a UPGMA cluster, utilizing log of Euclidian distance, we obtained a similarity group among autumn and spring. The summer season demonstrated to be the richest season. (Figure 3).

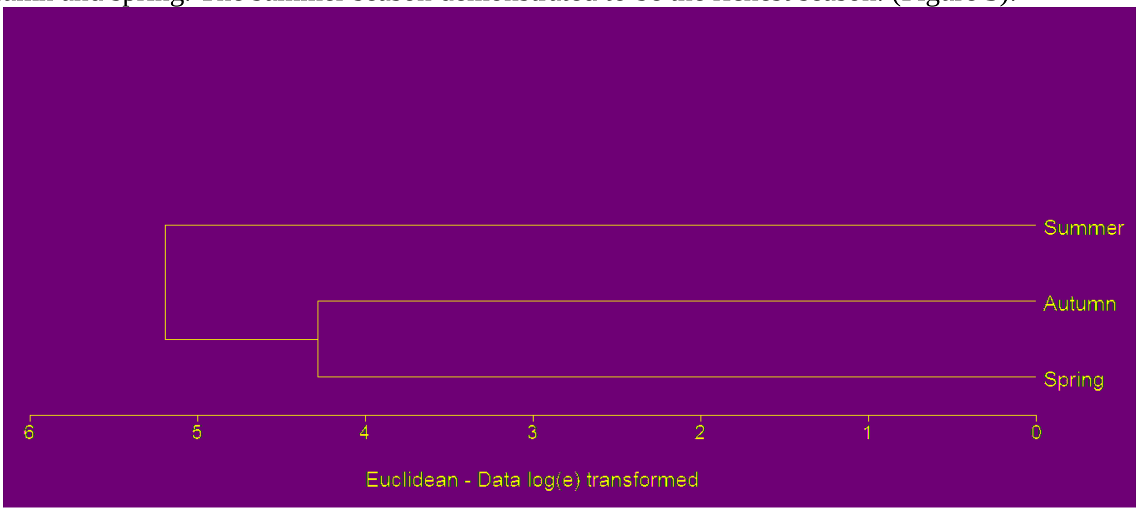


Figure 3: UPGMA cluster analysis using Euclidean distance among season samplings. Data were obtained in Cruzeiro do Sul, RS, from March 2011 to February 2012 and transformed by log(e).

Continuing the seasonality analysis (Table 1), the species richness and other indices as: Shannon, Jacknife 2nd order were calculated by season using the Estimates 8.0 software and richness, singletons, doubletons, uniques and duplicates were presented as real field data. The t test applied for Shannon for the seasons did not show significance between Spring and Autumn (p = 0,5374), Autumn and Summer (p = 0,0867) and was statistically significant between Spring and Summer (p = 0,0262).

Table I: Seasonal diversity indices obtained in Cruzeiro do Sul, RS, from March 2011 to February 2012. The Shannon index and Jacknife 2nd order were estimated by Estimates 8.0, while the Richness, Singletons, Doubletons, Uniques and Duplicates are represented by real field data.

	Spring	Autumn	Summer
Richness	23	26	24
Shannon	2.56	2.66	2.71
Jacknife 2nd order	24.34	36.34	42.67
Singletons	5	6	6
Doubletons	3	4	2
Uniques	8	11	7
Duplicates	1	3	3

The collector's curve was built using all the sampling efforts in the three analyzed seasons. The curve tendency is to stabilize from the 10th sampling effort and the observed and estimated curve are overlapping (Figure 4).

