



Unveiling South America

ICO
2015



INTERNATIONAL CONGRESS
OF ODONATOLOGY
LA PLATA • BUENOS AIRES
ARGENTINA

Book of abstracts

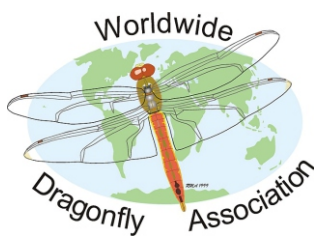


2015 INTERNATIONAL CONGRESS OF ODONATOLOGY

La Plata, Buenos Aires, Argentina

15th to 20th November 2015

ICO 2015 is organized by the group of odonatologists lead by Javier Muzón. Although, this group has started their work several years ago at the Instituto de Limnología “Dr. R.A. Ringuelet” (CONICET – FCNyM, UNLP), most of their integrants are now part of BioGeA (Laboratorio de Biodiversidad y Genética Ambiental) of the Universidad Nacional de Avellaneda (UNDAV).



UNDAV
UNIVERSIDAD
NACIONAL DE
AVELLANEDA



ICO 2015 is organized in consensus with the Worldwide Dragonfly Association (WDA) and the Societas Internationalis Odonatologica (SIO). This meeting is under the auspices of the Universidad Nacional de La Plata (UNLP) and its Facultad de Ciencias Naturales y Museo (FCNyM), the Universidad Nacional de Avellaneda (UNDAV), the National Research Council of Argentina (CONICET) and the Research Council of Buenos Aires province (CIC-BA). ICO 2015 has been supported by Seguros Rivadavia.

ICO 2015 Book of Abstracts

Director: Javier Muzón

Editors: Federico Lozano & Alejandro del Palacio

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ICO 2015 Organizing Committee

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ICO 2015 Grants

The ICO 2015 Organizing Committee has offered to young odontologists five grants to cover registration cost of the meeting. In order to make the selection from the 12 received applications we ask to the ICO organizers (editions from 2009 to 2017) to integrate the Grant Committee.

Grant Committee

Enrique GONZÁLEZ SORIANO (Mexico)

Kiyoshi INOUE (Japan)

Javier MUZÓN (Argentina)

Rodolfo NOVELO GUTIÉRREZ (Mexico)

Boudjéma SAMRAOUI (Algeria)

Florian WEIHRAUCH (Germany)

The ICO 2015 Grants have been awarded to:

Cornelio A. BOTA-SIERRA (Colombia)

Sónia FERREIRA (Portugal)

Angela NAVA BOLAÑOS (Mexico)

Samuel RENNER (Brazil)

Marciel Elio RODRIGUES (Brazil)



ICO2015 - GENERAL INFORMATION

Congress venue

The ICO 2015 will be held at the Cultural Hall of Cooperativa de Seguros Rivadavia, 755 7th Avenue, (basement), La Plata city.

Congress reception

The ICO 2015 Reception will be given in the Museo de La Plata on Sunday 15th from 18:30. This Museum, which was founded in 1888 by Perito Francisco Moreno, is one of the most relevant natural history institutions in South America.

Congress office

Seguros Rivadavia Cultural Hall reception: all days (except Thursday 19th) from 8:00 to 18:00.

Mid Congress Field Tour

It will take place on Thursday 19th, from 8:00 to 18:00 hs approximately. Buses will leave 8:00 AM (departure point to be confirmed). During the Mid-congress field tour will visit "El Destino" reserve, which is inside the Parque Costero Sur, a UNESCO Biosphere Reserve, approximately 60 km south of the city of La Plata. This reserve covers an area of 500 ha which have been preserved from farming for the last 60 years, integrating forests dominated by the spiny hackberry and the "coronillo" with shallow streams and several halophilic, wet and seasonally flooded grasslands on the Rio de la Plata coast. A typical Asado (meat barbecue) lunch in the field will be offer. Vegetarian meals will be available also.

Official Dinner

It will take place on November 20th in the city of Buenos Aires in a typical *porteño* restaurant where a traditional Tango show will be offered.

Post Congress Field Tour

The post-conference tour will visit the Lanin and Nahuel Huapi National Parks, Patagonia between November 22nd and 28th. We meet in San Martin de los Andes town (The ICO2015 Organizing Committee will not be in charge of the transfer between La Plata and San Martin de los Andes).

Itinerary:

Sunday 22nd. San Martin de los Andes, Neuquén province, check in from 14.00 hs

Monday 23rd. Visit of different areas around the city.

Tuesday 24th. Visit to Lanin National Park, return on motorboat through Lacar lake to San Martin de los Andes.

Wednesday 25th. Bus to San Carlos de Bariloche, Río Negro province, through National Route 234 known as Seven Lake's Road. Visit to Ñivinco Fall.

Thursday 26th. Visit around the Patagonian steepe.

Friday 27th. Visit National Park Nahuel Huapi (excursion to Puerto Blest included)

Farewell dinner.

Saturday 28th. Check out approx. 10.00 AM





ICO 2015



Unveiling South America

Our logo refers to the concept of integrating South American odonatology in general, and Argentinian odonatology in particular, to the international scenario, this is represented here by the wing venation pattern. While the tradition of odonatology in Argentina is recent compared to other regions of the planet, researchers in our country have worked steadily for the last 40 or 50 years contributing to the knowledge of different aspects of the biodiversity of this large and heterogeneous country.



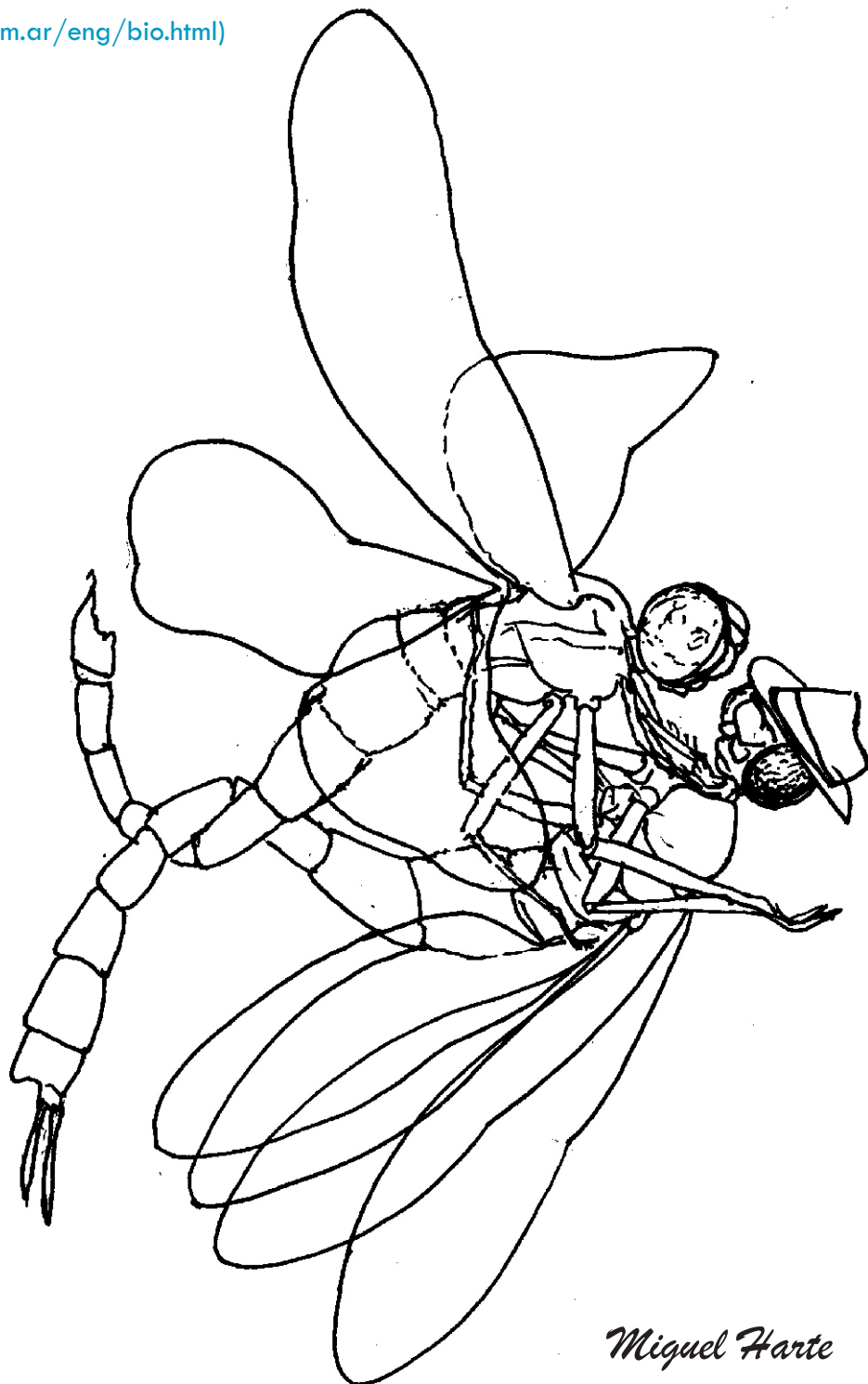
The background image on our website depicts the color pattern of the abdomen of *Rhionaeschna variegata* (Fabricius, 1775): the southernmost dragonfly of the planet, the only representative of the order on the borders of South America, and the first species described for Patagonia.



Miguel Harte is a renowned Argentine plastic artist whose passion for insects, especially dragonflies, has left a visible imprint on his work. This passion made him contact Javier Muzón and his team in 2004, with whom he enjoyed different field trips. When Miguel knew the ICO2015 was going to be held in Argentina he offered to make a drawing in honour of the meeting.

He was born in Buenos Aires in 1961. At the beginning of the Eighties he lived eight years in Rio de Janeiro (Brazil) and he exhibited in Galería Contemporánea and in parallel he continued to exhibit in Buenos Aires. In 1988 he returned to Argentina. His first solo exhibition was in the gallery Ruth Benzacar in 1998 and the last in 2013. For more information visit his website:

(<http://miguelharte.com.ar/eng/bio.html>)



Miguel Harte



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PROGRAM AT GLANCE

	MONDAY 16	TUESDAY 17	WEDNESDAY 18	THURSDAY 19	FRIDAY 20
8:00	Registration & Opening Session 1 - NEOTROPICS	Plenary talk K.D. Dijkstra Session 5 - GENOMICS	Plenary talk A. Cordero Rivera Session 7 - ETHOLOGY	MID CONGRESS TOUR	Plenary talk F. Suhling Session 10 - EVOLUTION
10:00 - 10:30	COFFEE BREAK				COFFEE BREAK
	Session 1 - NEOTROPICS	Session 5 - GENOMICS Session 4 - MISCELLANEA PART 2	Session 7 - ETHOLOGY		Session 10 - EVOLUTION Session 11 - LARVAE
12:15 - 13:30	LUNCH				LUNCH
	Session 2 - CORDULIIDAE Session 3 - PHYLOGENY	Session 6 - RED LISTING Session 9 - CONSERVATION	Session 8 - ECOLOGY		Session 11 - LARVAE
15:30 - 16:00	COFFEE BREAK				Plenary talk E. Gonzalez Soriano & R. Novelo Gutierrez ICO2015 Awards Closing and farewell words
18:00	Plenary talk M.J. May Session 4 - MISCELLANEA PART 1	Plenary talk M.J. Samways SOL Meeting	Session 9 - CONSERVATION Plenary talk G. Sahlen WDA Meeting		
19:30 - 24:00					ICO2015 Official Dinner

ICO 2015 FULL PROGRAM

Sunday, November 15th

18:30 Welcome cocktail. MUSEO DE LA PLATA.

Monday, November 16th

08:00 Registration

08:40 Opening

Session 1

Neotropics Chair: *Rodolfo Novelo Gutiérrez*

09:15 "Odonata from Patagonia. Diversity and distribution patterns"
Javier Muzón

09:30 "Odonata of Puerto Rico: an updated list and historical records"
Alonso Ramírez & Pablo E. Gutiérrez-Fonseca

09:45 "We salute the renaissance! A brief history and the current status of the Brazilian odonatology"
Ângelo P. Pinto

10:00 **Coffee break**

10:30 "State of knowledge of the Odonata of Southern South America: Argentina, Chile and Uruguay"
Federico Lozano

10:45 "An overview of the family Polythoridae with an emphasis on the genus *Polythore*"
Melissa Sánchez-Herrera, Christopher D. Beatty, Adolfo Cordero Rivera, Andrea C. Encalada, William R. Kuhn, Emilio Realpe & Jessica L. Ware

11:00 "Quest for *Protallagma* and *Oxyallagma* (Zygoptera: Coenagrionidae) in Peru"
Holger Hunger

11:15 "Composition and diversity of dragonflies and damselflies from Meta department (Colombia)"
Fredy Palacino-Rodríguez, Alexander Sabogal-González, Catalina Amaya-Perilla & Cornelio A. Bota-Sierra

11:30 "Current status of the study of Odonata biodiversity in Central and South America"
Jenilee M. Montes-Fontalvo

11:45 "Two busy weeks in Atlantic Forest of Brazil"
Erland Refling Nielsen

12:00 Questions and discussion

12:15 **Lunch**



ICO 2015 FULL PROGRAM

Session 2

Corduliidae Chair: Ângelo Pinto

13:30

“Gone with the wind updated – the Pacific story of *Hemicordulia*”
Milen Marinov

13:45

“Toward a synopsis of Central and South American corduliids: taxonomic status of the genera (Anisoptera: Corduliidae s.l.)”
Ângelo P. Pinto

14:00

“Unraveling the position of *Lauromacromia* within Corduliidae s.s. using molecular and morphological data”
Jessica L. Ware & Ângelo P. Pinto

14:15

Questions and discussion

Session 3

Phylogeny Chair: Jessica L. Ware

14:25

“The first insight into comparative transcriptome analysis of the Neotropical damselfly genus *Megaloprepus*”
Wiebke Feindt, Sara Oppenheim, Rob De Salle & Heike Hadrys

14:40

“Phylogenetic exploration of *Mesagrion* - *Heteropodagrion* complex: a molecular approach”
León Andrés Pérez Gutiérrez

14:55

“Evolution at Northern limits: Understanding the Treeline Emerald (*Somatochlora sahlbergi*)”
Manpreet Kohli

15:10

“Untangling highly polymorphic Polythore damselflies using computer vision”
William R. Kuhn, Melissa Sanchez-Herrera, Maria Olalla Lorenzo Carballa, Kathleen Harding, Nikole Ankrom, Thomas N. Sherratt, Joachim Hoffmann, Hans Van Gossum, Jessica L. Ware, Adolfo Cordero Rivera, Christopher D. Beatty

15:25

Questions and discussion

15:35

Coffe break

16:00

Plenary talk: “A framework of Anisoptera phylogeny”
Frank Louis Carle, Karl M. Kjer & Michael L. May

Session 4

Miscellanea Part 1 Chair: Tze-wai Tam

16:45

“Morphometric analysis of *Ischnura capreolus* and *I. cyane* and a possible intermediate morphotype on Colombia”
María Isabel Velásquez Vélez, Yiselle Patricia Cano Cobos, Emilio Realpe & Clara Inés Saldamando Benjumea

17:00

“Morphological adaptations of dragonflies (Odonata: Libellulidae) to migration”
Catalina María Suárez Tovar & Carlos E. Sarmiento



ICO 2015 FULL PROGRAM

17:15 “Fossil Odonata of Argentina through body fossils and endophytic ovipositions”
Julián F. Petrulevičius & M. Eugenia Romero Lebrón

17:30 “The seven “Oddities” of the Pacific Odonata Biogeography”
Milen Marinov

Tuesday, November 17th

08:00 Plenary talk: “Flying colours: will dragonflies be the first insect order to break the ‘vertebrate barrier?’”
Klass Douwe B. Dijkstra

Session 5

Genomics Chair: *M. Olalla Lorenzo Carballa*

08:45 “Odonata Genomics: why it matters”
Seth M. Bybee

09:10 “Preliminary results from the 1KITE Transodonata subproject”
Jessica L. Ware, Alexander Blanke, Caro Greve, Karl Ryuchiro Machida, Bernhard Misof & Oliver Niehuis

09:35 “Ecology and evolutionary dynamics in polymorphic damselflies: how can genomics and transcriptomics increase our understanding of evolutionary processes?”
Erik I. Svensson

Coffee break

10:30 “Transcriptomics of mating harassment in an polymorphic damselfly”
Katie Duryea, Yuma Takahasi, Chris Wheat & Erik I. Svensson

10:45 “Using Pool-seq to examine genetic variation affecting male fitness in *Libellula pulchella*”
Rudolf Schilder

11:00 “Population genomics of sexual and parthenogenetic *Ischnura hastata*”
M. Olalla Lorenzo Carballa & Phillip C. Watts

11:15 Questions and discussion

Session 4

Miscellanea Part 2 Chair: *Tze-wai Tam*

11:30 “The German atlas of dragonflies”
Klaus-Jürgen Conze

11:45 “Current status of the dragonflies in Hong Kong ten years after the territory wide survey in 2002-2004”
Tze-wai Tam



ICO 2015 FULL PROGRAM

12:00 “The status of *Rhionaeschna galapagoensis* (Currie, 1901) with notes on its biology (Odonata: Aeshnidae)”
Adolfo Cordero Rivera, A.C. Encalada, R.A. Sánchez-Guillén, S. Santolamazza Carbone & N. von Ellenrieder

12:15 **Lunch**

Session 6

Red Listing Chair: *Frank Suhling*

13:30 “First red list assessment for Odonata in Colombia, with some study cases”
Cornelio A. Bota-Sierra, Bill Maufray, Fredy Palacino-Rodriguez, Ken Tennessen & Edwin Ussa

13:45 “Applying the criteria of the IUCN Red List for assessing Odonata: interpretations and their consequences”
Frank Suhling

14:15 Red Listing Workshop (Organizers: Frank Suhling & Michael J. Samways)

15:30 **Coffee break**

16:00 “The Red List of African Dragonflies - backgrounds and perspectives”
Klass Douwe B. Dijkstra

16:15 Plenary talk: “Conservation of narrow range endemics: what are the ingredients of success”
Michael J. Samways

17:00 SOL Meeting

Wednesday, November 18th

08:00 Plenary Talk: “Insights into etho-diversity: a study of two mirabilis *Hemiphysalia* and *Pseudolestes*”
Adolfo Cordero Rivera

Session 7

Ethology Chair: *Georg Ruppell*

08:45 “Differences in flight between dragonflies and damselflies”
Georg Ruppell

09:15 “High-frequent threatening flights of *Calopteryx* females and males”
Dagmar Hilfert-Ruppell & Georg Ruppell



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- 09:30** “Visual signals influence the outcome of territorial fights in the tiger damselfly *Tigriagrion aurantinigrum* Calvert 1909 (Zygoptera: Coenagrionidae)”
Diogo Silva Vilela, Thaína A. A. Tosta, Rodrigo R. Rodrigues, Kleber Del Claro & Rhainer Guillermo Ferreira
- 09:45** “Physiological color change in response to mating-associated behaviors in *Argia apicalis* (Odonata: Coenagrionidae)”
Amanda Whispell & Michael L. May
- 10:00** **Coffee break**
- 10:30** “The remarkable wings and behavior of the Morpho-dragonfly *Zenithoptera lanei* (Odonata: Libellulidae)”
Rhainer Guillermo Ferreira, Pitágoras C. Bispo, Esther Appel, Alexander Kovalev & Stanislav N. Gorb
- 10:45** “Identified neurons in the dragonfly ventral nerve cord signal the approach of flying prey”
Andrea Worthington & Robert Olberg
- 11:00** “Individual neurons in the dragonfly ventral nerve cord control wing, head, leg, and mouth movement”
Robert Olberg & Andrea Worthington
- 11:15** Questions and discussion
- 11:25** “Details of dragonfly behaviour from high speed photography”
Georg Rüppell
- 12:15** **Lunch**
-
- Session 8**
Ecology Chair: Andreas Martens
- 13:30** “Habitat selection of dragonflies in terms of vegetation and aquatic environments in an Atlantic Forest conservation unit, RS, Brazil”
Samuel Renner, Göran Sahlén & Eduardo Périco
- 13:45** “Experiments about drought resistance of dragonfly eggs”
Franz-Josef Schiel
- 14:00** “Urban Dragons - Do dragonflies benefit from urbanisation?”
Diana Goertzen, Göran Sahlén & Frank Suhling
- 14:15** Questions and discussion



ICO 2015 FULL PROGRAM

Session 9

Conservation Chair: *John P. Simaika*

- 14:25** “Role of ponds in maintaining connectivity between *Ischnura elegans* populations along a Blueway in Normandy (France)”
Mickaël Le Gall, Audrey Chaput-Bardy & Aurélie Huste
- 14:40** “Distribution, habitat requirements and conservation of two rare dragonflies in southeast Texas and western Louisiana, United States”
John C. Abbott & Kendra K. Abbott
- 14:55** “Odonata in the European Habitats Directive”
Ulf Bjelke
- 15:10** “Nonlinear responses in damselfly community along a gradient of habitat loss in a savannic landscape”
Marciel Elio Rodrigues, Fabio De Oliveira Roque, Diogo Caribé de Sousa, João Carlos Pen & Paulo De Marco Junior
- 15:30** **Coffee break**
- 16:00** “Predicted response of dragonflies to climate change along an elevation gradient”
John P. Simaika
- 16:15** Questions and discussion
- 16:30** Plenary Talk: “Dragonfly biodiversity in Swedish forest lakes: current interpretations of patterns observed”
Göran Sahlén
- 17:15** WDA Meeting

Thursday, November 19th

- 08:00** Mid-Congress Tour

Friday, November 20th

- 08:00** Plenary Talk: “Dragonfly distribution in times of global warming: presumptions, patterns, processes”
Frank Suhling

Session 10

Evolution Chair: *Ola M. Fincke*

- 08:45** “Evolutionary history of *Coenagrion mercuriale* clade: the importance of multilocus genetic approaches to detect cryptic diversity, introgression and selective sweeps”
Sónia Ferreira, David J. Thompson, Paulo Célio Alves, José Carlos Brito & Phillip C. Watts



ICO 2015 FULL PROGRAM

- 09:00** “Sexual isolation in *Argia* damselflies: insights from sexual responses, genetic distance and distribution ranges”
Angela Nava Bolaños, Rosa A. Sánchez-Guillén, Roberto Munguía Steyer & Alex Córdoba Aguilar
- 09:15** “Fertile Hybridization in the Odonate and evolution within the order”
Thomas W. Donnelly
- 09:30** “Trade-offs in female signal apparency to males offer alternative anti-harassment strategies for color polymorphic females”
Ola M. Fincke
- 09:45** “Ontogenetic color change and intersexual communication in the Common Bluetail damselfly (*Ischnura elegans*)”
Beatriz Willink, Mary C. Duryea & Erik I. Svensson
- 10:00** **Coffee break**
- 10:30** “Is the American Rubyspot damselfly a species complex? Unraveling the evolutionary history of *Hetaerina americana* (Odonata)”
Yesenia Margarita Vega Sánchez, Luis Felipe Mendoza-Cuenca & Antonio González-Rodríguez
- 10:45** “Founder effect and signal of adaptation in the most widespread dragonfly, *Pantala flavescens* Fabricius (Odonata: Libellulidae)”
Ingrid E. Alvial Chandia, David Véliz, Irma Vila & Héctor Vargas
- 11:00** “Body Size Evolution in Dragonflies and Damselflies: comparing micro- and macro- evolution”
John Waller
- 11:15** “*Trithemis stictica* (Odonata: Libellulidae) - lost in the desert mountains?”
Joachim Falk, Frank Suhling & Kamilla Koch
- 11:30** Questions and discussion
-
- Session 11**
- Larvae Chair:** Richard Rowe
- 11:40** “Advances on the larval taxonomy of the genus *Epigomphus* Hagen, 1854 (Anisoptera: Gomphidae)”
Rodolfo Novelo Gutiérrez, Alonso Ramírez & Débora L. Delgado Camilo
- 11:55** “Cordulegastridae – large dragons of small streams”
Klaus Guido Leipelt



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- 12:15** **Lunch**
- 13:30** “Exploring the vision of larval odonates”
Camilla R. Sharkey, Nicholas W. Roberts, Julian C. Partridge & Seth M. Bybee
- 13:45** “Effects of zebra mussel colonization on emergence of the dragonfly, *Macromia illinoiensis*, on a northern lake in the US”
Ola M. Fincke
- 14:00** “Unflexible versus flexible: a comparison of the pre and post eyespot development in Libellulidae (Odonata)”
Lisa Hesse, Joachim Falk & Kamilla Koch
- 14:15** “Estivation of larvae - a rare phenomenon in bionomy of the *Cordulegaster* species?”
Otakar Holuša & Kateřina Holušová
- 14:30** “High proportion of broken and deformed procts and lateral spines in larval *Boyeria irene* (Odonata: Aeshnidae)”
Andreas Martens & Hansruedi Wildermuth
- 14:45** Questions and discussion
- 14:55** Plenary talk: “Development in the study of Mexican odonatology. From larval to adult stage”
Enrique González Soriano & Rodolfo Novelo Gutiérrez
- 15:40** ICO2015 awards
Closing and farewell words
- 19:30** ICO2015 farewell dinner



PLENARY TALKS

Insights into Ethodiversity: a study of two *mirabilis*

Adolfo Cordero Rivera

The concept of biodiversity emerged as a unifying idea in the study of biology in the mid-1980, in parallel with high estimates of global extinction rates. It embraces a multifaceted and hierarchical analysis of the complexity of life, which has implications in many areas of science, and also in philosophy, ethics, politics and even religion. There have been many attempts to define this concept, and most authors emphasize the fact that biological diversity is found at three main levels of the hierarchy of life: genetical, species and ecosystem diversity, going from the intraspecific level to the landscape. Here I review the concept of biodiversity and argue that, at least for some groups of animals - and odonates are one of these -, a fourth level of biodiversity, never included in biodiversity studies, is of prominent relevance: ethological diversity. Many studies describe alternative behaviours, ethological plasticity and even personality, as characteristics of many animal populations. Behaviour has profound ecological consequences, particularly in species interactions, and models that ignore ethological diversity, treating all individuals as equivalent, are unlikely to have good predictive power. As an example, here I describe the reproductive behaviour of two relict and unique odonates: *Hemiphysalis mirabilis*, from Hainan (China) and *Pseudolestes mirabilis*, from Victoria (Australia) and highlight their relevance in maintaining ethological diversity. Both are surprisingly bizarre in their behaviour, suggesting that ethodiversity might be important also in phylogenetic studies.

Flying colours: will dragonflies be the first insect order to break the vertebrate frontier?

Klaas-Douwe B. Dijkstra

Odonata can be 'the new birds': the first insect order to break the 'vertebrate frontier' of universal application and understanding in science, conservation, and public interest. With their beauty and sensitivity, no other group represents the neglected 'freshwater fliers' as well: over 80% of animal species can fly, and 10% depend on inland waters that cover less than 1% of Earth's surface. Nonetheless, taxa applied in research and conservation that fly are largely terrestrial (birds, bats, butterflies), popular aquatic groups are less mobile (amphibians, fish), while others represent neither the aquatic nor aerial realm (remaining mammals, reptiles). As the emphasis on global change and citizen science grows, dragonflies provide a model group that is both popular and responsive. Freshwaters are under the greatest pressure, impacted directly by climate change, and harbour the densest biodiversity. Insects can potentially respond to any change by active dispersal. The odonatological community's successes and avenues for improvement will be discussed, focusing on Africa and 60 new species, the greatest number of Odonata to be named in one publication in 130 years.



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Dragonfly Biodiversity in Swedish forest lakes: Current interpretations of patterns observed

Göran Sahlén

Following ongoing environmental change caused by increased forestry, liming programs to combat the loss of fish due to acidification and warmer summers due to global warming, the odonates inhabiting the thousands of small forest lakes which dots the northern landscape are undergoing rapid changes in both abundance and species composition. In this talk I will point out the major drivers of changing species composition, the species most sensitive and the future implications for landscape conservation. Looking at historical species abundance vs. modern the differences are not very pronounced. The majority of species seems to have increased in numbers, while only a selected few have become rarer. This is consistent with observations of increased species abundance, in numbers and individuals, in lakes the past 20 years. Lakes today have more species than before but their species composition is also more similar. Clear cutting has been used for timber harvesting since mid-1900s. While forest companies state that they have considerations regarding nature protection, the reality is more depressing. As of today only fragments of the original forest remain and the new plantations, albeit by native tree species, are species poor; also regarding water bodies in their vicinity. Analysing forestry as a regulating factor shows, however, that it is not clear cutting itself which regulate species occurrence, but other factors such as lake vegetation, age of surrounding forest, water pH, and, not least, ongoing climate change. Clear cutting have a local but not a regional effect on species; some of the other factors like pH changes by liming have a much more pronounced effect on which species will occur regionally. The 'new' species pools taking shape due to immigration of southern species have led to profound changes in the abundance of many native species. Changes have occurred due to a reorganization of the ecological niches in the lakes, changing numbers of individuals surviving in the food web. This can be seen by the increase of many formerly 'rare' species which used to reproduce only in selected habitats. Today they are found at a wide spectrum of water bodies. Recent observations also suggest that the southern immigration has halted with species not moving any further to the north than was the case some 5-10 years ago. Day length and winter conditions may prevent them moving forward. Looking at current abundance of species in southern Sweden there are the issues of what is a rare species and if there is a need to implement protection measures. Here I will present a few cases which may need some new thinking.

Conservation of a highly endemic odonate fauna

Michael J Samways

Areas of high endemism are often land islands facing similar stressors and threats as oceanic islands. South Africa, having had no glaciations for >200 million years, has a high level of national odonate endemism (28 species out of 162, with several other near endemics). Several of these endemic species have an ancient phylogenetic heritage, and are rare, irreplaceable flagships. Also,



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several have been Red Listed, but their decline has been stabilized recently. As species in general are connected to others in interaction networks, conservation of these endemics requires a landscape approach, as much as a species perspective. This is especially so in South Africa, where several endemic species may occur in the same local area and share common anthropogenic threats and where a landscape approach can conserve more than one threatened species in the same action. Determining these threats and addressing them through co-operative interaction with land stewards can have a remarkably positive effect on the conservation of these endemic species. Furthermore, this action also has a positive effect on other endemic taxa. Inevitably this conservation of endemics translates into ecosystem restoration where a wide range of species benefit and where there is also recovery of ecosystem function.

The development in the study of Mexican odonatology. From larval to adult stage ?

Enrique González Soriano & Rodolfo Novelo Gutiérrez

The study of Odonata in Mexico has a long and rich taxonomic history. Philip P. Calvert's chapter in *Biologia Central- Americana* (1901-1908) is a pivotal work when studying the dragonfly fauna of this country. "Modern" Mexican odonatology began with Dennis Paulson's (1982) chapter "Odonata" published in *Aquatic Biota of Mexico, Central America and the West Indies*. Further syntheses on Odonata of Mexico by González and González & Novelo in the last two decades were partially based in Paulson's work. Since 1996 our efforts have focused on regional inventories in poorly known areas of Mexico including adult and immature stages. As a result, new species have been described both as adult and larval stages and high diversity areas (hotspots) have been identified. Presently a total of 356 species are known for México, 50 of them endemic to the country. In recent years the work of several US colleagues in parallel with our own work has allowed us to fill gaps in the knowledge of the fauna from Northern, Central and selected areas in the Pacific slope of the country. Our pioneering studies with immature stages started in 1985, since then we have described the larvae of several previously unknown neotropical taxa. To date, larval stages are known for 67% of the Mexican species. Three main issues require further attention: the exploration of poorly known areas in southern and North-Central states to fill important gaps in information; 2) Compiling databases from other National and foreign collections to generate distributional maps using georeferenced collecting points and 3) The description of immature stages of still other little known neotropical groups.

Dragonfly distribution in times of global warming: presumptions, patterns, processes

Frank Suhling

Since dragonflies are endotherms there is good reason to presume that global warming should affect them in several ways, among them expansions of distribution range. Such range expansions may have consequences at the community level, i.e. may alter interactions and trophic structures. Indeed, several dragonfly species have been observed expanding their distribution ranges in the last decades.



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Well-established examples include expansions over several 100 km and from subtropical to temperate or from temperate to boreal environments. Consequently, most of these shifts have been linked to global warming. However, the causal relationship between such range expansions and warming is in most cases not well demonstrated. And other factors, such as anthropogenic creation of new habitats, have not often been considered. Moreover, mathematical models have been applied to simulate the effects of warming on species ranges. Usually these were species distribution models (SDM), e.g. climate envelope models where present distribution patterns are correlated to environmental variables. However, SDM assume equilibrium between species distribution and current environmental conditions, which is problematic when modelling species that are supposed to spread or retract their distribution ranges. Which simulation model ever – there is rarely evidence so far that the forecasted changes in patterns will occur. Moreover, these attempts also rarely scrutinize the relevance of the chosen variables for the modelled species. Few attempts have been made to use physiologically structured models (PSM). The likely reason is that PSM require knowledge of ecological traits of species, e.g. temperatures responses. But, it is relevant to understand the possible mechanisms behind the presumed relationship of range expansions and warming (respectively other climate variables). In my presentation I will suggest some possible mechanisms and propose to go back to study ecological traits of species to enable the proper application of more derived prediction models, which will hopefully give us hints what kind of alterations in communities we can expect.

A framework of Anisopteran Phylogeny

Frank Louis Carle, Karl M. Kjer & Michael L. May

For an insect order of minimal economic importance, Odonata phylogeny has received a remarkable amount of attention over the past 30 years, and a much clearer picture of their relationships has emerged. Nevertheless, odonatologists manage to maintain a reasonable level of disagreement, and we hope to foment some here. A phylogeny of Anisoptera employing 510 representatives of 184 genera (of ca. 380) in 11 families is presented based on an analysis of over 10,000 nucleotides from portions of mitochondrial (12S, 16S) and nuclear (18S, 28S) rDNA, the mitochondrial protein coding genes COI and COII, and portions of the nuclear protein coding genes EF-1 α and Histone H3. Ribosomal sequences were structurally aligned and sequences carefully checked to eliminate alignment errors, contamination, misidentification and paralogous gene amplicons. Both the RAxML and Bayesian topology, with consolidation of data at the generic level, is ((Austropetaliidae, Aeshnidae) ((Gomphidae, Petaluridae) ((Chlorogomphidae (Neopetaliidae, Cordulegastridae)), (Synthemistidae (Macromiidae (Corduliidae Libellulidae)))))). As the position of Petaluridae is weakly supported and those of Chlorogomphidae, Neopetaliidae, and Cordulegastridae are inconsistent with some morphological evidence, possible alternative hypotheses are discussed. New taxonomic groups established include: in Gomphidae, Stylogomphini trib. n. and Davidioidini trib. n.; in Libellulidae, Dythemistinae subfam. n. including Dythemistini trib. n., Pachydiplactini trib. n. and Elgini trib. n. New taxonomic arrangements include: placement of



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Hemigomphini in Ictinogomphinae, and provisional expansion of Synthemistidae to include Gomphomacromiinae and other genera formerly placed in several small subfamilies of Corduliidae. "Hemicorduliidae" and "Macrodiplactidae" are nested within Corduliidae and Libellulidae, respectively, and therefore are not recognized as families. Eleven monophyletic subdivisions of Libellulidae are tentatively recognized as subfamilies: Dythemistinae subfam. n.; Sympetrinae; Macrodiplactinae; Brachydiplacinae; Tetrathemistinae; Trameinae; Zyxommatainae; Palpopleurinae; Diastatopidinae; Pantalinae; and Libellulinae.



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Odonata from Patagonia. Diversity and distribution patterns

Javier Muzón

Patagonia represents one of the main austral landmasses of the World. It generally refers to a large area south to parallel 35°S of 1,100,000 km², including both slopes of the Andes Mountains. It is characterized by a distinctive environmental heterogeneity consisting of two main biomes: the subantarctic forests and the arid or semiarid areas of the steppe. This heterogeneity is mainly determined by a west – east rainfall pattern with the highest values on the west slope. Its northern limit is the Maule - Valdivian area in Chile and the Colorado river basin in Argentina. The Odonata is represented by 36 species belonging to nine families and 18 genera. The endemism level is high being approximately 60% of the species and 40% of genera endemic. The specific richness in Patagonia decreases from West to East and from North to South, being Nahuel Buta (Chile) and Andes mountains between 38° and 41° S on the forest area, and the Somuncurá plateau (Argentina) on the steppe the richest areas. This odonate fauna features a combination of Neotropical, Andean and Subantarctic (exclusive to the forest) lineages. Higher diversity spots in the steppe are promoted by exceptional environmental conditions as those of thermal springs in volcanic plateaus.

Odonata of Puerto Rico: an updated list and historical records

Alonso Ramírez & Pablo E. Gutiérrez-Fonseca

Puerto Rico is the smallest of the Greater Antilles, an oceanic island with mountainous terrain and peaks of no more than 1300 m of elevation. The island has numerous streams, reservoirs and coastal wetlands. Studies of Odonata in Puerto Rico started in the 1930s when the island was mostly covered with agriculture. Today the island is predominantly a mosaic of urban areas and secondary forest. Within this communication we present a revised list of Odonata of Puerto Rico and an assessment of changes in composition over time. For the first objective, we reviewed published information, museum records, and field collections. During the 1930-1940s the records of Elsie Klots, followed by those of Julio García Díaz and James Needham, provided the first comprehensive review of the fauna of the island. Together, they reported 40 species of Odonata, 14 Zygoptera and 26 Anisoptera. Very little has been published in respect since then. An updated list was obtained after adding our own registers, totalizing 55 species, 14 Zygoptera and 41 Anisoptera. The ultimate larval stadia of 84% of the species are known. In relation to the other large Caribbean islands, Puerto Rico is as diverse as Jamaica (58 species) and less so than Cuba (88 species) and Hispaniola (68 species). For the second objective, we have to bear in mind the economic transformation that Puerto Rico suffered from the late of 1940s, which changed its economy from an agricultural to an industrial based. We used museum collections and early publications to explore whether the Odonata fauna shows signs of change in response to increasing in forest cover. Interestingly, additions to the earlier list are groups of good flyers and their addition to the fauna are probably the result of their ability to disperse. While our knowledge on the Odonata fauna of Puerto Rico advances, several gaps of information remain:



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(A) there is a need to identify threatened species and better understand faunal distribution; (B) we still have very limited natural history information; and (C) as urbanization on the island increases, there is a need to assess how urban impacts might affect Odonata species.

We salute the renaissance! A brief history and the current status of the Brazilian odonatology

Ângelo Parise Pinto

Dragonflies are among the most captivating insects, its graceful flight, bright colors and they as mandatory predators, has inspired artists from different fields, such as songwriters, designers and the most exciting of all, the scientists. Its importance to freshwater ecosystems, combined with the appealing to the society in general, lead them be considered as flagship or umbrella taxon for conservation actions. Such appeal carried out them as one the most well-known insect orders, however, very rich biotas still are understudied mainly in the countries traditionally known as Neotropics. Indeed, South America itself remains as the last frontier for odonatological studies even compared to other landmasses such as the rich Australasian biotas, which mostly thanks to M. A. Lieftinck works is relatively well-known. Current research in odonatology has undergone drastic changes throughout Latin America, with new researchers and with establishment of fresh research centers in various countries, constituting a very promising field. It would be almost unimaginable for nearly a decade ago. Brazil is the larger South America country. From a traditional view its vast megadiverse area encompasses at least six major phytogeographic dominions from the cherished tropical Amazonia, passing to the southeastern chains mountains at the Atlantic Forest to the subtropical savannahs of the Pampa. Nowadays, studies in zoology developed in the country as whole occupy important position in worldwide biodiversity research, a status not shared by odonatology. However the newly emerged research groups observed in last decade can be collectively termed as a renaissance of the odonatological research in the country. Within this scenario is presented an overview of Brazilian odonatological research from the *Systema Naturae*, through the legions of Selys to the contemporary systems based on phylogenetic approaches, highlighting key characters that have influenced and molded the field. During this process is carried out an assessment of current research status and prospects for the future on the Brazilian scene.

State of knowledge of the Odonata of Southern South America: Argentina, Chile and Uruguay

Federico Lozano

Southern South America comprises mainly Chile, Argentina and Uruguay. It is a vast area in which latitudinal extent, topography and complex geological history provide a wide variety of ecological conditions which determine a complex biota. Odonatology in Southern South America



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begun at the beginning of the XX century with collecting trips made by European entomologists. Traditionally, the main focus has been taxonomy because of the need to broaden the knowledge of the area. However, advances on this group remained slow and sporadic mainly because of a shortage of specialists working on the region. Argentina, starting in 1977 with the contributions of L.A. Bulla, has had a steady development of the knowledge of its fauna, which is due to the work of resident entomologists working in the country. This is not the case for Chile and Uruguay in which the main contributions have been made by visiting researchers. Odonata diversity shows a clear latitudinal species richness decline from north to south in Southern South America, with more than 250 species in northern Argentina to 1 in Tierra del Fuego inland. Two hundred and seventy nine species (in 13 families and 85 genera) have been recorded for Argentina. There are two main faunistic components, a neotropical one in the north, where the southernmost limit of many widespread species is found, and a subantarctic one in the south which includes many remarkable Patagonian endemics (e.g. Family Neopetaliidae). The same happens in Chile where only 50 species have been recorded. Almost 25% of them are endemics (3 coenagrionids, 4 austropetalids, 2 aeshnids, 2 gomphids, and *Gomphomacromia chilensis*). The Anisoptera are represented by nine families (with 40 species in 16 genera) whereas the Zygoptera comprise only two families (with 10 species in 6 genera). Most of the endemic taxa are restricted to southern Chile where a mixture of subantarctic and neotropical faunistic components coexist. The state of knowledge of the Odonata of Uruguay is scarce and fragmentary. The first checklist was published by Paulson in 1977 which included only 20 species. Just a few years later, in 1982, De Abenante & Phillipi published the second species list, raising this number to 51. This paper remained as the only compiled reference of the dragonfly fauna for Uruguay for more than 20 years. In 2009 von Ellenrieder, Molineri & Emmerich provided an updated checklist for this country in which a total of 70 species were recorded. A total of six families are present, the most diverse being the Coenagrionidae (with 22 species in 11 genera) and Libellulidae (with 26 species in 14 genera). No endemic taxa have been recorded so far. Unfortunately, the conservation status of the Odonata from Southern South America is incomplete; from the 301 species recorded 66% have not been evaluated according to the IUCN Red List criteria. 86 species are considered LC, 8 are DD, 3 species are NT (*Allopetalia reticulosa*, *Andinagrion garrisoni*, *Progomphus kimminsi*), 3 species are VU (*Phyllopetalia excrescens*, *Antiagrion blanchardi*, *Phyllogomphoides joaquina*), and 2 species are EN (*Staurophlebia bosqi*, *Phyllopetalia altarensis*).

An overview of the family Polythoridae with an emphasis on the genus *Polythore*.

Melissa Sánchez-Herrera, Christopher D. Beatty, Adolfo Cordero Rivera, Andrea C. Encalada, William R. Kunh, Emilio Realpe & Jessica L. Ware

The Neotropics holds the highest species richness of Odonata, however this region is still understudied. Despite an increase in biodiversity surveys and new species descriptions for odonates, there are very few studies that look at the genetic and morphological diversity within taxa. The Neotropical damselflies of the family Polythoridae are stunningly colourful; their wings display



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orange, black and/or white. Despite this color diversity, they lack variation in classical reproductive traits (e.g. male appendages) commonly used for species description. Here we explore the phylogenetic relationships of the 7 genera using 5 molecular loci (COI, ND1, 16S, 18S, 28S and EF1). Furthermore we explore in detail the genetic and morphological diversity within the genus *Polythore*. Which comprises 21 described morphospecies distributed along the Eastern slopes of the Andes cordillera and the Amazon basin, through Colombia to Northern Bolivia. They dwell in small fast flowing creeks with highly oxygenated waters; their larvae are the only mesoamerican damselflies that possess abdominal gills and highly modified structures at their posterior end for stability in fast flowing waterfalls. The novel morphological methods (geometric morphometrics, chromaticity analysis, and Gabor wavelet transformation) that help us to analyze the complexity of the wing color pattern present in this genus. Species delimitation using the mitochondrial (COI, ND1) and nuclear (PMRT, MLC) data shows a lack of congruence between wing color morphs, supporting the presence of possible cryptic and/or polytypic species within *Polythore*.