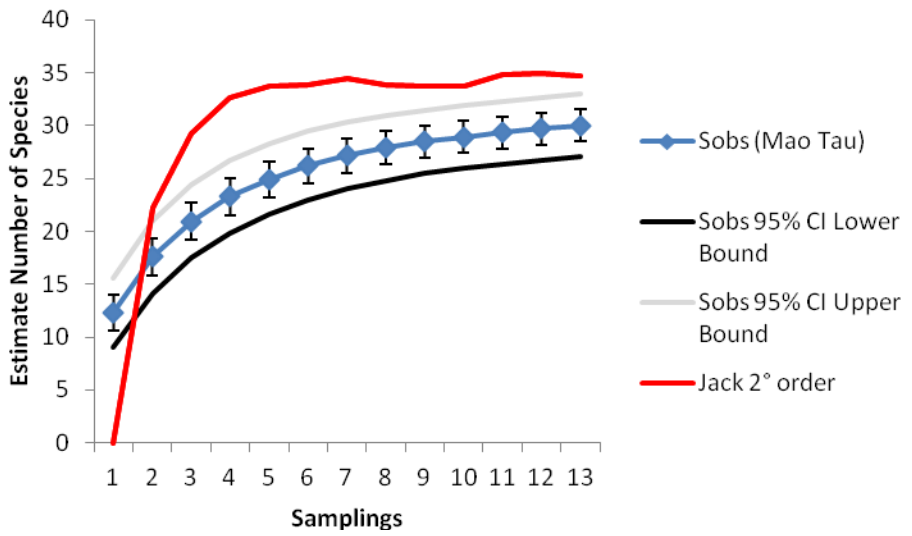


Figure 4: Collector's curve of the sampling efforts carried out between March 2011 and February 2012 in Cruzeiro do Sul, RS, performed by Estimates 8.0.

4. CONCLUSION

Using this survey as inventory tool for this region of Brazil, we indentified 34 dragonfly species, which seems to be a quite rich species composition for the Subtropical Atlantic Forest biome.

According to the collected field data, can be seen a strong relation between the environmental conditions encountered for each sampling site and the species richness counted there, it can be realized not only in the Odonata taxa, but practically in every taxa. The reason why dragonflies function as indicators of several things is what [5] purposed when concluding that Odonates can function as bio-indicators in a broad sense, as they are in the top of the food chains. The Odonata community can be analyzed in a way to determine the current conservation status of fragmented areas as well to work as evaluation tool besides other factors, working together with other taxa, e.g. amphibians and other macro-invertebrates.

Another interesting finding is the distribution pattern of the species occurrence among the year seasons, which denotes conditions that are preferred for several species and how weather parameters as temperature, humidity and light period can determine these patterns. The seriation of the occurrence patterns showed that some species (i. e. *Telebasis carmesina*, *Oxyagrion terminale*, *Argia indocilis*, *Erythemis peruviana*) are found in only one season, while some species occurred in all sampled seasons.

Finding such indicative "hotspots", we can be one step ahead in the future decisions for the conservation and management of the proven rich areas as well in the environment evaluation for areas in process of recovering.

The Atlantic Forest actually is a highly fragmented biome, which in several aspects demands urgent actions to the preservation of its remnants and recovering areas, so the today's work can be a useful tool for the future generations, before the diversity has been totally lost.

5. ACKNOWLEDGEMENTS

Financial support was provided by FAPERGS (Fundação de Amparo à Pesquisa do Estado do Rio Grande do Sul). We thank also our field assistants who gave a worthy help in the sampling effort and the landowners who agreed and gave permission to use their properties during the development of this survey.