Quest for *Protallagma* and *Oxyallagma* (Zygoptera: Coenagrionidae) in Peru

Holger Hunger

On a trip through the Peruvian Andes in 2007, my colleagues Franz-Josef Schiel and Joachim Hoffmann and I discovered a formerly unknown damselfly species which we described as *Protallagma hoffmanni*. I will present this species as well as its only habitat known so far, a tiny rivulet discharging into Laguna Querococha (High Andes). *Protallagma hoffmanni* is only the second species of its genus that has been discovered so far. Another species-poor genus is *Oxyallagma* with only two known species as well. I will try to give an overview about what is currently known about these two closely related genera of small red and blue Coenagrionids. Following this congress, the afore mentioned team will head out to Peru once again in order to hopefully find out more about these two enigmatic damselfly genera.

Composition and diversity of dragonflies and damselflies from Meta department (Colombia)

Fredy Palacino-Rodríguez, Alexander Sabogal-González, Catalina Amaya-Perilla & Cornelio A. Bota-Sierra

Odonata diversity and composition from Meta region (Colombia) were analyzed. Two richness indices based on abundance and other two on incidence were used to calculate species richness with EstimateS 9.0. An alpha diversity analysis with Shannon (H'), Simpson (Dominance -D-), and Berger-Parker (B) indices was conducted comparing: (i) environments (lotic and lentic), (ii) weather seasons (rainy and dry), (iii) three altitudinal ranges (<300, 300-600, and >600 meters above sea level), and (iv) five ecosystem types (gallery forest, other forests, crops, foothill, and savannah), with the help of the "Compare Diversities" test, using PAST 2.17c. Beta diversity was estimated for those four data groups as well, with cluster analysis using the UPGMA method and Chao-Jaccard similarity index [Jabd], which was calculated with EstimateS 9.0 software, and a dendrogram drawn with Past 2.17c



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software. An estimate indicates that there could be between 115 and 144 species (sampling efficiency: 69-86%) mainly associated with Villavicencio (62 spp.) and Puerto López (57 spp.). The lotic and lentic environments share 40% of the species, 20% are exclusively lotic, and 40% lentic. The highest number of species (85) is found between 300 and 600m asl. The greatest alpha diversity is related to the savannah ecosystem type. The highest species turnover takes place in the forests (65%) compared to other ecosystems. The composition of odonates for this region could be influenced by a strongly fragmented and polluted environment, which is the consequence of several agricultural and industrial activities generated by settlements and other human activities in this area.

Current status of the study of Odonata biodiversity in Central and South America

Jenilee Maarit Montes-Fontalvo

Central and South America are regions that compared to other regions still have poor knowledge about the description of new Odonata species in contrast to the high biodiversity. Causes like the few scientists in the area, low inversion for scientific research and few regional species inventories are influential in advancing on this knowledge. The last compilation works have served to show the importance of the region also evidence the importance of creating papers that summarize the biodiversity of the region. This study summarizes all works that have been done during the last 6 years (2010-2015) in relation to species descriptions and immature stages descriptions of Odonata in South and Central America. A literature search was carried out and a database by countries is created with this information. During the period 88 new species and 85 larval stages has been described in the region. Some countries like Brazil contributed most to that number. In addition to the faunal list, some comments about endangered species and / or in risk are included. Also comments on the advantages of these organisms as models in the estimation of biodiversity in freshwater ecosystems, discussions of dragonfly and ecosystem conservation and research priorities are discussed too.

Two busy weeks in Atlantic Forest of Brazil

Erland Refling Nielsen

The Serra dos Orgaos in Rio de Janeiro, part of the Atlantic Forest mountain range, has been subject to fauna investigation by Tom Kompier, based at and in cooperation with REGUA (Reserva Ecológica de Guapiaçu). A group of 14 persons led by Tom Kompier, and equipped with an early electronic version of the species texts in his now published book (A guide to the Dragonflies and Damselflies of the Serra dos Orgaos, REGUA Publications), spent two weeks at the REGUA reserve in January 2015. Locations were visited in the reserve and in its vicinity, ranging in altitude between 50 and 1200 meter above sea level. The number of species observed by the group reached around 160, quite a big portion of the 199 species found by Tom Kompier, during his 150 days at REGUA over a span of three years. Both, species critically endangered and species awaiting description were observed during the two weeks. Knowledge of the fauna in the region is not complete, and a few



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species observed are not fully matching original descriptions and material in collections. This is reflected in the book, but the group had no problems enjoying and photographing these species. During the two weeks a few species was added to the known fauna of the region, reaching the astounding number 204 covered by the book. The history of the reserve is the story of recreating forest which was destroyed in the last century. Converting farm land back to forest, planting native trees, and purchasing forest to protect it from being destroyed, is their mission. In 2005 a wetland was created to restore the conditions that existed before farming and was introduced to the area. Water brought back a lot of animals including dragonflies, and around 70 species are known from the restored wetlands today.



SESSION 2: CORDULIIDAE

Gone with the wind updated – the Pacific story of *Hemicordulia*

Milen Marinov

All published information on the Pacific Corduliidae is critically revised in relation to taxonomic changes proposed in Lieftinck (1975) [The dragonflies (Odonata) of New Caledonia and the Loyalty Islands. Part 1. Imagines. *Cahiers O.R.S.T.O.M. Série Hydrobiologie* 9: 127-166] and the view on the taxonomic issues expressed in Van Tol (1997) [The genus *Procordulia* Martin in Western Malesia (Odonata, Corduliidae). *Tijdschrift voor Entomologie* 140: 133-146]. An updated distribution map on *Hemicordulia* species following Marinov (2012) [Description of female *Hemicordulia hilaris* Lieftinck, 1975 (Anisoptera: Corduliidae) with brief notes on the biogeography of the genus. *Records of the Auckland Museum* 48: 97-105] is suggested. The uncertainties in species distribution along the line Samoa-French Polynesia is partly fulfilled after a recently completed field study (Marinov *et al.*, in press) [Marinov, M., M. Schmaedick, D. Polhemus, R. Stirnemann, F. Enoka & P. Siafoi Fa'aumu. Faunistic and taxonomic investigations on Odonata fauna of the Samoan archipelago with particular focus on taxonomic ambiguities around the so called "Ischnurine complex". *Faunistic Studies in South-East Asian and Pacific Island Odonata*]. Pacific islands *Hemicordulia* follows a general scheme – almost every archipelago has its own endemic species with *H. hilaris* as an extra element for the fauna of New Caledonia, Vanuatu, Fiji and Samoa. This species is the sole representative of the genus on Tonga and Cook Islands. If it goes to French Polynesia is unclear because all of the studies published in the early XXth century reported on unidentified *Hemicordulia* sp. only. The possibility of a recent invasion and probable pathways of colonization are discussed.

Toward a synopsis of Central and South American corduliids: taxonomic status of the genera (Anisoptera: Corduliidae s.l.)

Ângelo P. Pinto

Among students of Central and South American dragonflies, corduliids have some kind of mystical aura partly because collectors have no more than furtive encounters with the capture of one or two adult specimens. In general are rare in collections with no more of a dozen of specimens from few taxa housed in a single institution, even considering those large and longtime established. Two major aspects have contributed for its scarcity, secretive habit and inadequacy in the collecting efforts. Adults are rarely observed in the field, while their larvae are commonly collected, consequently almost all of the freshly new species were described based on larvae reared till emergence. Corduliids by a long time were considered at family taxonomic level, however very likely are paraphyletic in respect to the dominant and most diverse Libellulidae. Although the comprehensive classification by Tillyard-Fraser has been only slightly modified in later catalogs, in the end of 1990 decade a few attempts to promote a more 'natural' classification were presented. In these largely intuitive systems, several groups of genera were elevated to families, such as Oxygastridae which includes *Neocordulia*, the richest genus in the neotropics. The recent updated dragonfly classification emphasizing the difficult to infer



SESSION 2: CORDULIIDAE

phylogenetic relationships among corduliids and accurately several genera were considered *incertae sedis*. The biota of corduliids in Central and South America is composed by 53 species, excluding two from the North American *Epithea*, remainder genera are endemic and pertains at least to three main lineages: Corduliidae s.s. (including *Aeschnosoma*, *Cordulisantasia*, *Navicordulia*, *Paracordulia*, *Rialla* and '*Schizocordulia*'), Synthemistidae s.s. (only *Gomphomacromia*), and two puzzling *incertae sedis* genera (*Lauromacromia* and *Neocordulia*). As a first step toward a synopsis of Neotropical corduliids, several Brazilian collections were studied, including types of most species, and the taxonomic status of each taxon evaluated. About of 550 specimens of 76 species from distinct biogeographical regions were located. In this work is presented an overview of taxonomic knowledge of Neotropical corduliids genera, with a full nomenclatural revision and summary of their distribution

Unraveling the position of *Lauromacromia* within Corduliidae s.s. using molecular and morphological data

Jessica L. Ware & Ângelo P. Pinto

The Corduliidae are a group of extremely heterogeneous, charismatic dragonflies. Within the past decade molecular evidence has suggested that the group should be split at least into two major lineages, comprising the Corduliinae and Synthemistidae s.l. (GSI group of genera, Ware *et al.* 2007) [Ware J.L., May M. & Kjer K. Phylogeny of the higher Libelluloidea (Anisoptera: Odonata): An exploration of the most specious superfamily of dragonflies. *Molecular Phylogenetics and Evolution* 45: 289-310]. While the placement of many Corduliidae s.l. taxa has been evaluated using molecular and morphological data, several taxa have not yet been investigated and their position remains uncertain. To infer the *Lauromacromia* phylogenetic relationships a Bayesian analysis was undertaken using mitochondrial cytochrome oxidase I (COI) and nuclear histone (H3) as molecular markers and additional morphological characters from about of 20 terminal taxa. Here we present the first molecular evidence that supports *Lauromacromia* within the Corduliinae, and discuss its position with respect to morphological synapomorphies. Our results are also compared to the early hypotheses on *Lauromacromia* phylogenetic relationships based on morphological data presented in Pinto & Carvalho (2010) [Pinto A.P. & Carvalho A.L. A new species of *Lauromacromia* (Odonata: Corduliidae) from Southeastern Brazil, with a cladistic analysis of the genus and comments on Neotropical dragonfly biogeography. *Zootaxa* 2425: 45-68].



SESSION 3: PHYLOGENY

Speciation at the genomic level: First insights into comparative transcriptomics in the Neotropical damselfly genus *Megaloprepus*

Wiebke Feindt, Sara Oppenheim, Rob De Salle & Heike Hadrys

Explaining the exact patterns of speciation, adaptation and biodiversity is one primary goal of ecological and evolutionary genomic research. Comparative transcriptomic studies of closely related sister species represent a promising tool for understanding diversification and speciation. Recent research on the Neotropical damselfly genus *Megaloprepus* highlighted a 'cryptic' speciation event resulting in three so far hidden species and one subspecies. We here present an RNA-Seq study to further elucidate the differentiation process within this genus. We used comparative transcriptomics to identify genes involved in *Megaloprepus*'s diversification. We extracted and sequenced total RNA from larval thoraxes of the nominal species: *M. caerulatus* from the La Selva Biological Research Station in Costa Rica (n = 1) and the putative new species: *M. caerulatus* spec. nov. from the Corcovado National Park in Costa Rica (n = 2) and from the Pico Bonito National Park in Honduras (n = 1). More than 100x10⁶ reads (125 bp, paired end) were obtained for each library and assembled *de novo* using Trinity. Final assemblies included from 73,190 to 81,683 transcripts, with BUSCO (core arthropod gene content) scores of 93 to 94%. Ongoing analyses have so far revealed that approximately 70% of the identified genes are shared between species. Functional annotation and gene ontology (GO) assignment are underway. Variant calling using GATK (Genome Annotation Toolkit) will be presented for both intraspecific, geographic-level variation within *M. caerulatus* subsp. nov. and for interspecific comparisons. The study of the genomic basis of speciation in a highly specialized odonate species with niche conservatism may contribute to elucidate the complex evolutionary processes and causal interplays of speciation and adaptation.

Phylogenetic exploration of *Mesagrion* - *Heteropodagrion* complex: A molecular approach

León Andrés Pérez-Gutiérrez

In order to interpret the affiliation between species in the zygopteran *Heteropodagrion* - *Mesagrion* complex and their position within Megapodagrionidae, we reconstructed phylogenetic trees based on criteria of maximum likelihood and Bayesian inference using two molecular markers, the ITS1 and COI. The *Heteropodagrion* complex is clearly comprised of divergent lineages, which are recognized as fully differentiated species based on the absence of mixing among haplotypes. Although the *Mesagrion leucorrhinum* lineage is the most widely distributed geographically with isolated populations, these were recovered as monophyletic and separate from groups of *Heteropodagrion*. Therefore, despite sympatry between *M. leucorrhinum* and *H. croizati* our data does not support theories of hybridization between these taxa. Finally all analyses are consistent with the hypothesis that *Mesagrion* can be considered as the ancestral lineage within the complex.



SESSION 3: PHYLOGENY

Evolution at Northern limits: Understanding the Treeline Emerald (*Somatochlora sahlbergi*)

Manpreet Kohli

Somatochlora sahlbergi Trybom is the northern most breeding dragonfly and is usually found in the cold habitat of palsa mires (peat mounds of permafrost). This species has a very unique circumpolar distribution and is found along the tree line in Alaska, the Yukon, Scandinavia and Russia. Because of the unique nature of its habitat and range, *S. sahlbergi* is an interesting case for studying evolutionary history of Arctic fauna. Yet, there are still huge gaps in our understanding of this species with no consensus yet on its ecology and population structure. How it gained such a wide distribution throughout the Arctic is still a mystery. In this study we hypothesize that incipient speciation is occurring among populations of *S. sahlbergi* such that populations in North America are genetically different than those in Eurasia. We also try to unravel the biogeographic history of this species using molecular analysis. Studying this species is particularly important since climate change is very likely to impact this taxon because of its northerly range.

Untangling highly polymorphic *Polythore* damselflies using computer vision

William R. Kuhn, Melissa Sánchez-Herrera, Maria Olalla Lorenzo Carballa, Kathleen M. Harding, Nikole Ankrom, Thomas N. Sherratt, Joachim Hoffmann, Hans Van Gossum, Jessica L. Ware, Adolfo Cordero Rivera & Christopher D. Beatty

The damselfly genus *Polythore* is an enigma: genital morphology is unusually conserved among its member species, while their wing patterns are highly polymorphic. In this study, we developed a method for quantifying different aspects of *Polythore* wing patterns in order to quantitatively compare morphospecies. Wing color, texture, and banding pattern information were extracted from images of 5 *Polythore* species from Peru using chromaticity analysis, Gabor wavelet transformation, and a specially-designed landmarking analysis, respectively. These morphological characters were used to reconstruct a phylogenetic tree for these species, which was compared to a second tree that was reconstructed using cytochrome oxidase I (COI) molecular evidence. Incongruence between our phylogenetic analyses suggests both cryptic speciation and polymorphic species among *Polythore*.



SESSION 4: MISCELLANEA

Morphometric analysis of *Ischnura capreolus* and *Ischnura cyane* and a possible intermediate morphotype on Colombia

María Isabel Velásquez Vélez, Yiselle Patricia Cano Cobos, Clara Inés Saldamando Benjumea & Emilio Realpe

The genus *Ischnura* (Odonata: Coenagrionidae) is found worldwide, and has a wide distribution and diversity in Colombia. There are two related species reported in the State of Cundinamarca, *Ischnura cyane* and *Ischnura capreolus*, and there is a possible hybrid that shows an intermediate morphology between the two reported species. In this study we analyzed 270 wings (between males and females) and 151 male caudal appendages, the samples were taken from five different locations (three of those locations are sympatric and two are allopatric). To find differences and similarities between localities and species (allopatric or not) and locate the intermediate morphotype we used geometric morphometrics to determine if there are morphological differences between allopatric and sympatric populations of these species. The analysis of the wings reveals sexual dimorphism, and no differences within males and females of different localities. The male caudal appendages analysis showed that there are significant differences between the allopatric populations of the reported species but not in the sympatric ones, that include the intermediate morphotype; this can indicate that the caudal appendages shape of this sympatric populations are alike and that inter-specific mating and its consequent hybrid offspring are possible in the Colombian Andes.

Morphological adaptations of dragonflies (Odonata: Libellulidae) to migration

Catalina María Suárez Tovar & Carlos E. Sarmiento

Migration is a very expensive behavior for individuals who adopt it as a survival strategy in some state of their life cycle. Insects migrate mostly through flight, thus, it might be expected that migratory insect species have multiple morphological, ecological, and physiological adaptations to overcome the significant amount of energy invested in this behavior. Studies comparing migratory and non-migratory dragonflies have shown differences in the planform and in the allometric relationships between wing and body size. However, in addition to these traits, there are other morphologic characteristics that can influence flight performance and can improve efficiency during dragonfly's migrations. We studied wing and thoracic morphological differences between 12 migratory and 25 non migratory Libellulid species. We assessed the following wing traits: size (length and width), shape, surface, and microtrichiae number. To compare wing surface traits, we defined three types of wing membrane corrugations: ridges, hollows, and flat areas; we compared area proportions of each category. For the thorax we compared external dimensions (length, width, and height) and number and length of setae of the anterior region. Given that species can not be considered statistically independent, we used modern comparative methods when necessary. We found no differences between migratory and non-migratory species for wings aspect ratio, thorax linear measurements, nor microtrichiae number on wings; this lack of differentiation may reflect restrictions imposed by basic

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aerodynamics of flight. We found differences between migratory and non-migratory species for wing size, some wing regions, wing shape, and number and length of thoracic setae. Migratory species have wider and longer wings with a greater number of flat areas and a wider basal area. Additionally, more and longer setae were found on the thorax of migratory species. As a whole, these characteristics favor gliding during flight, allowing migration with low energy expenditure. Different responses were observed for the fore and hind wings and differences found on the internal corrugations of wings were non-uniform. Our results highlight the importance of a close look at different structures related with flight to understand the selective pressures on migration behaviors in libellulid dragonflies.

Fossil Odonata of Argentina through body fossils and endophytic ovipositions

Julián F. Petrulevičius & M. Eugenia Romero Lebrón

Fossil Odonata in Argentina are recorded from the Triassic to the Paleogene. They are represented by body fossils of nymphs and imagines, and traces. They were nearly unknown before the latest years of the last century, because of the historical lack of paleoentomologists and of collections of fossil insects in the country. From the last decade until today a nice fauna represented by new taxa up to family level was discovered in the Paleocene and Eocene of Argentina. These fossils belong to all major groups of Odonata, Palaeomacromiidae (derived Anisoptera), Frenguelliidae (basal Epiproctophora), Latibasaliidae (Caloptera) and Austroperilestidae (Euzygoptera). The Palaeomacromiidae are italoansids basal to Libellulida found in the late Paleocene of Northwest Argentina. Later, they were found in the Eocene of Monte Bolca, Italy, showing a wider distribution and a probable Cretaceous history. The amphipterygoid family Latibasaliidae, also found in the Northwest, has two described species. The Frenguelliidae are considered basal Epiproctophora, which have a cryptic history from the Triassic, reappearing in the Miocene (Sieblosiidae) and Recent (Epiophlebiidae). The eulestiformian family Austroperilestidae is found as the Frenguelliidae in the Eocene of Patagonia. It seems to be related to the Afro-South American family Perilestidae. There are other three genera from the Northwest, *Jujusia* and *Austrolibellula* whose relationships with the italoansids are unknown, and *Palaeophya*, related to African Neophyinae. There are also two species of Aeshnidae from the Eocene, probably related to *Oligaeshna*, one from the Northwest and the other from Patagonia. Nymphs are restricted to the Eocene of Patagonia and attributable to Synlestidae, Libellulidae, and Gomphidae. Older Odonata are nearly unknown with only two species, a Triasolestidae from the Triassic of Mendoza belonging to a genus with two South African species, and *Argentinopetala*, a Petaluridae from the Cretaceous of Patagonia. Ovipositions of Odonata are recorded in the Cretaceous and Eocene of Patagonia and are related to leaves of angiosperms associated to water. Of course, until now there are few species discovered to give definite conclusions on the Odonata fauna, but it appears that it is a highly specialized one with a high level of endemism.



SESSION 4: MISCELLANEA

The seven “oddities” of Pacific Odonata biogeography

Milen Marinov

The existing literature on the Odonata inhabiting the three large divisions of the Pacific Ocean (Micronesia, Melanesia, Polynesia) is revised taking into consideration earlier discussions on the species origin, historical faunistic records, various palaeogeographical models proposed for the area, general data on the biology and ecology of this insect order. The widely accepted view of long distance dispersal from a centre of origin as the only possible means for species to occupy remote oceanic island archipelagos is critically reviewed. There are seven phenomena in the current Pacific Odonata distribution that cannot be explained only by random gene transfer mediated by wind dispersal. Those are called “oddities”, however, they are believed to be regularities of past geological events and modern day human activities within the Pacific. A new approach is suggested to tackle the question of the origin of the Pacific Odonata by relating the higher taxa distribution to the geological events and palaeontology of the families. It is not intended to be a new hypothesis yet before more systematic studies of the taxonomy and fauna of the group. Discussion on its applicability is provided.

The German distribution atlas of dragonflies

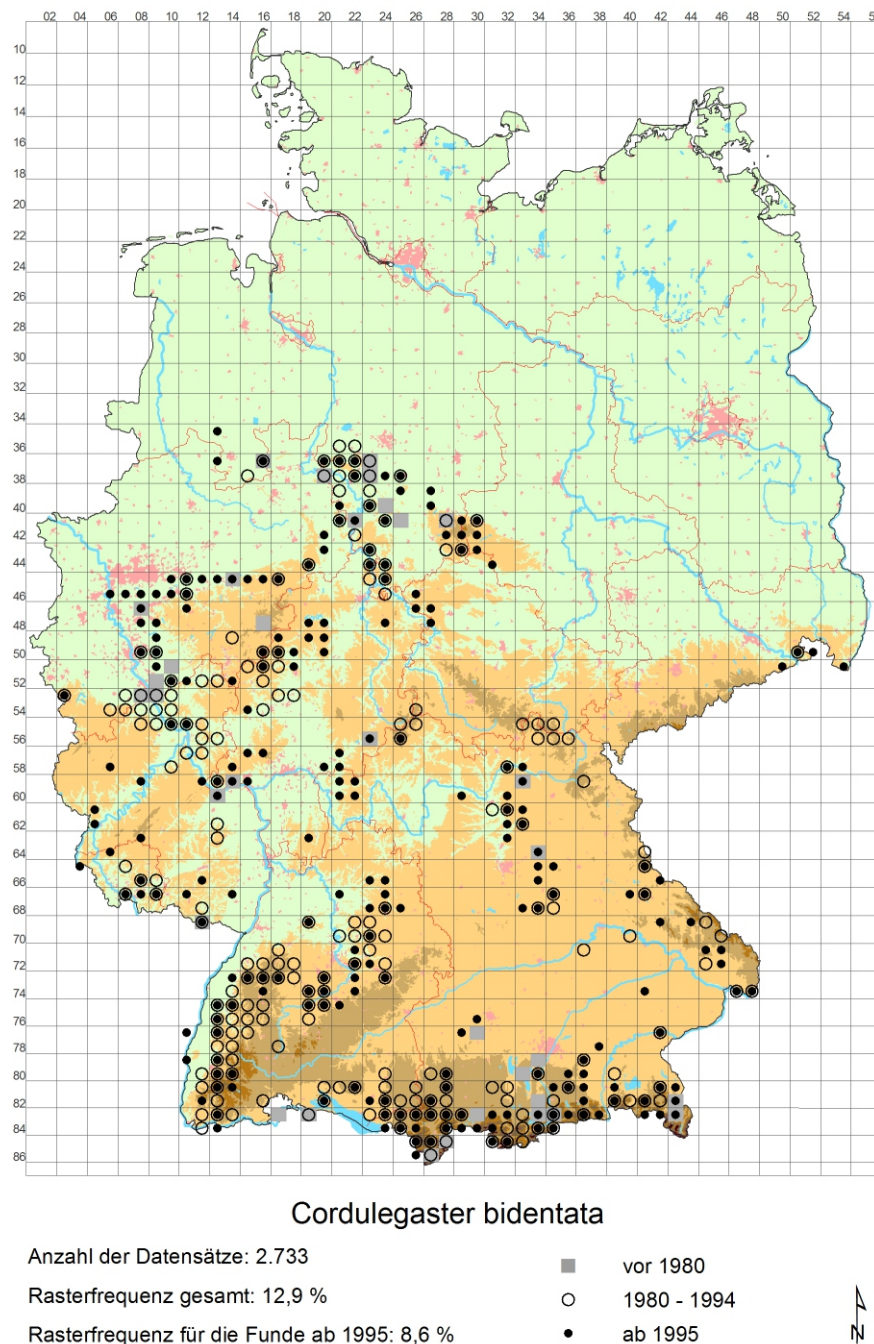
Klaus-Jürgen Conze

In March 2007 the *Gesellschaft deutschsprachiger Odonatologen* (GdO) decided on its annual meeting to start the work on an atlas of the distributions of all dragonflies occurring in Germany and to publish it as a supplement of its organ: the journal *Libellula*. So far there were only distribution atlases for some Federal states of Germany available. Within the last six years a working group organized the production and the atlas will be published in 2015. It is based on more than a million datasets collected from the 16 federal states where different institutions (administrations for nature conservation, NGO's and a numerous volunteers) provided data on distribution of dragonflies. Now for the first time distribution maps in a grid of approximately 10 by 10 kilometres (10 latitudinal x 6 longitudinal minutes) are available as the core of the atlas [as example see the map of *Cordulegaster bidentata*, a European endemic, reaching its northwestern distribution boundary in the low mountain range of Germany]. Included are short monographs for each species ever recorded in Germany. The atlas also contains a current red list as a result of the analysis of the distribution database. In Germany so far 81 species of Odonata were recorded in the wild of which 79 species are considered to be established. 30 species were classified into one of the german Red List categories and five species into the category “near threatened”. *Onychogomphus uncatus* and *Coenagrion hylas* are considered as “extinct” in Germany. Since 1998, when the last Red List was published, *Boyeria irene* was newly found for Germany. Furthermore, the national responsibility for the conservation of odonate species was assessed based on the share Germany has of the total population size of species. According to this, Germany is responsible to a great extent for conservation of *Cordulegaster bidentata* and *Aeshna*



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cyanea. There is also a notable responsibility for isolated outposts of *Sympecma paedisca*, *Nehalennia speciosa*, *Coenagrion armatum*, *C. ornatum*, *Aeshna caerulea* and *Somatochlora alpestris*. Furthermore a list of hitherto known introduced dragonflies is given as well as a compilation of fossil German records of Odonata. As part of the project Libellula Supplement 11 (Schorr, M. & Wolf, J. 2012. Bibliographie der für Deutschland publizierten Libellenliteratur (Odonata). *Libellula Supplement 11, Libellen Deutschlands*, Band I: 5-420) had already been published in 2012, which is a bibliography of German literature on odonatology with more than 6.000 titles. In the presentation will be given further information on the background, the results and benefits and an outlook of subsequent activities. Various information can already be found at www.libellula.org.



SESSION 4: MISCELLANEA

Current status of the dragonflies in Hong Kong ten years after the territory wide survey in 2002-2004

Tze-wai Tam

Long-term study on the dragonflies of Hong Kong was carried out by the Agriculture, Fisheries and Conservation Department, Government of the Hong Kong SAR since 2002 to obtain comprehensive geographical baseline information about the dragonfly species in Hong Kong. The study included baseline survey and monitoring of representative sites. The baseline survey was carried out from April 2002 to October 2004, covering all wetland habitats throughout the territory. A total of 207 sites were surveyed and five new species records, including a species new to science, were made in the survey by October 2004. Subsequent monitoring of the representative sites identified in the survey was commenced in 2005. Three more new species records were made in the monitoring and eight additional new records of species were reported by other researchers/non-government organizations/dragonfly amateurs by July 2015. In addition, more locality records were made for the endemic species and those endangered/vulnerable species listed by IUCN during the monitoring. At present, a total of 123 dragonfly species have been recorded in Hong Kong, in which 9 species are rare, 24 species are uncommon, 58 species are common, 22 species are abundant, 5 species are vagrant and 5 species are historical records. All the extant 113 species (after excluding the five historical records and five vagrant records) and the dragonfly representative sites were well protected by the protected area system or other appropriate conservation measures in Hong Kong.

The status of *Rhionaeschna galapagoensis* (Currie, 1901) with notes on its biology (Odonata: Aeshnidae)

Adolfo Cordero Rivera, A.C. Encalada, R.A. Sánchez-Guillén, S. Santolamazza-Carbone & N. von Ellenrieder

A morphological, molecular, and behavioral characterization of *Rhionaeschna galapagoensis* is presented, based on a series of specimens and observations from San Cristóbal Island, Galápagos, including both adults and larvae. Several of the characters proposed earlier to distinguish between the adults of this species and its closest relative, *R. elsia*, are found to be variable, but the presence of a black band over fronto-clypeal suture is confirmed as a good diagnostic character. Molecular analysis confirmed that *R. galapagoensis* and *R. elsia* are sister species, and showed that their genetic distance is the closest among the analyzed species. The larvae of *R. galapagoensis* were very common and widespread in the mountain streams and a pond in the Southwest of San Cristóbal. Swarms of tens of individuals formed at sunrise in the coastal vegetation, together with adults of *Tramea cf. cophysa*, feeding on small flying insects. Males showed patrolling behavior on small sections of the streams and at a pond. Only one copulation was observed, which lasted 10 min. Females oviposited alone on floating vegetation in running and standing waters. Our observations corroborate that *R. galapagoensis* and *R. elsia* are two parapatric species, morphologically and genetically close. In San Cristóbal, *R. galapagoensis* had large populations apparently not threatened.



SESSION 5: GENOMICS

Preliminary results from the 1KITE TransOdonata subproject

Jessica L. Ware, Alexander Blanke, Caro Greve, Karl Ryuchiro Machida, Bernhard Misof & Oliver Niehuis

Dragonflies and damselflies (Odonata) are a charismatic insect order with a little more than 6000 species; their closest relatives are the mayflies, but the inter-ordinal relationships among these lineages has remained elusive. Within Odonata, the two suborders, Anisoptera and Zygoptera, are well supported. In contrast, the interrelationships among families within each suborder have remained unclear since datasets partly contradict each other. Here we present and discuss our efforts in the "TransOdonata" 1KITE subproject, which aims to use morphology and transcriptomics to infer the phylogeny of Odonata, Ephemeroptera, and the umbrella grouping of "Palaeoptera". We will highlight our taxon selection, and discuss the results of our sequencing and morphological work to date, which resulted in a dataset with over 3000 genes for over 100 odonate and mayfly taxa.

Odonata Genomics: why it matters

Seth M. Bybee

The possibility of sequencing genomes, entirely or partially, for nearly any organism is well established due to emerging technologies and bioinformatics tools that extend beyond traditional model organisms. The generation of genomic resources for Odonata has lagged behind other insect groups, because in large part they are not economically or medically important. However, they are central to evolutionary and ecological biology due their phylogenetic position, adaptive traits, sensitivity to climate change, complex life cycle and unique behavior, to provide a modest list of their importance. In this talk we attempt to frame the importance of odonata for genomics work and outline where odonates are potential models for evolutionary and ecological research.

Transcriptomics of mating harassment in a polymorphic damselfly

Mary C. Duryea, Yuma Takahasi, Chris Wheat & Erik I. Svensson

Female color polymorphisms have evolved over 100 times within odonates. In many of these species, the color polymorphisms are represented by one or more female specific morphs as well as an andromorph that looks (and may even behave) like the male of the species. These andromorphs are likely the result of the intense sexual conflict that is present within many species of odonates and is typified by male mating harassment of females. These morphs also demonstrate frequency dependent selection, in which the rare morph in a population suffers less harassment. A recent study in *Ischnura elegans* has shown that the average female fecundity is highest when population frequencies of color polymorphisms are most balanced. Here, we investigate the genetic correlates of this finding to uncover the transcriptomic response of mating harassment and how this response may vary among rare and common morphs in a population. We manipulate the frequencies of two female color



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polymorphisms of *Ischnura elegans* in field enclosures and test for differential gene expression among females in three treatments: andromorph biased, gynomorph biased, and balanced morph frequencies. We hypothesize that gene expression related to mating harassment will be detected in the common morph in the biased morph treatments. Thus, we use a combination of field and lab studies to investigate the physiological response of sexual conflict in female odonates.

Using Pool-Seq to examine genetic variation affecting male fitness in the 12-spotted skimmer, *Libellula pulchella*

Rudolf Schilder

In my lab we are interested in mechanisms underlying broad sense phenotypic plasticity in insect locomotion. We study a variety of insects, but an ongoing project involves the study of intraspecific variation in flight performance of male *Libellula pulchella* dragonflies. A large amount of standing variation in male flight performance (and hence mating success) is apparent in the natural populations we study. Such variation is somewhat surprising given that high performing males tend to mate more and therefore should be at a selective advantage. Historically, we have used physiological and single gene approaches to examine variation in this trait and possible trade-offs with others, but here I will present and discuss the outcomes of our recent efforts to sequence the genomes and flight muscle transcriptomes of ~70 field-caught high- and low performing males of this species to assess genetic (i.e. genomic and/or transcriptomic) variation affecting male flight performance in a more global sense.

Ecology and evolutionary dynamics in polymorphic damselflies: how can genomics and transcriptomics increase our understanding of evolutionary processes?

Erik I. Svensson

In our research laboratory, we have studied mating behaviour, sexual conflict, population biology, morph frequency variation, thermal adaptation, biogeography and evolutionary dynamics of the common bluetail (*Ischnura elegans*) for 15 years and across multiple spatial and temporal scales. Here I will synthesize this past research of ours, present the results of some of our ongoing experimental work and also present some as yet unpublished data from Next-generation Sequencing (NGS), including RAD tag DNA sequencing and transcriptomics (Illumina). I will critically discuss how these novel NGS-approaches can increase our understanding of evolutionary processes, particularly when combined with manipulative experiments and when put into a rigorous theoretical framework aimed at testing explicit and fundamental hypotheses in ecology and evolution. One main message of this talk is that neither NGS-approaches nor other methodological "bandwagons" can replace a thorough knowledge of the natural history of the study species in question. I therefore caution against uncritical enthusiasm of these methods and argue that they need to be embedded in to a rigorous



theoretical and history framework to be of interest to odonatologists, ecologists and evolutionary biologists.

Population genomics of sexual and parthenogenetic *Ischnura hastata*

M. Olalla Lorenzo Carballa & Phillip C. Watts

The advance in next-generation sequencing technologies is having a great impact on many areas of biology, including the analysis of genetic diversity in natural populations of non-model species. Restriction-site associated DNA sequencing is a method that produces thousands of sequenced markers across many individuals at a reasonable cost; thus delivering high resolution population genomic data. Here, we present the results on Genotyping by Sequencing (GBS) of 400 sexual and parthenogenetic *Ischnura hastata*, with the objective to analyze genetic diversity and disentangle the geographic origin of the asexual lineage of this species found in the Azores islands.



SESSION 6: RED LISTING

First Red List assessment for Odonata in Colombia, with some study cases

Cornelio A. Bota-Sierra, Bill Mauffray, Fredy Palacino-Rodriguez, Ken Tennessen & Edwin Ussa

During the first week of September in 2014, the IUCN made a workshop to assess the Red List status of freshwater mussels, plants, fish and dragonflies, from Ecuador and Colombia. Three odonatologists for Colombia, (Cornelio A. Bota-Sierra, Fredy Palacino and Edwin Ussa), and two for Ecuador (Ken Tennessen and Bill Mauffray) were invited. This team, with the help and information compiled by the IUCN staff, made the first assessments for the 110 endemic Odonata species in the region (42 Colombian endemics). Close to 5% were Critically Endangered (CR), 19% Endangered (EN), 15% Vulnerable (VU), 5% Near Threatened (NT), and 31% Data Deficient (DD). As a general conclusion, Colombia needs more surveys especially in the Amazon region. The most endangered species are the endemics from the Magdalena River valley and the Andean high elevation specialists which are in the most disturbed regions in the country. Some of the most controversial and worrying species are:

- *Mesamphiagrion nataliae* a species only known from two localities close to Bogotá. Recent surveys have failed to recover it in one of the localities and its surroundings (EN).
- *Heteragrion peregrinum* was collected and described by the Williamson cousins in the 1910's-20's. They collected a series of more than 50 specimens in just a couple of weeks, implying that this species was not rare. Recent surveys on the type locality and more than 20 surrounding areas have failed to recover this species which therefore may be Extinct (CR).
- *Lestes sternalis*, described by Navás from the Cordillera Oriental close to Bogotá, has not been recorded again since 1930 (DD). This may be due to taxonomic issues because the original descriptions by Navás were unclear.

Applying the IUCN Red List criteria for assessing Odonata: interpretations and their consequences

Frank Suhling

The IUCN Red List includes various categories from Extinct to Least Concern. To evaluate whether a taxon belongs to one of those categories, various definitions and criteria are used according to the IUCN Red List guidelines, such as the definitions for “Extinct”, “Possibly Extinct”, or “Data Deficient”. Five different criteria are used to evaluate whether a taxon belongs to a threat category (Critically Endangered, Endangered or Vulnerable). These are based mainly on population reduction, small geographic range, small population size and decline, very small restricted population or even on quantitative analysis (hence a population viability model). Although only one of these has to be met, applying them to Odonata is not always easy. Mostly, the geographic range in form of the area of occupancy or the extent of occurrence is used. In particular, some of the subcriteria, such as “severely



SESSION 6: RED LISTING

fragmented” or the number of “locations” require interpretation and adaption for Odonata. In my presentation I will give some examples how these definitions, criteria and subcriteria may be applied and the possible consequences for a species' status.

The Red List of African Dragonflies: backgrounds and perspectives

Klaas-Douwe B. Dijkstra

With over 700 named species treated by 2010, African Odonata was the first insect group to be assessed completely for the IUCN Red List of Threatened Species. The challenges and successes will be presented, as well as examples of endangered species. The three most critical factors were firstly a sound taxonomic basis, secondly the collaboration of regional experts across a vast continent (three times as large as China or the USA!), and thirdly and most importantly the complete, centralized and continuously updated records in the Odonata Database of Africa (ODA), which now contains over 127,000 records of 770 known species.



SESSION 7: ETHOLOGY

Differences in flight between dragonflies and damselflies

Georg Rüppell

Scaling and dimensions of Zygoptera and Anisoptera are very different. Does this lead to different flight characteristics? By means of slow-motion filming the flight of several species of Coenagrionidae, Calopterygidae (as Zygoptera) and of Libellulidae and Aeshnidae (as Anisoptera) will be compared. Wing beat frequencies show large differences, being higher in the small Zygoptera species and being used to accelerate the flight. In Zygoptera, at high velocities the fore wings are beaten at large angles, clapping together in backward position causing the clap & fling effect, a possible explanation for the increase of speed. Anisoptera accelerate more by increasing the wing beat angles, easy for them because they fly normally at small angles in contrast to Zygoptera. Furthermore, they glide in between flapping causing an increase of possible flight endurance. The wing stroke directions differ, too, being more wide and horizontal in Zygoptera and more narrow and inclined in Anisoptera. As a compensation Anisoptera show an unusual behaviour: they bend their thorax upwards to get upward and backward flight and downward to fly downward or a loop. Loops I could film only one time in Zygoptera (backwards) but many times in Anisoptera (forwards). Turns are managed faster by Zygoptera and more effective as by the larger Anisoptera. The turning speed is higher in Zygoptera and the turn range got by one wing beat is larger, too. The power produced by one wing beat in Anisoptera is higher than in Zygoptera. This can lead to behavioural advantages concerning pairing and escape from predators.

High-frequent threatening flights of *Calopteryx* females and males

Dagmar Hilfert-Rüppell & Georg Rüppell

A new flight pattern was discovered on a day with heavy winds at the River Oker, Braunschweig, Germany. No damselfly could fly in open space. In a small bay of the bank sheltered by vegetation five females of *Calopteryx splendens* were foraging, starting from time to time for catching small insects in flight. Perches where females returned for degusting the prey or for waiting for another take-off were limited. Females fought for perches and showed a special threatening flight by counterstroking wing-beats with a high frequency. In all other flights females stroke fore and hind wings nearly parallel with a much lower flight frequency. As this flight mode resembles the courting flight mode of males the female's threatening flight is compared with it. This behaviour by counterstroking flapping of the two wing pairs was found in threatening of a female against a male of *C. xanthostoma*, too. The context was a very high density and the extremely low chance of submerging for females to lay eggs because of a strong current of the river Célé, Southern France. So the access to the females was easy and the refusal behaviour of the females against harassing males intense. In another extreme situation males of *C. virgo* threat each other: the River Isar near Freising, Bavaria, had high water level for weeks and only a few emergent water plants offered possibilities for egg-laying. At such a spots several males fought for territories by normal parallel beating by a frequency about 20 Hz– but by



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high-frequent beating (about 40 Hz), too. This seemed to be an enhancement of normal threatening. This high-frequent flapping resembles to that of the courting flight of *C. virgo* males. Finally we found this high-frequent threatening flight in *C. splendens* males to conspecific males and to *C. virgo* males, too. Being shown at the same time by two opponents the high-frequent threatening was winning against normal parallel threatening.

Visual signals influence the outcome of territorial fights in the tiger damselfly *Tigriagrion aurantinigrum* Calvert 1909 (Zygoptera: Coenagrionidae)

Diogo Silva Vilela, Thaína A.A. Tosta, Rodrigo R. Rodrigues, Kleber Del Claro & Rhainer Guillermo Ferreira

Several studies have shown that male coenagrionid damselflies are usually non-territorial. Nevertheless, there are some rare cases of territorial species, where it is known that larger males are usually winners of male-male contests and, consequently, acquire increased fitness. Furthermore, male coenagrionid damselflies usually exhibit bright sexually dimorphic coloration patterns which are frequently related to contest outcome and reproductive success. However, there is a lack of evidence on the role of these visual traits as signals in intraspecific communication. Therefore, we addressed whether face pigmentation is selected via intrasexual competition in males of the tiger damselfly *Tigriagrion aurantinigrum* (Zygoptera, Coenagrionidae). We observed 43 males, noting their territorial status and contest outcome. We measured head orange markings in male heads using photographs and a script for MatLab language. Winners exhibited larger body size, body weight and head orange pigmentation when compared to losers. Post-ocular pigmentation exhibited a positive correlation with male body size and body weight. Male coloration, body size and weight were positively correlated with territory quality. Our results suggest that orange pigmentation on the post-ocular area of the head may be an honest signal of male quality, predicting contest outcome and the competition for territories in tiger damselflies.

Physiological color change in response to mating-associated behaviors in *Argia apicalis* (Odonata: Coenagrionidae)

Amanda Whispell & Michael L. May

In Odonata, the gradual development of adult coloration during their teneral period is a well-known phenomenon, and this type of morphological color change occurs slowly and irreversibly. Physiological color change, in contrast, is always rapid and reversible, and has only been studied in a few insect species. While the change exhibited by most odonate species is primarily temperature sensitive, changing to dark-phase coloration (DP) when below a certain temperature threshold, then returning to bright-phase coloration (BP) when the temperature rises above it, this is not always the case. *Argia apicalis* males also change colour, from BP to DP, in response to mating-associated activities. In order to study this color change, we marked and released a total of 859 males over the



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course of three summers, subsequently resulting in data documenting 117 separate mating events. Within each one-month period of data collection, we found that significantly more males changed from BP to DP over the course of a mating event (Mann-Whitney U-Test, $z = 3.31$, $P < 0.001$), than remained in BP throughout (mean \pm SE: DP 13.5 ± 0.56 , $N=108$; BP 1.13 ± 0.10 , $N=9$). Sufficient data was obtained from 26 of these mating events to warrant our examining which mating-related behaviors could be correlated with the greatest overall thoracic darkening – tandem formation, copulation, or oviposition – and the males in all 26 cases exhibited their darkest coloration during oviposition. Since colors are often so important in intraspecific communication, it could be advantageous for *A. apicalis* males to publicize their readiness to mate while in BP, and then reduce their conspicuousness when at their most vulnerable, by transitioning to DP.