1. BARBOUR, M. T.; GERRITSEN, J.; SNYDER, B. D.; STRIBLING, J. B. *Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers, Benthic Macroinvertebrates and Fish.* Washington, DC, United States Environmental Protection Agency, Office of Water, II+841p. 1999.
2. CARLE, F. L. Environmental monitoring potential of the Odonata, with a list of rare and endangered Anisoptera of Virginia, USA. *Odonatologica,* 8*:* p.319–323, 1979.
3. CASTELLA E. Larval Odonata distribution as a describer of fluvial ecosystems: the Rhône and Ain Rivers, France. *Advances in Odonatology,* 3: 23-40, 1987.
4. CLARK, T. E.; SAMWAYS, M.J. Dragonflies (Odonata) as indicators of biotope quality in the Krüger National Park, South Africa. *Journal of Applied Ecology,* 33: 1001-1012, 1996.
5. CORBET, P.S. Are Odonata useful as bioindicators? Libellula 12: 91-102, 1993.
6. CORBET, P.S. *Dragonflies - Behavior and Ecology of Odonata.* Ithaca, NY, Comstock Publishing Associates, Cornell University Press, XXXII +829p. 1999.
7. DE MARCO, P.; VIANNA, D. M. Distribuição do esforço de coleta de Odonata no Brasil: subsídios para escolha de áreas prioritárias para levantamentos faunísticos*. Lundiana suplemento* 6: 13-26, 2005.
8. DE VILLIERS, D. *Birds and the Environmental Change: Building an Early Warning System in South Africa.* Pretoria, South Africa National Birding Agency, I+4p. 2009.
9. DUCATTI, A.; PÉRICO, E.; AREND, U.; CEMIN, G.; HAETINGER, C.; REMPEL, C.; Análise da paisagem por Sistemas de Informação Geográfica (SIGs) e métricas de paisagem como subsídio para a tomada de decisões em nível ambiental. *Espacios,* 32(1): 36-42, 2011.
10. DUNKLE, S.W. *Dragonflies through binoculars, a field guide to dragonflies of North America,* NY, Oxford University Press, 22-24, 2000.
11. FRANK, G.W.; MATTA, A. *Biodiversity Conservation in Costa Rica*. Berkeley, University of California Press. +341p. 2004.
12. GARRISON, R.W.; VON ELLENRIEDER, N., LOUTON, J.A. *Dragonfly Genera of The New World: an illustrated and annotated key to the Zygoptera.* Baltimore, The John Hopkins University Press, +368p. 2006.
13. GARRISON, R.W.; VON ELLENRIEDER, N.; LOUTON, J.A. *Damselfly Genera of The New World: an illustrated and annotated key to the Zygoptera.* Baltimore, The John Hopkins University Press, +490p. 2010.
14. GOERCK, J. M. *Patterns of Rarity in the Birds of the Atlantic Forest of Brazil. Conservation Biology.* Society for Conservation Biology, University of Missouri. 11 (1): 112-118, 1997.
15. HECKMAN, C.W. *Encyclopedia of South American Aquatic Insects: Odonata – Anisoptera.* Dordrecht, The Netherlands, Springer, +725p. 2006.
16. HECKMAN, C.W. *Encyclopedia of South American Aquatic Insects: Odonata – Zygoptera.* Washington, U.S., Springer, +691p. 2010.
17. INPE (Instituto Nacional de Pesquisas Espaciais). *Centro de Previsão de Tempo e Estudos Climáticos,* Banco de Dados Meteorológicos. Ministério da Ciência e Tecnologia. Available at: http://bancodedados.cptec.inpe.br/ [accessed 20 march 2012].
18. MACHADO, A.B.M. Studies on neotropical protoneuridae (Odonata, Zygoptera). *Revista Brasileira de Zoologia,* 21(2): 333-336, 2001.
19. MOORE, N.W. Dragonflies as indicators of environmental health. *IUCN Species Survival Commission Newsletter*, 1984: 7-8, 1984.
20. OERTLI, B. *Dragonflies and Damselflies - Model Organisms for Ecological and Evolutionary Research.* Oxford, Oxford Biology, +290p. 2008.
21. PEREZ, G. A. R.; RESTREPO, J. J. R. *Fundamentos de Limnología Neotropical***.** Colombia, Editorial de la Universidad de Antioquia, II+440p. 2008.
22. PIRATELLI, A. J.; DE SOUSA, S.L.; CORRÊA, J.; ANDRADE, V. A.; RIBEIRO, R.; AVELAR, L. H.; OLIVEIRA, E. F. Searching for Bioindicators of Forest Fragmentation: passerine Birds in the Atlantic Forest of Southeastern Brazil. *Brazilian Journal of Biology*: 259-268, 2008.
23. RAVEN, S.; PIMM, S. Extinction by numbers. *Nature,* 403: 843-858, 2000.
24. RITH-NAJARIAN, J.C. The influence of forest vegetation variables on the distribution and diversity of dragonflies in a northern Minnesota forest landscape: a preliminary study (Anisoptera). *Odonatologica,* 27: 335-351, 1998.
25. SAHLÉN, G. The impact of forestry on dragonfly diversity in Central Sweden. *The International Journal of Odonatology,* 2: 177-186, 1999.
26. SAHLÉN, G.; EKESTUBBE, K. Identification of dragonflies (Odonata) as indicators of general species richness in boreal forest lakes. *Biodiversity and Conservation,* 10: 673-690, 2001.
27. SAMWAYS, M. J. Diversity and conservation status of South African dragonflies (Odonata). *Odonatologica,* 28: 13-62, 1999.

28. SAMWAYS, M.J.; CALDWELL, P.M.; OSBORN, R. Spatial patterns of dragonflies (Odonata) as indicators for design of a conservation pond. *Odonatologica*, 25: 157-166, 1996.
29. SAMWAYS, M.J.; STEYTLER, N.S. Dragonfly (Odonata) distribution patterns in urban and forest landscapes, and recommendations for riparian management. *Biological Conservation,* 78: 279-288, 1995.
30. SCHMIDT, E. Habitat inventarization, characterization and bioindication by a Representative Spectrum of Odonata species (RSO). *Odonatologica*, 14: 127-133, 1985.
31. SICK, H. *Ornitologia Brasileira, Uma Introdução.* Brasília, Editora UnB, II+862p. 1982.
32. STEWART, D. A. B.; SAMWAYS, M. J. Conserving dragonfly (Odonata) assemblages relative to river dynamics in an African savanna game reserve. *Conservation Biology*, 12: 683-692, 1998.