The remarkable wings and behavior of the Morpho-dragonfly *Zenithoptera lanei* (Odonata: Libellulidae)

Rhainer Guillermo Ferreira, Pitágoras C. Bispo, Esther Appel, Alexander Kovalev & Stanislav N. Gorb

Zenithoptera dragonflies are known for their remarkable bluish coloration on their wings and unique male behavior of folding and unfolding their wings while perching. However, nothing is known about the optical properties of such coloration and its structural and functional background. In this paper, we aimed to study the relationship between the wing membrane ultrastructure, surface microstructure and color spectra of male wings in *Zenithoptera lanei* and test the hypothesis that coloration functions as a signal in territorial fights between males. The results show that the specific wing coloration derives from the cuticle layers of dark pigment causing metallic interference of the wing membrane combined with the two different layers of wax crystals, one lower layer of long filaments, and one upper layer of leaf-shaped crystals. The results also show that the thicker wax coverage of the dorsal surface of the wings results in increased brightness and reduced chroma. In the field experiments, we have demonstrated that there is a reduction of aggressive reactions of rivals towards individuals with experimentally reduced amount of blue wing coloration.

Identified neurons in the dragonfly ventral nerve cord signal the approach of flying prey

Andrea Worthington & Robert Olberg

Locating and interacting with moving objects is a fundamental problem for animal visual systems, a problem that includes both spatial and temporal components. For the dragonfly, which survives by foraging on flying insects, the problem is to arrive at a point in space at the same time as its prey. To do this the dragonfly steers a course that intercepts the prey's flight path, its flight trajectory aimed at a point that leads the flying prey (Olberg *et al.* 2000, Mischiati *et al.* 2015). As it approaches the point of interception from below, the dragonfly pitches its body upward and thrusts its legs out to

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grab the prey insect. This final maneuver reflects an accurate collision-time calculation, with the leg thrust beginning consistently about 20 ms before time to contact. In the ventral nerve cord of the dragonfly, 2 target-selective descending neurons respond to expanding images. These 2 neurons, identified by intracellular dye injection as DIT3 and MDT3, show bursts of spike activity in response to black and white expanding images, whose time course of expansion simulates real approaching objects. The neurons do not show similar activity to light-on or light-off stimuli, indicating the responses are to expanding contours and not simply to changes in light intensity. What features of expanding images trigger the neuronal responses in DIT3 and MDT3? Because the image of an approaching object grows at an accelerating rate, we asked whether the timing of spike activity of each looming sensitive neuron reflects a given size, a given speed, or a given acceleration of the expanding image. Our data suggest that speed of expansion is the salient variable; spike activity is initiated at an image expansion rate of about $200^\circ/\text{s}$. We hypothesize that the timing of this neuronal activity controls the suite of movements (leg thrusts, wing movements and head rotation) required for grasping flying prey.

Individual neurons in the dragonfly ventral nerve cord control wing, head, leg, and mouth movement

Robert Olberg & Andrea Worthington

Eight bilateral pairs of neurons in the dragonfly ventral nerve cord respond only to the movement of small contrasting objects. These neurons, called Target-Selective Descending Neurons (TSDNs), are purely visual. Their receptive fields are in the dorsal frontal visual field, the high acuity region in which prey images are fixated during pursuit. TSDNs are highly selective for the direction of prey movement, and so their activity transmits information about size, location, speed, and direction of the prey. We have shown that each of the TSDNs is capable of eliciting small movements of the wings, and thus we hypothesize that these are the neurons that guide prey interception flight. In this study we investigated whether the TSDNs, the largest axons in the nerve cord, might also control other movements, such as head orientation. We penetrated individual axons with microelectrodes, which allowed us to monitor the spiking responses of the neurons to visual stimuli and also to inject electrical current into the cells to control their activity. We left the head and wings unrestrained so that we could monitor their movements. In some cases the microelectrodes were filled with a fluorescent dye, so that we could identify the penetrated neuron anatomically. The most important result of our study was the finding that, in some recordings, high-frequency activity in the axons of individual TSDNs was sufficient to elicit head rotation, in addition to movements of the wings. Furthermore, one neuron, putatively identified as DIT3, also caused the prothoracic legs to move and the mouth to open. This latter result is especially interesting, because DIT3 is a neuron that responds just before prey contact, suggesting that this neuron is coordinating the activities associated with capturing the prey. There are few cases in the neurophysiological literature of single neurons that drive a whole suite of behaviors. Why should this be the case in dragonflies? Our hypothesis is that the same neuron that causes a flight turn in one direction also causes the counter-rotation of the head in the opposite direction, allowing the eye to



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remain fixated on the prey during pursuit. It is known that the dragonfly precisely fixates its prey in real time (Olberg *et al.* 2007, Mischiati *et al.* 2015). These neural connections may be the basis for this remarkable ability.

Details of dragonfly behaviour from high speed photography

Georg Rüppell

Why high-speed photography? Because of better resolution and very short exposure time. By chance one can get photos of details of wings or legs as well as body positions. The talk focuses on flight and other behaviour, showing unknown details. Distortion of the beating wings are a general trait, especially during accelerating. Changing air pressure leads to changes of the curvature of the wing cells. During narrow turns intense banking is typical especially for Anisoptera at fast speed. Then the head stays horizontally leading to a turning of the body against the head of more than 100°. During extreme banking the lower hind wing are twisted largely. Phase relationships between fore and hind wings are seen precisely in photos giving the same time phase of their movement. In Demoiselles the fore wings are leading the beat period of both wing pairs of about 5-10 %. Pictures of leg movements and their use offer new insights in until now uninvestigated behaviour. Legs are not used as catapults during take-off but as shock-absorber during landing. They are used as weapons during fights. They are directed towards the opponent in nearly all directions, even upwards. The sharp claws can hit and damage the wings. *Anax imperator* crashes into an opponent by outstretches legs, the fore legs held above the head. In different Zygoptera species this was not the case. Biting was documented, too, leading to a percentage of about 30% of damaged wings in a high population of *Calopteryx xanthostoma*. In female refusal behaviour fighting with legs and biting occurred, too. This may lead to damages also of the legs. In *Aeshna cyanea* pairing in full flight with not cooperating females could be photographed several times. This means that for pair-building in Anisoptera the females cooperation is not obligatory. Finally details from prey catching of frogs are presented.



SESSION 8: ECOLOGY

Habitat selection of dragonflies in terms of vegetation and aquatic environments in an Atlantic Forest conservation unit, RS, Brazil

Samuel Renner, Göran Sahlén & Eduardo Périco

The objective of this study was to obtain an overview of the species distribution patterns among the various habitats and to make a species inventory in Mixed Ombrophilous Forest (MOF), one of the forest formations occurring in Southern Brazilian Atlantic Forest: one of the richest biomes on Earth. We sampled adult dragonflies in 30 aquatic habitats in the Floresta Nacional de São Francisco de Paula, a national reserve divided into sectors of MOF, planted *Araucaria angustifolia*, planted *Pinus elliottii* and open fields. Forty seven species from seven families were recorded during one year. Using Non-metric Multidimensional Scaling (NMDS), clear occurrence patterns were found, denoting that habitat preferences of the species were directly related to biotic and abiotic features. Six generalist species occurring in all the vegetation types were found: *Oxyagrion terminale*, an indet. *Oxyagrion* species, *Rhionaeschna diffinis*, *R. planaltica*, *Erythrodiplax diversa*, *E. hyalina* and *E. media*. The *P. elliottii* sector had the highest species diversity. The highest number of habitat specific species was found in both the MOF and in *A. angustifolia* sectors, six species in each. The NMDS showed that the species composition of the pristine forest (MOF) and the planted *A. angustifolia* were similar, a fact explained by the majority of native tree species occurring in both vegetation types, being able to shelter a set of forest specialized species. The *P. elliottii* plantations had a species composition distinctly separated from that of the MOF. Looking at the aquatic environments the NMDS analysis showed that the richest assemblage occurred in lakes, and being totally distinct from the other sampled environments. Swamps and streams were found to have a similar species composition: most of the species occurring in the swamps also occurred in the streams. We explain the variation in assemblages by particular ecological requirements of the species recorded. As expected, open areas contained mainly generalist species, but the small MOF and stream/swamp communities showed a great homogeneity. This is a pioneer study given the poor knowledge of the Odonata in the Atlantic Forest/MOF, which we hope will lead to a better understanding of the communities, as well as the development of conservation measures.

Experiments about drought resistance of dragonfly eggs

Franz-Josef Schiel

In Central and Western Europe at least five dragonfly species out of three families (Lestidae, Aeshnidae, Libellulidae) are more or less specialized to reproduce in summer dry temporary water bodies. Two of them, *Aeshna affinis* and *Sympetrum flaveolum*, usually oviposit at the dry bottoms of temporary waters or at the humid shoreline of ponds that are not completely dried up. These species usually show an egg diapause, i.e. the larvae hatch in late winter or spring following oviposition. Therefore, a drought resistance of the eggs has to be expected. Some authors assume that in typical temporary pond species hatching can be delayed under unsuitable drought conditions and that these species may be able to survive for more than one year in the egg stage. I conducted the following two



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drought experiments with eggs of eight species, two of the genus *Aeshna* (Aeshnidae) and six of the genus *Sympetrum* (Libellulidae). Experiment 1 was carried out with eggs in which no embryonic structures were visible. Each 400 of these eggs were put into dry petri dishes with air temperatures ranging from 18 to 30°C and humidity ranging from 55-65 %. Each 200 eggs per species were put back onto a humid piece of filter paper after 10 days and each 50 eggs after 6, 12, 18 and 24 months. After this translocation the regeneration of these eggs and the portion of eggs, in which an embryogenesis could be observed after this treatment, were documented. Experiment 2 was conducted with eggs in which embryonic structures were apparently differentiated. Each 30 eggs per species were subjected to drought for time spans from 1 to 10 days and afterwards transferred to water again. In this experiment, air temperatures ranged from 13.0 to 16.4 °C, and humidity from 37-52%. In this experiment, hatching rate in comparison with a blank test with 30 eggs was documented as well. Results can be summed up as follows: 1) The degree of drought resistance of eggs is species specific and depends on the embryonic development stage; 2) In eggs without visible embryonic structures only those of *Aeshna mixta* and *Sympetrum flaveolum* survived a drought of 10 to 30 days; 3) In eggs with visible embryonic structures, five (*Aeshna affinis*, *A. mixta*, *Sympetrum depressiusculum*, *S. flaveolum*, *S. vulgatum*) out of eight species survived a drought from 10 days, including two typical species of summer dry temporary ponds.

Urban Dragons - Do dragonflies benefit from urbanisation?

Diana Goertzen, Göran Sahlén & Frank Suhling

Urban freshwaters can host high dragonfly species richness: Indeed, in major Central European cities a near-to-complete range of the respective dragonfly fauna can occur in cities. In this study we investigate the response of dragonfly species to different kinds of land-use to find out whether urbanisation is beneficial or negatively affects them at the landscape scale. Therefore, we compared the abundance of 30 common species in urban, agricultural and forestal areas in several regions in Central and Northern Europe. Results show significant patterns: one third of the species had a clear preference for urban areas (e.g. *Anax imperator*) while others preferred forestal areas (e.g. *Aeshna juncea*), or had no clear preference at all. For two species we could prove a negative impact of urbanisation (*Aeshna grandis*, *Lestes sponsa*). The results provide valuable information for which species urbanisation may constitute a threat and which species may benefit from urbanisation. Furthermore, the results will allow for trait analyses that may reveal which traits make species able to cope well with urban conditions and which do not.



SESSION 9: CONSERVATION

Role of ponds in maintaining connectivity between *Ischnura elegans* populations along a Blueway in Normandy (France)

Mickaël Le Gall, Audrey Chaput-Bardy & Aurélie Huste

Human activities strongly impact biodiversity altering habitat suitability and connectivity between patches. In this context, dispersal may be a fundamental process to maintain populations when connectivity is preserved. In France, the concept of Greenways and Blueways is more and more considered in order to promote interconnectivity between natural areas. Considering Blueways only, mainly active waters are often studied while ponds seem to be less interesting. Yet ponds are regularly announced as "potential relays" in Blueways. We studied the dispersal of a damselfly *Ischnura elegans* between two unconnected watersheds located in Upper Normandy (France). This species is a common species in the studied area. Particularly, 25 ponds along the Seine river, 11 ponds along the Durdent river and 8 ponds between the two river basins were considered. As riverbanks do not always ensure connectivity and especially in strongly urbanized habitats, we tested the role of ponds to ensure this connectivity along and between the two river basins. The spatial genetic structure and the isolation by distance of the 44 *Ischnura elegans* populations were studied. To do this, 25 tarsi of males and 25 of females were sampled in each pond and genotyped using 17 species-specific microsatellite markers. Assuming that the considered rivers may be Blueways at larger spatial scale, we expected an overland dispersal between rivers and ponds. However, we expected an isolation by distance pattern as long distances between ponds limit individual exchanges. To our knowledge, studies considering the influence of a pond network on genetic population structure are rare in the context of Greenways and Blueways. Nevertheless these ponds can become essential to maintain continuity in a Blueway when anthropic pressure in the surroundings of the rivers become too high to allow sufficient quality of suitable habitats.

Distribution, habitat requirements and conservation of two rare dragonflies in southeast Texas and western Louisiana, United States

John C. Abbott & Kendra K. Abbott

The range of *Cordulegaster sarracenia* (Cordulegastridae) and *Somatochlora margarita* (Corduliidae), two rare anisopterans, is limited to *Sarracenia alata* pitcher plant bogs and small forest streams, respectively, in southeast Texas and western Louisiana in the United States. Characteristics of these species' nymphal and adult habitat, flight period and adult activity are described. The nymph of *C. sarracenia* is described and details of *S. margarita* nymphal habitat requirements, never before observed in the wild, are discussed. The life history of *C. sarracenia* is inferred from size and frequency data taken in two populations. Similarities of *C. sarracenia* and *S. margarita* to some of their respective congeneric species in North America are discussed. Habitat destruction and loss, due to lack of management are the main threats to the conservations of these species.



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Odonata in the European Habitats Directive

Ulf Bjelke

The Habitats Directive is a conservation legislation in the European Union with 15 Odonata species being listed. This means both individuals and their habitats have a certain level of protection. Every six years the 28 member states are obliged to report the number of populations, status and known threats for each species present in their respective country. This talk will cover the legislation, and the results from the latest reporting (2013) will be analyzed. Regional differences in conservation status will be covered. An important issue is whether the intrinsic traits of the 15 species make them suitable representatives for dragonfly habitats of Europe, i.e. whether they are good indicator species regarding the biodiversity and conservation status of freshwater habitats. The talk will also make a critical analysis on whether the listed species really are those most in need of conservation efforts. Additionally, an important factor is the substantial differences in knowledge of the Odonate fauna among the various countries and regions. However, in several countries the Habitats Directive has led to a substantial build-up of knowledge on not just the 15 species but on the Odonate fauna in general. This may be the most significant effect of the Directive so far.

Nonlinear responses in damselfly community along a gradient of habitat loss in a savanna landscape

Marciel Elio Rodrigues, Fabio De Oliveira Roque, Diogo Caribé de Sousa, João Carlos Pena & Paulo De Marco Junior

Human activities are the main cause of habitat loss and changes in landscapes configuration, affecting different biological communities. Freshwaters are among the most threatened ecosystems affected by land use changes. These changes have resulted in nonlinear responses, as thresholds or breakpoints, which are recognized by the rapid response of the systems to relatively small pressures. However the existence of a threshold in aquatic communities as a response of modifications in terrestrial landscapes are poorly quantified and understood. Many organisms in riparian zones can be sensitive to such landscape changes due to biological characteristics such as ability to dispersion, behavior, choice of territories, habitat specificity, resource use, naturally low abundance among others. This indicates that the loss of species is not random, but rather affects organisms that share certain specific ecological traits that make them more vulnerable to habitat disturbance. Odonates are a good model for assessing the effects of landscape changes because species differ in their dispersal and thermoregulatory abilities, species size body, behavior and they have an aquatic and a terrestrial phase. Thus, factors other than variation in local characteristics (e.g., integrity of the riparian forest and of the vegetation beyond the riverside) can influence communities by changing the environments for dispersal and survival during the adult phase. This sensitivity to environmental conditions and the distinct phases of the life cycle of these insects may potentially provide insights into disturbances in both aquatic and terrestrial systems, which justify their use as bioindicators to assess environmental



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integrity. In this study, our goal is to answer whether the community of damselflies (Odonata: Zygoptera) shows non-linear responses in relation to the decline of forest cover around streams. For this purpose, we sampled damselflies in streams in a continuous gradient of forest cover in a savanna landscape in Brazil. In general, we expect that a set of damselfly species would show a threshold in relation to the forest cover loss, given that: i) some damselfly species have low dispersal capacity, ii) they require streams with dense riparian vegetation due to their ecophysiological constraints (high body heat exchange with the environment temperature), iii) they have narrow ecological requirements, iv) they have high dependence on habitat structure promoted by vegetation for adult percher behavior and larvae climber and grabber behavior associated with the roots of the riparian vegetation. We conducted this study in sixty-nine streams in which native fragments are embedded in a matrix dominated by grazing pastures and monocultures. We collected adult damselflies with a hand net along a 100-m transect parallel to the stream banks from 2010 to 2012. Samplings were conducted once at each site, for one hour in each stream. The identification of specimens to species or morphotype followed taxonomic keys and original descriptions, and confirmation by experts. We delineated a circular buffer area (250 m radius) around a point located in the centre of each stream channel sampled, and calculated the percent of forest cover. We used the Threshold Indicator Taxa Analysis (TITAN) to test whether the community of damselflies showed nonlinear responses related to forest cover decline. We collected 805 individuals of damselflies, representing 32 species. Ten species are associated with low disturbed sites. From those species, five showed a threshold located between 38% and 43% in the relationship of presence and forest cover, while the remaining five species showed a threshold located above 52%. As terrestrial groups, aquatic organisms show a drastic decline of species richness when forest cover is below 40%. Our results support the existence of a common landscape level threshold in agricultural landscapes. Above this threshold disruptions in ecological processes as linkages between terrestrial and stream habitats, may affect terrestrial and aquatic environments. This reinforces the implications related to an appropriate landscape management, maintaining forest cover within pastures and agriculture landscapes above the threshold and preserving biodiversity in aquatic-and-terrestrial environments. The Cerrado is under a rapid process of conversion to soya, maize and sugar cane plantations and extensive cattle raising. Currently, about of 39% of its total area is converted in non-Cerrado land cover types and a recent study reported that only 40% of this biome, located in the Pantanal plateau, is covered by native vegetation (SOS Pantanal and WWF-Brazil). This emphasize the relevance of our work giving that almost all our sampling sites are located within this region. This is critical for biodiversity conservation because, i) the plateau controls the hydrological dynamics of the Pantanal, the biggest wetland in South America, ii) our study together with many others have shown that 30-40% the native cover is critical for persistence of many taxonomic groups. So, the consequences of overpassing this critical landscape threshold may cause large impacts in the biodiversity and ecological services in South America. This picture claims for the construction of a large scale societal initiative to conserve, protect and restore the Pantanal plateau.



SESSION 9: CONSERVATION

Predicted response of dragonflies to climate change along an elevation gradient

John P. Simaika

Rapid anthropogenic climate change is perhaps the most pervasive, indirect environmental change facing humans and biodiversity alike. For an already water-stressed country like South Africa, changes in temperature and precipitation regimes, coupled with increasing water demands, are likely to lead to great losses in aquatic biodiversity. The impact of climate change on insect taxa in southern Africa has, to date, not been thoroughly investigated, with studies focusing mainly on vegetation and terrestrial mammal and bird species. Their aquatic larval and terrestrial adult life stages, make dragonflies excellent surrogate taxa for freshwater biodiversity. In this study, I created species distribution models of 14 dragonfly species, and predicted the changes in species richness, extent of occurrence and habitat suitability for the years 2050 and 2080 in South Africa, along an elevation gradient from Durban to Sani Pass. Model predictions of two different emissions scenarios I discuss the changes in species richness and composition over the scenarios, and the implications this has on the conservation of the endemic and Afrotropical fauna.



SESSION 10: EVOLUTION

Evolutionary history of *Coenagrion mercuriale* clade: the importance of multilocus genetic approaches to detect cryptic diversity, introgression and selective sweeps

Sónia Ferreira, David J. Thompson, Paulo Célio Alves, José Carlos Brito & Phillip C. Watts

Coenagrionidae is the most speciose damselfly family and thus provides an excellent opportunity to understand the influence of distinct processes of speciation and their outcomes. Despite nearly half of the *Coenagrionidae*, including species of *Coenagrion*, forming a well-supported clade, there is limited information about the evolutionary processes that generated such diversity. For instance, the relative high species' diversity of *Coenagrion* in the Western Palaearctic combined with their varied distribution ranges suggests a role for divergence both in sympatry and allopatry. The extent of reproduction between apparently distinguishable taxa (*i.e.* hybridization) and of the movement of genetic material from one taxa into the gene pool of another (introgression) is poorly understood. Additionally the study of a relatively specious group as the genus *Coenagrion* allows an assessment of the reliability of DNA barcoding (based on mitochondrial loci). The genus *Coenagrion* is widespread with nearly 40 species that inhabit the Palaearctic (from Portugal to Japan) and three species present in the Nearctic. Swaegers and colleagues' recent molecular phylogeny provided insights about the relations between most European *Coenagrion* (and the three North American species), demonstrating that the southern European species are divided in two main groups: (1) *C. scitulum* and *C. caerulescens* (2) *C. mercuriale*, *C. puella*, *C. pulchellum* and *C. ornatum*, with *C. intermedium* and other *puella*-related species probably belonging to the second group. Our study focused on the second group (hereafter designated as the *Coenagrion mercuriale* clade). The oldest split within the clade is between *C. mercuriale* and the three other species. This clade is particularly interesting as species have quite different distributions and extent of range overlap. For example, *Coenagrion mercuriale* and *C. ornatum* are restricted to the south of Europe, but in almost complete allopatry as *C. mercuriale* is present in the west and in North Africa while *C. ornatum* is present in the East; in contrast, *C. puella* and *C. pulchellum* are widely distributed (extending from the Iberian Peninsula into Russia) and often occur in sympatry with each other and other congeners. The question remains how these distinct distributions scenarios promote (or hamper) speciation, affect genetic diversity patterns within species and if they generate cryptic diversity between isolated population? Here, we study the evolutionary history of *Coenagrion mercuriale* clade and clarify the phylogenetic relationships between these four species. We employ a multilocus approach given the numerous concerns regarding the use of mitochondrial markers alone to reconstruct a species' phylogeography, especially in arthropods. We provide a tangible example in odonates about the importance of using DNA multilocus approaches to detect cryptic diversity, introgression and selective sweeps using *Coenagrion mercuriale* clade as a case study. Moreover, the data illustrate why DNA barcoding based on mtDNA might fail.



SESSION 10: EVOLUTION

Fertile hybridization in the odonate and evolution within the order

Thomas W. Donnelly

Ernst Mayr, who gave us the species concept, regarded hybridization as a biologic mistake, and he influenced generations of biologists to disregard hybrids. The Code of Zoologic Nomenclature, which was heavily influenced by Mayr, does not allow hybrids (sterile or fertile) to bear species-group names. Veteran collectors have generally encountered many hybrid odonates in their careers, but few have considered any of them to be fertile. In North America there are three genera which show putative fertile hybridization. The coenagrionid genus *Enallagma* contains two species (*annexum* (previously *cyathigerum*) and *vernale*) which hybridize commonly in central New York and western New England. In central New York at several localities virtually all collected specimens are hybrids, a circumstance impossible to achieve without the hybrids themselves being fertile. The distribution of collected specimens approximates a bell-shaped curve, and collected specimens span the entire range between end members. In Pennsylvania, West Virginia, and eastern New England hybrids are more scarce and always a minority of collected specimens. There is no reason to regard these as fertile. In the cordulid genus *Epithea*, two species (*cynosura* and *costalis*) co-occur over a wide range (Texas to Nebraska, and eastward to New Jersey to Florida). In most of Ohio, and much of adjacent Indiana and southern Michigan, collected species mainly fall somewhere between the two end member species, as in the case of the *Enallagma*. A third species, *petechialis*, co-occurs with both of these from south central US northward to Nebraska and hybridizes with both, but, as in the case of the *Enallagma* pair, there is no reason to conclude that these hybrids are fertile. The third case is perhaps the most interesting. The libellulid genus *Sympetrum* has three species that hybridize. In the case of *internum* and *obtrusum*, the hybrids are invariably a very minor fraction of the specimens present; I conclude that these are sterile hybrids. The species pair *internum* and *rubicundulum* locally hybridizes so thoroughly, that in many places, pure end-member examples are not found, and the collected material spans the entire range between end members. Localities where these hybrids are probably fertile include Cape Cod, Massachusetts, and adjacent coastal New Hampshire; southern New Jersey, roughly adjacent to the Delaware River; central Maryland, between Washington and Baltimore; and northeastern Delaware, near the Delaware River. Elsewhere that the species ranges overlap, they are mainly found as completely distinct species, with a very few hybrids. The most critical observation is that there exist localities where the end-member species are not found, and essentially all collected specimens are hybrids. There is a strong possibility that fertile hybrids might become genetically incompatible with the end members themselves, and continue to exist as a “new” species.

Trade-offs in female signal apparency to males offer alternative anti-harassment strategies for color polymorphic females

Ola M. Fincke

Color polymorphisms are known to influence receiver behavior, but how they affect a



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receiver's ability to detect and recognize individuals is usually unknown. I hypothesized that polymorphic female damselflies represent an evolutionary stable strategy, maintained by trade-offs between the relative apparency of morphs to male receivers. Using field experiments and focal studies on *Enallagma* damselflies, I tested the predictions that 1) green heteromorphs and blue andromorphs gain differential protection from sexual harassment via background crypsis and sexual mimicry respectively, and 2) female morphs behaviorally optimize their signal apparency to mate-searching males. First, based on male reactions elicited by females, against a high contrast dowel the two morphs did not differ in being detected by males and once detected, did not differ in being recognized. In contrast, on green ferns heteromorphs were detected less often than andromorphs but once detected, did not differ from blue females in being recognized. In contrast, when perched with two male signal distractors on a dowel, andromorphs were detected less often and once detected, were recognized less often than heteromorphs. Males were also more likely to detect individuals perched in sun than shade, suggesting that they detect conspecifics visually. Second, in fields where females foraged, andromorphs perched higher on vegetation than heteromorphs, and were more often in the vicinity of males. Neither harassment rate nor evasive behaviors differed between morphs. Solitary females were rare near shore where males aggregated. Equilibrium frequencies of these and other color morphs should reflect the relative ease with which receivers detect and recognize them in the context where they are encountered.

Ontogenetic color change and intersexual communication in the Common Bluetail damselfly (*Ischnura elegans*)

Beatriz Willink, M. C. Duryea & E. I. Svensson

Visual signals advertising sexual maturity are widespread across Odonata. These signals can be advantageous, particularly in species with short-lived adults, as failed mating attempts with immature partners are time consuming for both sexes. However, when multiple matings and pre-mating male harassment take a toll on female fecundity females may benefit from signaling reproductive unsuitability even if sexually mature. In the Common Bluetail (*Ischnura elegans*) three genetic female-limited color morphs co-occur, and this polymorphism is largely maintained by frequency-dependent male mating harassment. While sexually immature all three female morphs and males display a blue patch on the eighth abdominal segment. Throughout development this patch becomes melanized and appears brown in two of the three female types, whereas both males and androchrome females maintain the blue coloration. Thus, we hypothesized that this ontogenetic color change may have evolved as a signal of reproductive suitability and the retention of the blue coloration in mature androchrome females can act as a dishonest signal to avoid excessive harassment. To test this idea we experimentally manipulated the abdominal coloration of all three morphs in both sexually mature and immature stages. We exposed experimental and control (sham or unmanipulated) females to groups of four males in a paired design and recorded male harassment. Females of all morphs and stages experienced more male approaches when the abdominal patch was brown. However, the outcome of



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a male approach, whether or not it resulted in a clasp and attempted mating, depended upon the female morph, stage and abdominal phenotype. Our results are in line with an important role of ontogenetic color changes on intersexual communication in damselflies, but they highlight the complexities of these interactions in female polymorphic species, where discrete color variation is associated with different reproductive strategies.

Is the American Rubyspot damselfly a species complex? Unraveling the evolutionary history of *Hetaerina americana* (Odonata).

Yesenia Margarita Vega-Sánchez, Luis Felipe Mendoza-Cuenca & Antonio González- Rodríguez.

Cryptic species are organisms that include two or more independently evolving lineages that have been classified as a single nominal species because, mainly, they are morphologically similar. In recent years, thanks to molecular data, discovery of cryptic species has been expedited. *Hetaerina americana* is a species that has a wide distribution and can colonize a variety of habitats. It also shows considerable variation in the morphology of the male cerci and, for this reason, several synonyms have been described (e.g. *H. pseudamericana*, *H. texana*, *H. californica*, *H. basalis*). Although *H. americana* has been widely used as a model system in behavioral studies, the genetic diversity exhibited within this species has never been documented. We genetically characterized 220 adult individuals (males and females) of *H. americana* from 31 localities from Guatemala to Canada, using the mitochondrial cytochrome oxidase I gene and six nuclear microsatellites. We also analyzed the morphology of the male cerci of 101 males with geometric morphometric techniques. Mitochondrial DNA sequences revealed the presence of three haplogroups and strong phylogeographic structure. Microsatellite data indicated two highly differentiated main genetic groups. The variation in the morphology of the male cerci showed, at least, two clearly distinguishable morphs that differ in the shape of the median lobe and in the extension of the superior ridge, and this was strongly congruent with the two genetic groups. *Hetaerina americana* has been treated as a single species, mainly because there is considerable variation in the male cerci morphology that overlap along the whole distribution, but when this variation is systematically analyzed with relation to genetic data the results suggest that a cryptic speciation process has occurred in *H. americana*. On the other hand, mitochondrial DNA variation did not show congruence with the morphological and nuclear DNA differentiation pattern that could be explained as a result of incomplete lineage sorting due to the probably recent divergence of the putative species.

Founder effect and signal of adaptation in the most widespread dragonfly, *Pantala flavescens* Fabricius (Odonata: Libellulidae)

Ingrid E. Alvial, David Véliz, Irma Vila & Héctor Vargas

Wide geographical distribution is common in highly mobile insects and can include different



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continents and climate areas. In this context, these species have few opportunities for isolation and local adaptation. One of these species is *Pantala flavescens*, which inhabit all continents with exception of the Antarctica. Previous analysis pointed out the presence of this species in Easter Island and reported unusual morphological characteristics in insular individuals. Easter Island is one of the most isolated islands in the Pacific Ocean. This peculiar ecosystem has shown low richness of invertebrates and lack of insect endemisms, in comparison to others islands from the Pacific Ocean. In order to study the genetic isolation and divergence in their morphological characteristics, we collected and analyzed *P. flavescens* individuals from northern Chile, southern Peru and Eastern Island, and explored the variability in COI markers and twelve morphological measures. Results showed reduced COI haplotype diversity in Easter Island in comparison to Chile and Peru. The haplotype frequency distribution in Easter Island showed evidence of bottleneck: most of individuals of one haplotype and 1 of a second. However, both of them were present in Chile and Peru sites. Further, specimens from Eastern Island showed the shortest wing length and largest femur length when compared with specimens from Peru and Chile. These analyses suggested a founder effect in Eastern Island and some changes in morphological characteristics that would be related with adaptation and a decrease in the ability of flying long distances.

Body Size Evolution in Dragonflies and Damselflies: comparing micro- and macro-evolution

John Waller

I will discuss body size evolution in Odonates on the micro- and macro- scales. Body size touches almost every aspect of an organism's biology. Odonate body size has been of particular interest to biologist due in part to large specimens found in the fossil record. On the micro scale, we found that adult male body size is most likely positively selected in *Calopteryx splendens* and *virgo* over several years. In a mark-recapture study of adult males and females, we find that minimum lifespan is positively associated with adult body size. Similarly for males, observed copulations in the field (sexual selection) are likewise positively related to adult body size. These analyses were performed using standard Lande-Arnold methodology, which can detect linear, disruptive, and stabilizing selection. Nevertheless, with large sample sizes ($N > 2000$), we find no evidence for stabilizing selection in the adult life stage. This agrees with meta-analysis (Sokolovska *et al.* 2000) on adult body size, which show that adult body size selection is predominantly positive in Odonates. This positive selection in adulthood I argue is likely, at least partially, opposed by increased development time in the larval stage. By comparing development times with body size of extant European Odonates, I found a positive relationship between time spent as larva and adult body size (PGLS: Est = 0.028, $p = 0.023$, $N = 87$). Since selection in the larval stage is difficult to measure in the field, I turned to phylogenetic comparative methods and the fossil record to help uncover if positive selection in the adult stage is largely counter-balanced in the larval stage. If body size is positively selected at the micro-scale perhaps it is opposed at the macro-scale through extinction or differences in speciation rate. Finally, I



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will discuss the value of collecting phenotypic data [behavioral, morphological (body sizes ect.), ecological] in addition to genetic and morphology related to taxonomic differences, as this data can be used for interesting comparative studies.

Trithemis stictica (Odonata: Libellulidae) - lost in the desert mountains?

Joachim Falk, Frank Suhling & Kamilla Koch

In spatially fragmented populations, adapting to varying habitat conditions can lead to allopatric speciation. Mainly small populations are affected due to the stronger impact of the genetic drift on the gene pool. Arid environment may represent a barrier, which might lead to reduced exchange between populations of freshwater organisms. In Namibia, a highly fragmented population of *Trithemis stictica* exists in the Naukluft Mountains; the distance to the most proximate populations being more than 900 km. We aimed to investigate the potential of speciation in the Naukluft population. We compared the Naukluft population with a large population in the main range of the species in South Africa by measuring several morphological traits. These included three size measures: abdomen length, head width, and wing length. For the wing shape we worked with 46 landmarks within the fore- and hindwing and for the wing cell structure we compared in the forewings the discoidal field and in the hindwing the anal loop and the triangle. We compared the results of *T. stictica* with those of two widespread species without fragmented populations in the Naukluft species, viz. *T. arteriosa* and *T. kirbyi*. We found that *T. stictica* were significantly smaller in Namibia than in South Africa. The two *T. stictica* populations from Namibia and South Africa also differed over the entire wing shapes. The cell number of the discoidal field, the cell number of the anal loop, and the cell eye number within the anal loop differed significantly between the two *T. stictica* populations. The two spatially isolated populations of *T. stictica* in Namibia and South Africa may perhaps be attributed to a separate gene pool, leading to an independent development of the wing structures of both populations. So far, we see a high potential for speciation in the Naukluft population. In future, comparative genetic studies between the isolated and some large populations should be conducted to determine the level of genetic drift and the relationship between the populations.



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Advances on the larval taxonomy of the genus *Epigomphus* Hagen, 1854 (Anisoptera: Gomphidae)

Rodolfo Novelo Gutiérrez, Alonso Ramírez & Débora L. Delgado Camilo

The New World genus *Epigomphus* occurs from Mexico to northern Argentina. To date, 28 species are known, but only the larvae of six species have been described: *E. paludosus* Hagen in Selys (very brief, inadequate for diagnosis), *E. echeverri* Brooks, *E. subobtusus* Selys, *E. subsimilis* Calvert, *E. hylaeus* Ris, and recently, Novelo-Gutiérrez *et al.* discovered and described the larva of *E. crepidus* Kennedy. Here, we provide details of the morphology of the larva of *Epigomphus jannyae* Belle, a larva similar to *E. hylaeus*, bringing to seven the total larvae known for this genus. As is the case for species level identification of other genera, larvae of different species of *Epigomphus* tend to be highly similar among themselves. We explore new larval characters that might facilitate species-level identification in this genus and perhaps other Gomphidae as well. Two useful characteristics are the shape and length/width ratio of the 3rd antennomere, and the form of the labial palp tip (e.g., rounded and smooth). Overall, *Epigomphus* larval descriptions need to be more detailed to facilitate comparisons among species and the construction of taxonomic keys.

Cordulegastridae – large dragons of small streams

Klaus Guido Leipelt

Information on larval biology, distribution patterns and habitat requirements of Cordulegastridae was revisited, compiled and supplemented by hitherto unpublished data. As burrowers the larvae inhabit fine sediments of more or less lentic microhabitats in running waters; however, e.g. in Europe species of the so-called *bidentata*-group are restricted to springs and spring brooks, whereas species of the *boltonii*-group are also found at lentic margins of broader rivulets. Species of the *bidentata*-group seem to have an inadequate behavioural response to hydraulic stress which could explain their limitation to running water stretches with low discharge, i.e. springs and springbrooks. On catchment basin level, presence/absence data of European *Cordulegaster* species could mainly be explained by water temperature and geological conditions. The current state of research in Europe was compared with the situations in North America and Asia.

Exploring the vision of larval odonates.

Camilla R. Sharkey, Nicholas W. Roberts, Julian C. Partridge & Seth M. Bybee

Odonate vision has been the subject of much interest. This is perhaps not surprising as adult Odonata possess large eyes, are often highly colourful and exhibit impressive aerial agility. Although the aquatic larvae are also highly reliant on vision, particularly amongst the aeshnids, larval odonate vision has been largely unstudied. Odonates experience distinct photic environments at different



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stages of development, as adults and larvae occupy terrestrial and freshwater aquatic environments, respectively. Generally speaking, when compared with the terrestrial environment, light in freshwater habitats has a lower intensity and is shifted towards the longer wave lengths. Thus, odonates provide a valuable opportunity to study the effect of light environment on the evolution of visual systems, within a single species. Although in some species (e.g. zygopterans), a large proportion of the adult eye is formed from retained larval tissue, the anisopteran eye undergoes extensive expansion and remodelling during the final stage of metamorphosis. As anisopterans move between visual environments, there is potential for significant ontogenetic shifts in many aspects of the visual system, such as visual acuity, colour vision and polarization sensitivity. In our study, we aimed to determine whether larval and adult visual systems exhibit adaptations for the different photic environments they experience. We undertook molecular and behavioural studies to explore colour and polarization vision in the Emperor dragonfly (*Anax imperator*). Our results demonstrate that aspects of larval and adult visual systems are distinct and show adaptations for the photic environments in which they have evolved.

Effects of zebra mussel colonization on emergence of the dragonfly, *Micromia illinoiensis*, on a northern lake in the US

Ola M. Fincke

The invasive species of zebra mussel, *Dreissena polymorpha*, has invaded North American lakes within the past two decades. In northern lakes, it has begun colonizing large dragonfly larvae. Previous work on two common species of dragonfly larvae indicated that when colonized by zebra mussels, final instars of *Macromia illinoiensis* and *Hagenius brevistylus* have a lower probability of leaving the water to emerge. Here I present data from a field study at Douglas Lake, Michigan on the effects of attached zebra mussels on dragonfly larvae that successfully exit the water. *Micromia illinoiensis* without zebra mussels typically crawl out of Douglas Lake and as far as 65 m into the adjacent forest before climbing as high as 15 m up the trunks of large trees before emerging in the early morning hours. From repeated censuses of forest plots, I found that dragonfly larva carrying one or more zebra mussels traveled a shorter distance from the water's edge, and emerged lower down on trees than larvae without any zebra mussels. Once emerged, dragonflies with attached zebra mussels had greater risk of an unsuccessful emergence. This work is part of a long-term study that indicates that colonization rates have decreased over the past eight years.

Unflexible versus flexible: a comparison of the pre and post eyespot development in Libellulidae (Odonata)

Lisa Hesse, Joachim Falk & Kamilla Koch

Temperature and photoperiod are two important environmental parameters for organisms.



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This study tests the hypothesis that temperature and photoperiod have different influences on pre and post eyespot development in Libellulids. Eggs from eight species (*Crocothemis erythraea*, *Libellula quadrimaculata*, *Orthetrum cancellatum*, *O. coerulescens*, *Sympetrum striolatum*, *Trithemis arteriosa*, *T. kirbyi*, *T. stictica*) from different regions (Africa / Europe), of five different genera, and two different habitat preferences (lentic / lotic) were used. The eggs were reared under different constant and fluctuating temperature and light conditions. There was no general species-specific duration, degree-days or light-days for the pre or the post eyespot development. In all study species, the variance within and between the treatments of the duration in days, the degree-days, and the light-days of the pre eyespot development was lower than of the post eyespot development. The pre eyespot development appeared to be more independent of external influences. In contrast, the post eyespot development seemed to be more dependent on external influences. This can be seen as a strong hint that there is a general pattern in Libellulidae. This pattern might help them to cope successfully with variation in seasons, habitats and climate. Since eyespot development and katatrepsis occur shortly after each other, the above-described pattern might also appear in other odonates and insects, which have a katatrepsis. To all of them, it is essential to match the time of emergence with adequate external temperature conditions for survival.

Estivation of larvae - a rare phenomenon in bionomy of the *Cordulegaster* species?

Otakar Holuša & Kateřina Holušová

Estivation dragonfly larvae were found only sporadically in some species, this is an unusual strategy for larval dragonflies. Larvae of *Cordulegaster* species inhabit habitats with running waters - flowing streams, creeks or springs. The drying of habitat is considered to be one of the major factors that exclude or limit occurrence of these species. So far, the only known case of estivation in a *Cordulegaster* species involved *Cordulegaster boltoni* from the Mediterranean region, where larvae survived for 4 weeks drying habitat during the summer. In the Mediterranean area, the genus *Cordulegaster* includes the species (subspecies) - *C. trinacria* in Italy in the southern part of the peninsula and Sicily, *C. bidentata sicilica* in Calabria and Sicily, *C. helladica* in southern Greece and *C. princeps* in Morocco. In this area, the fluctuation of small streams flow and drying out are a completely regular phenomena. In a completely dry watercourse in VIII. 2014 in the Madonie Mountains at Sicily in Italy was found viable larva *Cordulegaster bidentata sicilica* and several exuviae *Cordulegaster trinacria*. Due to the length of larval development of these species, which lasts longer than one year, it is possible that a significant part of the population of both species will be exposed to the drying effect of streams much more frequently than previously expected.



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High proportion of broken and deformed procts and lateral spines in larval *Boyeria irene* (Odonata: Aeshnidae)

Andreas Martens & Hansruedi Wildermuth

Larvae of different stages sampled at several headwaters of the Gardon River in Southern France frequently showed malformed and injured elements of their anal pyramid. The majority of damage was to the chitinous strengthened spiny elements epiproct and paraprocts, which were broken at the tip or imperfectly regenerated. To quantify that phenomenon on a standardized level exuviae of *Boyeria irene* were sampled. Besides running water habitats with fish as the Gardon headwaters in France, exuviae were also collected at a lake habitat of the sp., the Lake Lucerne, Switzerland. The malformed and injured spiny appendages were interpreted as marks of the successful defense against predaceous fish. Disturbed anisopteran larvae spread the elements of their anal pyramid in different steric directions. We hypothesised that this behaviour is efficient to reduce the risk of being swallowed by fish. Most injuries may be generated by the strong stresses on these elements in the fish's mouth.



Morphological similarity affects the ecological segregation patterns of Odonata (Insecta) in Eastern Amazonia

José Max Barbosa De Oliveira Junior, Paulo De Marco Junior & Leandro Juen

Interspecific interactions and/or changes deriving from human activities can be determining factors in the structure of natural communities and species distribution. The aim of this study was to test the co-occurrence patterns of adult Odonata in order to assess whether there is morphological similarity limitation among species that allows for their coexistence. We sampled 98 streams in the Amazonia region, Pará, Brazil. Ten male individuals of each species were selected, and nine morphometric variables were measured. 3,588 Odonata specimens were collected, distributed in 11 families, 49 genera, and 134 species. Regarding species co-occurrence patterns in environments, there is a non-random co-occurrence pattern of Odonata species both in preserved ($C = 12.44$; $p = 0.000$; $C_k = 2524.00$; $p = 0.000$) and in altered streams ($C = 12.53$; $p = 0.000$; $C_k = 4499.00$; $p = 0.000$). The same results were observed for Zygoptera (preserved: $C = 16.51$; $p = 0.000$; $C_k = 1009.00$; $p = 0.000$; altered: $C = 13.95$; $p = 0.000$; $C_k = 991.00$; $p = 0.000$). For Anisoptera, the species co-occurrence pattern is random in both preserved ($C = 4.87$, $p = 0.068$; $C_k = 308.00$; $p = 0.046$) and altered streams ($C = 8.33$, $p = 0.849$; $C_k = 1130.00$, $p = 0.063$). In preserved streams, there is an intense interspecific competition of Odonata based on morphology ($p = 0.006$). This pattern was not observed in altered streams ($p = 0.929$). Both Zygoptera species from preserved ($p = 0.929$) and altered streams ($p = 0.073$) and Anisoptera species from preserved streams ($p = 0.546$) did not show overlap in different morphological values separated in random communities. For Anisoptera from altered streams, we believe that there is an intense interspecific competition based on the morphology of species ($p = 0.008$). Anisoptera species with larger body size and greater dispersion potential have random co-occurrence patterns, and Zygoptera species with smaller body size, high specificity, and low dispersion capacity generally show non-random patterns. Chessboard model distribution patterns are typically interpreted as evidence of competition. The competition in Odonata becomes more intense between closely related species and is likely to lead these species to habitat segregation. The morphological overlap in Odonata can also be an indication of flexibility in the diet mode and in changing environments.

How much do we know about odonates? A scientometric study of the order Odonata

Thiago Barros Miguel, Marcos Vinicius Carneiro Vital & Leandro Juen

Insects of the order Odonata have an aquatic larval stage and land-dwelling adults. These insects play an important role in aquatic ecosystems and are excellent bioindicators. Our study was based on a scientometric analysis of the research available on Odonata, which aimed to identify major trends and gaps in the database of these organisms, compiled from online databases: Institute for Scientific Information (ISI) and Scielo, and journals: Odonatologica and International Journal of Odonatology. A total of 2,317 papers were analyzed, allowing for the identification of the following



trends: a gradual increase in the number of papers over time, most of which had an ecological perspective and focused primarily on adult stage and species level; 49 studies focused on bioindication, used to answer issues such as variation in community composition, floating asymmetry, bioaccumulation, species richness and abundance, and Odonate Habitat Indices (OHI). This increase in ecological studies of odonates may reflect the dynamic characteristics of this order, and its relatively well-defined systematics, mainly for adults. Despite the increased number of publications, there are still many shortcomings, such as biogeography, parasitism, competition within and among species, evolutionary and phylogenetic relationships, as well as studies on larval stages. Considering how sensitive the members of this order are to environmental variables, they might be used in assessments of aquatic systems, given their roles as detectors, exploiters, or accumulators, depending on the type of response to environmental changes.

Ecological thresholds on the distribution of Odonata (Insecta) species in logging areas in eastern Amazonia

Lenize Batista Calvão & Leandro Juen

The logging in the Amazon forest is one factor which contributes to the degradation of natural areas, affecting terrestrial and aquatic systems. The distribution of species is dependent on specific environmental conditions within their tolerance limits, which are often modified by human activities. Our aim was to quantify the Odonata change points after logging, whose species may disappear or increase its abundance along the environmental gradient in streams distributed in logging areas in the Amazon region. This study was conducted in 49 streams in the Amazon region: 11 in reference areas, 26 in areas with reduced impact logging (RIL) and 11 in conventional logging areas. In each stream we measured dissolved oxygen in water, impact of human proximity (including roads, logging and building bridges) in relation to the water body (<10m) and canopy cover. The effect of these metrics on the Odonata community was evaluated by Threshold Indicator Taxa Analysis (TITAN) binary partitioning. Indicator species of undisturbed and disturbed sites showed values of IndVal: $\leq 0,05$; purity ≥ 0.95 and: confidence ≥ 0.95 ($p = 0.05$). The composition of Odonata species was dependent on the measured environmental variables, where the removal of timber affected their distribution. The species *Epipleoneura metallica*, *Argia thespis*, *Oligoclada walkeri* and *Fylgia amazonica* occurred in sites where oxygen concentration in the water was less than 5.5 mg/L and the impact of proximity to the larger body of water was higher than 65%. The species *Mnesarete aenea* and *Chalcopteryx rutilans* occurred in intact or RIL areas, whose concentration of dissolved oxygen in water was greater than 5.6 mg/L. *Chalcopteryx rutilans* occurred in intact areas with less than 51% impact of proximity and sites with values of canopy cover above 43%. Identifying Odonata change points and gradient of environmental conditions that determine the distribution of these species in aquatic ecosystems in logging areas, provides us methods to quantify and improve the effectiveness of conservation policies implemented in forest management. Therefore, making it possible to establish the minimum conditions



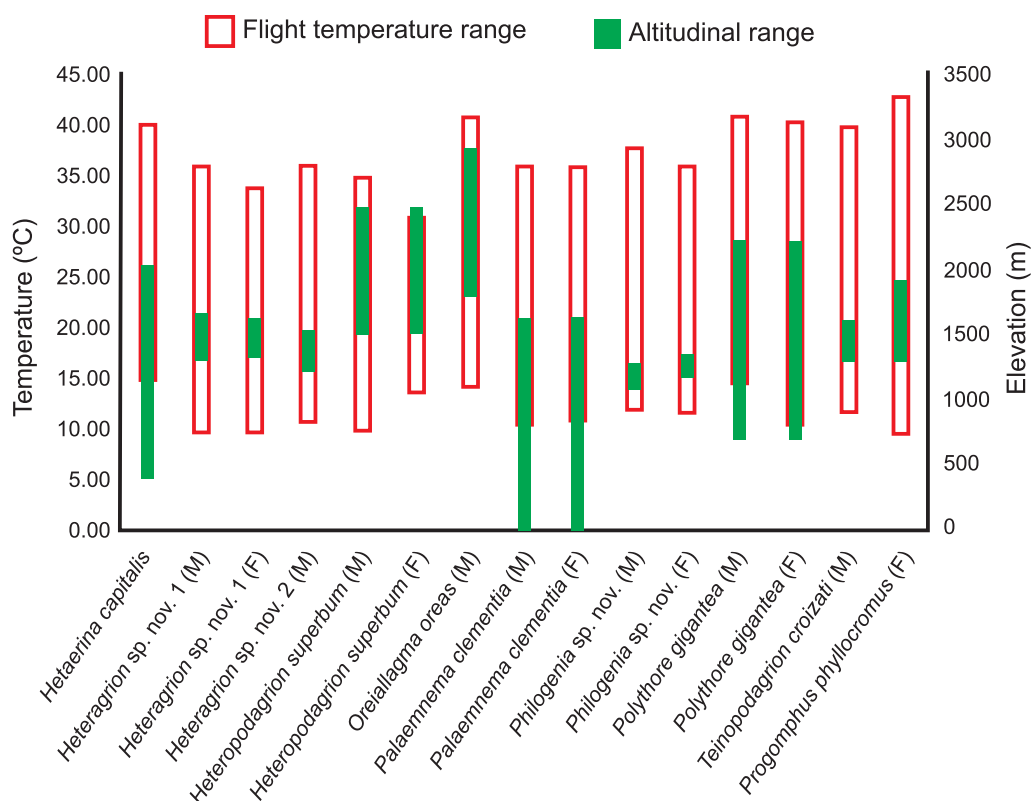
for each species occur in the environment as well as creating recovery strategies in degraded systems, aiming the restoration of aquatic biodiversity.

Dragonflies of the Tatamá National Park (Colombia): a case study of altitudinal distribution patterns using critical flight temperatures.

Cornelio A. Bota-Sierra & Gustavo Londoño

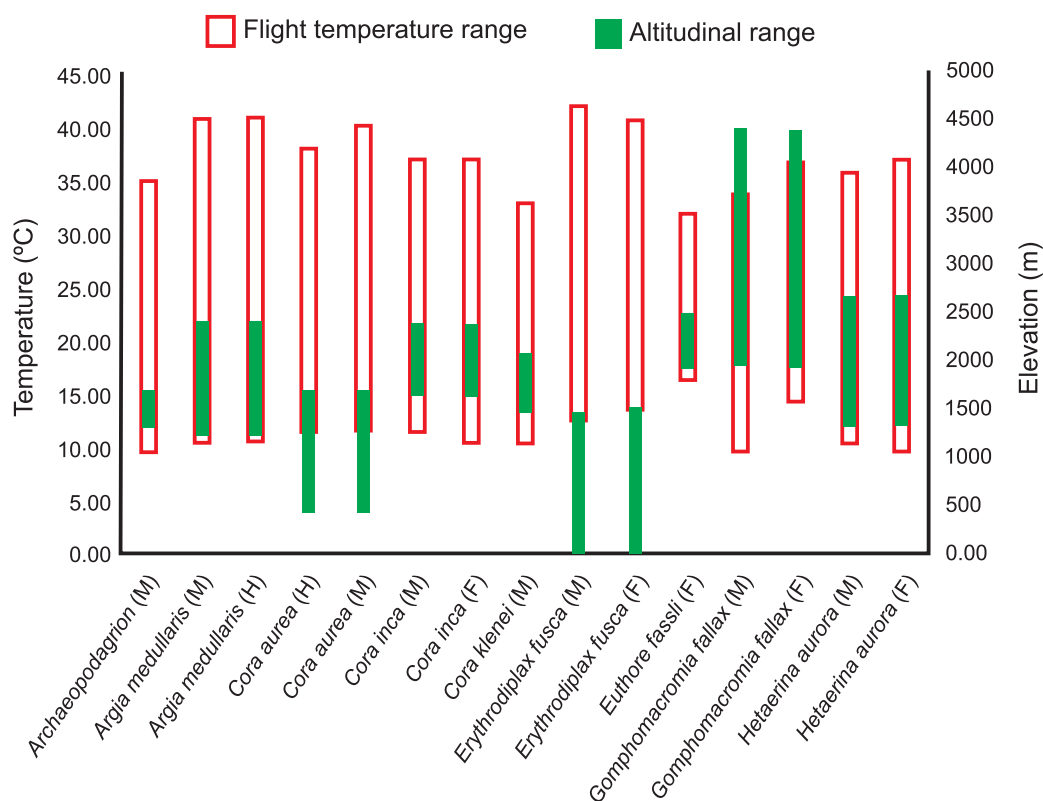
Tatamá National Park is located in the Cordillera Occidental, between the Cauca and San Juan river basins. It covers an altitudinal gradient from 800 to 4200 m, and its mean precipitation is close to 4000 cubic centimeters, making it one of the wettest places on earth. Since 2013 several field trips have been made in order to explore the dragonfly fauna of the site. To date, 43 species have been recorded, which includes three rare Colombian endemics, two new records for the country, and four undescribed species. Species recorded represent the families Calopterygidae, Coenagrionidae, Heteragrionidae, Megapodagrionidae, Philogeniidae, Platystictidae, Polythoridae, Aeshnidae, Gomphidae, Gomphomacromiidae, Libellulidae and one species in an *Incerta sedis* group. Since March until June 2015 we collected data on critical flight temperature experiments, using a PELT5 temperature controller and a refrigerator, for 136 captured specimens in 19 species, in order to test if the range of flight temperatures are related with the altitudinal distribution of the Odonata species. Although our findings are still preliminary, they have mainly shown differences between forest dwellers and open areas inhabitants (Figure 1), also some slight differences between sexes in the same

Figure 1. Flight temperature ranges and altitudinal ranges for different species



species have been observed (Figs. 1 and 2) and higher variation in maximum flight temperatures than in minimum flight temperatures, which in a scenario of global warming could give us some clues about how these species are going to react.

Figure 2. Flight temperature ranges and altitudinal ranges for different species



The effect of environmental variable in Odonata communities distribution in the Oriental Amazonia, Brazil

Driane Cardoso Ferreira, José Max Barbosa De Oliveira Junior, Lenize Batista Calvão & Leandro Juen.

The variation of environmental conditions acts as a filter in species distribution, since most of these need to specify conditions that may occur in the environment, allowing their growth and reproduction. Changes in the environmental conditions can lead to local extinctions, particularly anthropogenic impacts such as agriculture and grazing, due to drastic resulting changes. In this context, the goal of this study was to identify which environmental variables have effects on the structure of adults Odonata in streams entered into a land use gradient for agriculture and cattle ranching in the Amazonia. Testing the hypothesis that species of suborders Zygoptera and Anisoptera, by virtue of their differences in morphology, environmental specificity and thermoregulation, the filter exerted by environmental conditions, would be different, where Zygoptera would distribution associated with more pristine conditions and Anisoptera to impacted areas. The study was conducted in 50 streams at the region of Paragominas, Pará state, northern Brazil. The streams were classified as degraded, altered and preserved in accordance with Integrity Index. To test the effects of environmental

variables, average total shelter, water movement rapid, channel width, human impact, substrate, average of canopy cover and air temperature, canonical correspondence analysis was performed (CCA). Canopy cover showed associated species with higher average. The removal of riparian vegetation and the increase in human activities, influence the loss of microhabitats for species because it leads to a higher incidence of sunlight, which favors many lentic dwellers and widespread species of Anisoptera, however compromise the survival of species sensitive to the change process in the environmental conditions such as some species of Zygoptera. This scenario becomes severe for species associated with pristine condition and at putative risk of local extinction as *Protoneura tenuis*. Keep intact riparian vegetation or retrieve it after suffers impact are the first key steps for conservation or reestablishment of Zygoptera fauna in Amazonian riverine aquatic environments.

The larval ontogeny of *Coryphaeschna perrensi* (McLachlan, 1887): corroborating hypotheses of monophyletic groups in Aeshnidae

Alcimar do Lago Carvalho

The present study aims to record gradual morphological modifications occurring along the larval development of the South American dragonfly *Coryphaeschna perrensi* from the comparison of successive exuviae of reared specimens, between the second stadium and the ultimate (16th). Accentuated changes occur mainly in the labium and anal appendages, allowing for the definition of characters with ordered states by identity (empirical detection). Some of such transformation series, in which both terminal, less general, and nonterminal(s), more general(s), states could be corresponded by primary homology with those conditions exhibited by mature larvae of different species of dragonflies, were properly selected. Some examples: clypeus, orientation (directed downward to obliquely forward); antennal flagellum, number of articles (3 to 5); left mandible, number of teeth "m" on molar crest (6 or more to just 1); pair of spines marginal to median cleft of prementum, size and form (short, tubercle like, to long, spear-shaped); lamina of labial palp, structure (without to with a strong end hook); movable hook, longitudinal armature of setae on dorsal surface (absent to present); ventral encounter of metathoracic pleurae, pattern (touching at one point to forming a long discriminial line); cercus, length in relation to epiproct (smaller to similar); epiproct apex, structure (blunt to excavated to truncated). A hierarchical organization of 16 such a priori ordered, polarized and linear characters within a sample of 30 larvae of assorted Aeshnidae and Austropetaliidae resulted in a network comprising different levels of inclusion of *C. perrensi*, corresponding to the taxonomically recognized levels Aeshnidae, Aeshninae, Aeshnini, *Castoraeschna* + *Coryphaeschna* + *Remartinia*, *Coryphaeschna* + *Remartinia*, *Coryphaeschna* and *Coryphaeschna* except *C. adnexa*. Most of cited groups have already been hypothesized earlier as monophyletic on analyses considering adult morphology. The utilization of ontogenetic sequences of several species combined into a same matrix data in parsimony analyses potentially will contribute to the definition of monophyletic groups and the establishment of hierarchical patterns in Odonata.



Odonate fauna from Andean Tropical Dry Forest (Paicol, Huila, Colombia), preliminary assessment

José Alejandro Cuellar Cardozo & María Isabel Castro Rebolledo

The Colombian Macizo is a region where various natural biomes form highly diverse biological enclaves and life zones that cover 8% of the Colombian landmass, including the high-altitude inter-Andean Magdalena River Valley. Among these diverse enclaves are tropical dry forests. These play an important role in the conservation and dispersion of odonate diversity and related ecosystem quality. In spite of this, the study of odonates in these forests has been very limited. To contribute to the knowledge of dragonflies in this region, we sought to characterize the taxonomic groups of odonates present in the Colombian municipality of Paicol in the province of Huila. Adult and nymph specimens were collected with entomological nets and macrophyte nets, respectively. 43% of the odonate families found had previously been reported in Colombia. The other 57% were species and genera not previously reported in Colombia, namely: *Allopetalia* sp. nov. (Aeshnidae), *Libellula* sp. nov. and *Macrodiplax* sp. nov. (Libellulidae). In addition to this, the following species and genera were observed in the region of Huila for the first time: *Hetaerina*, *Mnesarete* (Calopterygidae), *Acanthagrion*, *Argia* (Coenagrionidae), *Neocordulia batesi* (Corduliidae), *Archilestes* (Lestidae), *Erythrodiplax*, *Macrothemis*, *Pantala* and *Perithemis* (Libellulidae). Finally, the study found one genus which had already been found in Huila: *Erythemis*.

Odonata composition and richness in three artificial, suburban wetlands in Cajicá, Cundinamarca-Colombia

José Alejandro Cuellar Cardozo, Erika Arteaga Guzmán, Laura Bernal Arriero, Aura Campo Garnica, Diana Capera, Caroline Ocampo, Mónica Ortiz Ruiz, Sebastián Rincón Aceldas & Francisco Sánchez

The landscape of the Sabana de Bogotá in and around Bogotá, Colombia has been significantly altered from its natural state by human activity. Moreover, artificial wetlands have been created for various purposes. Because little is known about the biodiversity of these wetlands, we compared the composition and richness of Odonata in three artificial wetlands on the campus of the Nueva Granada Military University in Cajicá, in the province of Cundinamarca, Colombia. The first of these wetlands was near the Bogota River. The second was a newly created temporal wetland surrounded by pastures. The third, whose bottom had been covered with a geomembrane, was surrounded by buildings. In all three wetlands, Odonata were caught using entomological nets during March and April, 2015. A total of 817 individual specimens were captured, all of which belonged to one of the following six species: *Rhionaeschna marchali* (Aeshnidae), *Enallagma civile* (Coenagrionidae), *Ischnura cruzi* (Coenagrionidae), *Ischnura* sp. (Coenagrionidae), *Mesamphiagrion laterale* (Coenagrionidae) and *Erythrodiplax fusca* (Libellulidae). The riverine and the temporal wetlands shared four species and were more similar to each other than to the geomembrane-covered



wetland. Wetland and species frequency were associated. For example, one species occurred exclusively in the riverine wetland (*R. marchali*), while another (*Ischnura* sp.) was found only in the temporal wetland. There were no differences in the estimated total species richness of the temporal and riverine wetlands. However, both had a higher species richness than the geomembrane-covered wetland. These results suggest that wetland characteristics affect Odonata composition, frequency, and species richness. They also suggest that increasing the abundance and diversity of macrophytes may help to maintain Odonata diversity.

The logging effect on the abundance and biomass of Odonata (Insecta) assemblages in Amazonian streams

Joás Da Silva Brito, Lenize Batista Calvão, Thamires Do Carmo Silva Oliveira, Darcilene Mafra Da Costa & Leandro Juen.

Conventional logging is one of the activities with greatest impact on the various ecosystems in Amazon forests. This activity profoundly changes aquatic systems, due to the dependence of the species to specific environmental conditions; as result, these species may even be extinct of environment. Comparative abundance/biomass curves (ABC curves) are based on r and k strategists, and provide that in preserved environments will be dominated by larger species with slower growth, and then, the biomass curve would extend above the abundance. However, in modified environments, preferably smaller and rapid growing species would dominate. This way, in the degraded environments the abundance curve would extend above the biomass curve. The aim of this study was evaluate the effects of conventional logging on abundance and biomass of species of the order Odonata, testing the hypothesis that in degraded environments, the abundance curve extend above the biomass curve, and in preserved areas the other way around. We collected samples from 46 streams: 11 in conventional extraction sites and 35 in reference areas in the municipality of Paragominas, PA. At least five sampled specimens from each species were selected and an analytical balance was used with 0.005 g accuracy to measure the specimens dry weight (g). The hypothesis that the biomass curve would be higher than the abundance curve in intact areas was confirmed ($W = 0.024$), however there was a decrease in the biomass curve relating to the abundance of species. Contrary to expectations, the biomass curve of Odonata species in degraded areas was greater higher than the abundance curve ($W = 0.155$). In modified areas (conventional logging), there was an overlap at the end of curves. It is possible that in intact areas, most forest species are k strategists, species with longer lifetime and higher biomass than species of fragmented areas, as predicted by the theory. In degraded areas, the fact that the biomass curve is above the abundance curve may be due to a higher number of species of the Anisoptera suborder, which generally, are bigger and tend to avoid shaded areas. The biotic predictor proved to be an effective method to detect the effects of conventional logging on patterns of abundance and biomass of Odonata species in fragmented environments.



Larval Odonata of Mesoamerica and the Caribbean: state of knowledge

Débora L. Delgado Camilo & Alonso Ramírez

Taxonomic studies on larval Odonata are limited. Most groups are known from a few descriptions. This limits our ability to advance our knowledge on the order, as many ecological and biomonitoring studies rely on the identification of larval stages. We summarize the state of knowledge of larval Odonata in Mesoamerica and the Caribbean. This is a key initial step in our overarching long-term goal of developing tools to identify larval instars and help advance our understanding of Odonata in the region. Mesoamerica extends from southern Mexico to Panama, forming a biological and cultural region. The Caribbean is defined as the Greater and Lesser Antilles and we did not include the Caribbean coast of South America. We conducted a literature review to determine the number of Odonata species described as larvae. The study region has 557 species distributed in 100 genera from 20 families. Of those species, our literature review indicates that 310 species (56%) have their larval stage described. Most families have at least one species per genera described, except Polythoridae and Coenagrionidae in Zygoptera and Aeshnidae and Libellulidae in Anisoptera. The suborder Zygoptera has 50% of its species described and most families only have half of their species described as larvae, ranging from 17% for Platystictidae to 86% for Calopterygidae and 100% for Synlestidae. The suborder Anisoptera presents a similar situation, 60% of the species are described. However, most families have over half of their species described, except for Synthemistidae. Known species per family ranged from 33% for Synthemistidae to 100% for Macromiidae and Corduliidae. The most speciose families of both suborders, Libellulidae and Coenagrionidae, have just around 60% of their species described. Tools to identify larvae are also scarce in the region. There are genera-level keys only for Mexico and Costa Rica and both need to be updated following recent changes in taxonomical organization and recent larval descriptions. Overall, our knowledge of larval Odonata in Mesoamerica and the Caribbean is still limited and in need of attention. In future projects, we will develop keys to identify known genera and help improve our ability to work with this group.

Lower sampling effort to determine the richness and composition of the assemblage of Odonata

Silvia L. Dutra & Paulo De Marco Jr.

We studied the effect of sampling effort on the loss of biological information (observed richness RO, estimated richness RE, and species composition). The data of one sampling day were compared with two, three, four and five accumulated days. The detectability of species were also examined. We visually inspected streams in preserved environments, riparian forest (n=5) and natural camp (n=3) in the Cerrado biome in the County of Alto Paraíso de Goiás, Goiás, Brazil. Natural camp streams had twice the RO and RE of forested streams. This pattern occurred regardless of the sample effort. There was no difference between ROs and REs of one and two day's sampling effort and this was less than three sampling days. However, only camp RE at one day of sampling effort was less than



four days. ROs in forest habitat were 55% in one, 75% in two, 85% in three, and 95% in four days. RO in camp presented an even higher rates at 68% in one, 84% in two, 98% in three, and 95% in four days. The composition of the forest community differed most dramatically with increasing sample size as early as the second day of sampling. By contrast, the composition of the camp communities differed only after 4 days of sampling. This pattern may be due to the lower detectability of species ($\leq 0,5$). About 50% of forest species presented lower detectability by contrast this occurs with only 29% of camp species. We conclude that required sampling effort may be the same for both forest and camp. If the goal of monitoring is to be more representative of communities, then a single day of sampling is sufficient. However, if the monitoring purpose is to detect less abundant or detectable species, then three days of sampling would be more appropriate.

Four in one: cryptic species in the genus *Megaloprepus* (Odonata: Zygoptera)

Wiebke Feindt & Heike Hadrys

Cryptic species still represent a great challenge for taxonomists. Unraveling and describing a significant percentage of this unknown biodiversity has enormous implications for conservation planning. In modern analysis of lineage divergence, critical criteria for species delimitation are investigated mutually, and concordant results in several characters finally allow species determination. Success highly correlates with the inclusion of complete species distributional ranges. However, *Megaloprepus* is a damselfly genus where diversification has been assumed for a long time but never proved yet. In a comprehensive study, population genetic analysis of nine populations from southern Mexico to Colombia were combined with a morphological data set based on field collections and museum material. The analysis of three mitochondrial and one nuclear sequence marker resulted in high population structuring and a strict separation into three distinct groups (min. 10.3 % in CO1). The additional morphological assay included linear and geometric morphometrics of 67 individuals. Very interestingly this analysis was significantly separating the genus into four species groups, which differ in wing shape, coloration, and size. Three of those four groups are in concordance with the genetically investigated Central American and Colombian forms. The fourth group only includes 100 years old individuals from the east side of the Andes belonging to the American Museum of Natural History. Consequently, these results strongly support a radiation of the genus *Megaloprepus* into four distinct lineages that are distributed across four geographically restricted and independent areas. As a consequence, we postulate the first cryptic damselfly species to our knowledge; whereat further support exists in 'old' species descriptions of Selys (1860, 1886) and Ris (1916). All over tropical America from Mexico to Peru *Megaloprepus* inhabits a narrow ecological niche. This strong adaptation could have favored a non-adaptive mode of speciation and therefore slow down morphological divergence. The diversification of the damselfly genus *Megaloprepus* may additionally provide insights into the highly complex pattern of biodiversity in Neotropical primary forests in general.



New EPIC nuclear DNA sequence markers to improve the resolution of phylogeographic studies of coenagrionids and other odonates

Sónia Ferreira, M. Olalla Lorenzo Carballa, Yusdiel Torres-Cambas, Adolfo Cordero Rivera, David J. Thompson & Phillip C. Watts

While phylogeographic data provide valuable information to inform conservation plans, there are comparatively few Odonata phylogeographic studies. This lack of research is partially due to a lack of independent DNA markers with appropriate levels of polymorphism that PCR-amplify in a range of species. We followed an exon-primed, intron-crossing (EPIC) PCR strategy to develop five new, polymorphic nuclear DNA sequence loci (six distinct DNA fragments) for the southern damselfly *Coenagrion mercuriale*. These markers were: cell division cycle 5 protein (CDC5), arginine methyltransferase (PRMT), acetylglucosaminyl-transferase (AgT), myosin light chain (MLC) and phosphoglucose isomerase (PGI). Between three and five of these new markers could be PCR-amplified in five other species from the genus *Coenagrion*; one locus (PRMT) can be used in 26 other species of odonates that we examined, including three species of Anisoptera belonging to the genus *Onychogomphus*. These new nuclear genetic markers will be useful for phylogeographic studies in a range of odonate species, but also for phylogenetic studies, providing a particularly useful complement to the existing mitochondrial and nuclear loci.

Note: the content of this poster presentation has been previously published and the poster aims to promote discussion on the results and their application in other taxa. FERREIRA S, LORENZO-CARBALLA MO, TORRES-CAMBAS Y, CORDERO-RIVERA A, THOMPSON DJ, WATTS PC (2014) New EPIC nuclear DNA sequence markers to improve the resolution of phylogeographic studies of coenagrionids and other odonates. *International Journal of Odonatology*. 17: 2-3, 135-147 doi: 10.1080/13887890.2014.950698

Larval Odonata diversity in a tropical lagoon with different land uses along the shoreline

J. A. Gómez-Anaya, Rodolfo Novelo-Gutiérrez, B. Brug-Aguilar & G. Vázquez-Hurtado

Patterns of Odonata diversity are closely related to watershed, land cover and management practices. However, how these practices affect the spatial distribution pattern of Odonata larvae along managed riparian zones in tropical lentic water bodies remains unknown. In this study, we assessed spatial and temporal changes in odonate larval diversity patterns among eight sites located on the shoreline of the Miradores Lagoon (LM), Veracruz, Mexico. All sites were categorized in five land uses: urban (most impacted), culture, recreational, paddock, and forest (least perturbed). Larval sampling was conducted in May (dry season), August and November (warm rainy season) 2008 and February 2009 (cold rainy season) using a D-net. Further, physical and chemical parameters such as temperature, dissolved oxygen, pH, conductivity (*in situ*), and turbidity, alkalinity, ammonium, nitrite,



nitrate (in laboratory), were evaluated. Renyi diversity profiles were used to evaluate and compare diversity in each site, and functional diversity (FD) was calculated as the proportion of plant-dependent species/non-plant dependent species (P/NP) for each site, using the Shannon diversity index. Water physical and chemical parameters did not differ among sites. A total of 929 larvae belonging to 28 species (13 Zygoptera and 15 Anisoptera) were collected in LM. Renyi diversity profiles showed the culture site as the most diverse and the urban site as the poorest diverse reflecting the degree of impact on each site. On the other hand, FD indicated that recreational use sites had similar proportions of plant-dependent/non plant dependent species. In contrast, urban site had the highest proportions of plant dependent species. Our findings indicate that changes in richness, abundance, composition, and FD are potentially related to physical changes in microhabitats among sites.

Odonata from Austral Yungas pedemontane forest: diversity patterns in a natural-productive ecotone

Daniela Gómez, José S. Rodríguez & Carlos Molineri

Pedemontane forest in the Yungas from NW Argentina is severely affected by human activities. Only small relict areas of natural vegetation remain, since most was converted to crops (sugar cane and citrus). Riparian forests (RF) may be continuous with the main forest (in protected areas), or impoverished in diversity/structure to totally absent in the productive areas. We studied adult Odonate diversity in these two situations in six localities (three with well preserved RF, and three with damaged RF) from Jujuy and Salta provinces. We made at least three transects per site/date of 30 minutes each, counting every individual visible at sight or using binoculars in a 20 m wide strip. Individuals were identified to species using a regional key, some of them were captured to confirm identification under magnification. The six sites were sampled four times, in dry and wet seasons 2013 and 2014 (N=77 transects). RF conservation status was studied from ten vegetation transects per site (forest structure) and satellite images of the area (continuity and width of the RF). We recorded 45 species (1,112 individuals): 30 Anisoptera spp. (487 ind.) and 15 Zygoptera spp. (625 ind.). Accumulation curves (CHAO2) indicated a good sampling effort, with the following observed percentage of diversity: Zygoptera in damaged RF= 81%, well preserved RF= 89%; Anisoptera in damaged RF= 66%, well preserved RF= 79%. In the three sites representing damaged RF we found 13 Zygopteran spp. (395 ind.) and 27 Anisopteran spp. (266 ind.); in well preserved RF 7 species of Zygoptera (230 ind.) and 19 Anisopteran spp. (227 ind.) were present. Only one species (*Hetaerina rosea*, Calopterygidae) showed a higher abundance in well preserved forest (T test, $p = 0.04$). We attribute the higher richness and abundance in the damaged sites to the presence of human-made pools at the margin of the rivers, that increased habitat heterogeneity.



Natural history of *Telebasis vulnerata* (Hagen, 1861) (Zygoptera: Coenagrionidae) in Puerto Rico

Pablo E. Gutiérrez-Fonseca, Josian Sánchez Ruiz & Alonso Ramírez

Telebasis vulnerata (Coenagrionidae) is a damselfly endemic to Puerto Rico and the Dominican Republic. In Puerto Rico, this species can be found in most lotic habitats, elevations (0-1300m) and land uses (forest, agriculture and urbanizations). We lack information on various aspects of population structure (e.g. sex ratio), behavior (e.g. territoriality, reproduction) and ecology (e.g. microhabitat use) for this species. The objective of our study was to obtain knowledge on the biology of *T. vulnerata*. Our study was conducted from June to July 2015 in Buruquena stream at El Verde Field Station, Puerto Rico (18°19' N, 65°45'W). Buruquena is a headwater stream with 0.50m in width and 0.30m in depth. We used a reach of 155m with a vegetation gradient (50m open area, 55m shrub area and 50m forested area). The reach was divided into sections of 5m to locate individuals and to characterize the substrate. Mark-recapture was used to study demographic parameters. Dispersal ability was studied by determining the position and movement three times per day (9:00, 12:00 and 15:00). Total body size and sex ratio were recorded. Behavioral observations consisted of observing individual damselflies at different periods of day. The information was classified into different categories related to reproduction, perch and territorial disputes. A total of 280 individuals (215 males, 65 females) were marked, which 169 males and 39 females were recaptured on subsequent days. We observed higher male density, with a relation 3.3♂:1♀. Males (36.4 ± 0.1 mm) were larger than females (35.9 ± 0.2 mm), but the difference was not significant ($p > 0.05$). Higher density of individuals was observed in open area sections. Most (75% of the observations) adults preferred to perch on vegetation. Peak activity was at 12:00, followed by 9:00 and finally less activity was observed at 15:00. Main male activities consisted of territorial disputes, follow by reproduction. Females oviposit in tandem with the males; the eggs were endophytically placed mainly in green submerged leaves. Oviposition lasted from 20 to 35 minutes. *T. vulnerata* showed a mating strategy similar to others Zygoptera. Male bias sex ratio and body size is common in territorial damselflies. Understanding basic aspects of the natural history of *T. vulnerata* is essential for their conservation.

Analysis of *Calopteryx splendens* / *balcanica* - Forms in the Peloponnesus / Greece and of other countries around of Greece

Matthias Hartung

Thirty five specimens of the *Calopteryx splendens* / *balcanica* - complex were analyzed by different methods. The length and diameter of the fore wings were measured. The mean of both wings was used for a cluster analysis. The results show two distinct groups, one which includes the specimens mainly from the Peloponnesus, and the other with specimens from other locations in Greece and other countries North, West and East from Greece. Some other structures of the wings were analysed. The



specimens from the Peloponnesus show differences in comparison to the specimens from other localities such as: broader fore-wings, more angulated at the nodus, more rows of post-nodal cells and the number of cells distal the arc caudal R1 to the oblique vein may be observed. The status of the form from the Peloponnesus will be discussed.

The occurrence and notes on the bionomy of *Cordulegaster vanbrinkae* (Odonata: Cordulegastridae) in Iran

Otakar Holuša, Kateřina Holušová & Javid Imanpour Namin

The genus *Cordulegaster* includes in the Western palearctic region 10 species, some with unclear taxonomic position. *Cordulegaster vanbrinkae* Lohmann 1993, which belongs to the subgroup *boltoni*, is the least known species. This is the darkest colored species with the largest reduction of the yellow coloration of the abdomen. *Cordulegaster vanbrinkae* was described on the basis of one male (village of Veysar near the town of Chalustown) in the Elborz Mts. in Iran, it has recently been found in 2010 in Armenia, in 2013 in Azerbaijan and repeatedly around the village of Veysar in Iran. The female, larvae, bionomy, and distribution area of this species was not yet known. In the frame of a detailed research in the Elborz Mts. during 2014 the species was found at 9 localities; a total of 59 males, 4 females, 32 larvae, and 99 exuviae were found. Females are unmistakable due to the color of abdomen, which is a predominantly black, with very small yellow patches on dorsal part of segments. The species was recorded at different elevations: 95 m a.s.l. in Azerbaijan, 1438 m.a.s.l. in Iran, and 1550 m a.s.l. in Armenia. The species was found in different streams within forests of *Carpinus* sp., *Quercus* sp. and *Alnus subcordata* which were classified according to stream features as follows: a. narrow, shallow streams in forests in middle and higher altitude, b. boulder stepped shaded forest streams, c. drying rubble forest streams and d. broader sunlit rivers. All known sites (N = 12) are located in the so-called “Hyrcanian forest” close to the Caspian Sea. Its known area extends from north eastern Iran near the border with Turkmenistan, across northern Iran to Azerbaijan, and Armenia. Probably the area may extend up to the foot hills of Caucasus Mts. in Georgia and S-Azerbaijan.

Intraspecific cannibalism in *Orthetrum sabina* – a casual phenomenon or a regular way of hunting of adults?

Otakar Holuša, Javid Imanpour Namin & Kateřina Holušová

Orthetrum sabina (Anisoptera: Libellulidae) has an area of occurrence from south eastern Europe and North Africa to Japan and south to Australia and Micronesia. In the area of Iran it is one of the most abundant eurytopic species, occurring from rice fields via canals through to quite natural habitats in forests. In 2014 the authors found this species as one of the most abundant species also in natural forests in the Caspian region in northern Iran (near surroundings of Rasht town), where it inhabits natural forest streams and forest rivers. Density of adults was very high in forest clearings or in



sun spots along streams. In those habitats were found up to 25 specimens at a 50 m transect along water courses. At 3 sites in 6 cases cannibalism between two males of *Orthetrum sabina* was documented in detail with photographs (see poster). The courses of the attacks were similar. Males were sitting on sunlit stones beside streams at a distance of about 30 cm from each other. After cca 30 seconds, one male attacked the other one. The attacking male first severed the head with prothorax and the first pair of legs (approx. to 3 min). That part was ejected. Then the male began to consume the thorax of the prey (thoracic flying muscles). After partial thorax consumption (approx. 10 min) the males carried their prey into nearby vegetation. After further consumption (reducing the weight of prey) they flew into treetops, where they continued consuming. Abdomen, legs, and wings were not consumed. Perhaps these results represent a common phenomenon in the hunting behavior of this species in areas with a high density of adults, and perhaps in these forests where food might be relatively scarce leads to cannibalism.

Abundance and threats to the population of *Cordulegaster helladica buchholzi* (Odonata: Cordulegastridae) at Cyclady islands in the Greece

Kateřina Holuřov & Otakar Holuřa

Cordulegaster helladica Lohmann, 1993 (Anisoptera: Cordulegastridae) is an European endemic species, which occurs in the southern part of mainland Greece and at the Cyclades islands in the Aegean Sea. In the Western Palaearctic region this species is among the rarest and therefore the most endangered species of the genus *Cordulegaster*. Three subspecies are recognized: *C. helladica helladica*, *C. helladica kastalia* and *C. helladica buchholzi*, which is the only taxon that occurs at large islands – i.e. Andros, Tinos a Naxos. The authors carried out in the years 2010-2014 a detailed survey of habitats and the status of the population on the islands of Andros and Tinos, with the aim of determining the factors threatening the population of this species. The species was found at 9 localities at Andros and at 3 locations at Tinos, totally 114 larvae and 35 exuviae were found. These sites were located at an altitude of 100 to 670 m.a.s.l. The important factor endangering the species population is the drying of streams (capturing the spring; use of water for agriculture), as some streams in the second half of the season completely dried, even if the larvae are able to survive drying stream. Further threats were deforestation along water courses, and pollution from settlements, even though it was established that *C. h. buchholzi* larvae show some tolerance to water pollution.

Species diversity patterns of Zygoptera (Insecta: Odonata) in Brazilian Amazonian streams

Leandro Juen, Leandro Schlemmer Brasil, Jos Max Barbosa De Oliveira Junior, Lenize Batista Calvo, Fernando Geraldo De Carvalho, Diego Pereira & Cludio Da Silva Monteiro Junior

Amazonia holds most of the world's primary rainforests and species diversity. Due to its



biogeographical processes, aquatic systems have a major role in species distribution patterns. In order to ensure the preservation of aquatic systems it is essential to understand the biodiversity that prevails in each environment, along with its variations and their corresponding causes. Our goal is to assess species richness and beta diversity of Zygoptera in small streams, and test if the main cause of variations is either turnover or nesting. Additionally, we test the effects of climatic (precipitation and temperature), spatial (spatial filters), and biogeographical variables on Zygoptera beta diversity and richness. We sampled 172 well-preserved streamlets (Igarapés) 2 - 5 meters wide in the northern Brazilian Amazonia. Observed species richness in each stream was 6.7 ± 3.5 (mean \pm standard deviation), and beta diversity was 0.86 ± 0.07 . The main variable responsible for effects on beta diversity was turnover (0.8 ± 0.1), with values one degree higher than nesting (0.05 ± 0.03). Climate was the best predictor for species richness, beta diversity, and turnover ($r^2 = 0.141$, $F = 4.43$, $p < 0.001$; $r^2 = 0.250$, $F = 10.99$, $p < 0.001$ and $r^2 = 0.213$, $F = 8.972$, $p < 0.001$, respectively), while biogeographic areas ($r^2 = 0.032$, $F = 5.54$, $p = 0.020$) were the best predictors for nesting. Beta diversity was mainly explained due to high species substitution among studied streams. This high variation shows the importance of establishing conservation areas throughout Amazonia, instead of having only a few, given the high turnover among studied sites. Climatic factors were the most relevant variables to explain community variability and, mainly, beta diversity; this corroborates the premises of niche theory, more specifically, Grinnellian niche. Despite its lower values, nesting was related to area, which demonstrates that these communities not only have a high turnover across areas but also nested groups inside biogeographical regions. When assessed in a large scale and nested within each biogeographical region this creates a Clementisian pattern across the landscape which demonstrates that species diversity is related both to biogeographical and environmental conditions.

Influence of air temperature on the emergence of Coenagrionidae, Corduliidae, Libellulidae and Platycnemididae (Odonata)

Melissa Lutsch, Lavinia Becker, Nina Emmes & Kamilla Koch

The last ecdysis is a fascinating event within the life cycle of odonates. The specimens leave the water body and become beautiful flying insects. Several abiotic parameters like weather conditions are assumed to have a strong influence on the duration of the emergence. For this study, we observed 108 emerging specimens from different odonate families (Coenagrionidae, Corduliidae, Libellulidae and Platycnemididae). We investigated the influence of air temperature on the duration of the emergence stages. Corbet (1999) defined four different emergence stages. To get an even more detailed view on the emergence, we subdivided these four stages into fourteen clear defined stages. We measured the duration of each of these stages. The emergence of the Coenagrionidae and Platycnemididae was much faster than of the Corduliidae and Libellulidae. The air temperature had a significantly positive influence on the emergence duration and the duration of the emergence stages in all families. This correlation between air temperature and the duration of the emergence stages was much stronger in Coenagrionidae and Platycnemididae than in Corduliidae and Libellulidae.



Coenagrionidae and Platycnemididae are not able to increase their body temperature due to muscle tremor. Therefore, the fast emerging might be more dependent on adequate emergence circumferences and might show stronger correlations between emergence duration and the air temperature. In contrast, the Corduliidae and Libellulidae emerge over several hours; there is a high risk that the weather conditions change during the emergence. Therefore, Corduliidae and Libellulidae need to be more flexible and independent of weather conditions as air temperature.

Odonata larvae as dispersal vectors of zooplankton resting stages: a preliminary study in the Parana River floodplain

Ramiro A. Manzo, Yamila S. Battauz, Juan C. Paggi & Javier Muzón

Different evolutionary strategies enable the zooplankton community to survive the seasonal heterogeneity of aquatic environments, one of the most interesting is the dormancy which includes states of diapauses and inactivity. Currently, it is known that in natural environments eggs that are deposited in the sediments and on different surfaces contribute significantly to the species dispersion. In the Parana River floodplain, one would expect that vectors with a significant presence in the region, such as the Odonata larvae, may play an important role in the dispersion of zooplankton. Our objective is to determine the importance of Odonata larvae associated with aquatic plants in the dispersion of resting stages of zooplankton by exo and endozoochory. Pleustonic larvae of Libellulidae, together with the zooplankton supply, were collected in shallow lakes, classified according to size (small, medium and large), and grouped into 3 replicates of the 11 individuals per size. In order to study the dispersion by exo and endozoochory, the larvae were washed, and left to defecate. The collected material was dried at room temperature and then stored in refrigerator at 4°C for 3 weeks. Then, the samples were placed on trays and incubated at 25°C with a photoperiod of 16/8 (light-dark) hours for 30 days. The supernatant water from each tray was filtered and examined every other day. 87 hatchlings were recorded, of which only 30% were associated with the dispersion by endozoochory. Rotifera, with 16 species, was the only group recorded. The most frequent species found were: *Lecane inermis*, *L. hamata*, *L. bulla* and *Bdelloidea*. The abundance and richness of hatchlings varied with the size of the larvae, in endozoochory a progressive increase of hatchlings until the larger size was observed, while in exozoochory, no pattern was observed. As for the faunal composition, Jaccard index denoted a clear dissimilarity between exo and endozoochory (Jaccard: 0.12). The results show that Odonata larvae could act as vehicles for the dispersion of resting stages of zooplankton. Being the Odonata a very important group in terms of density, they could play a key role in determining the structure of the zooplankton community.



Description of the last instar larva of *Argia inculta* Hagen in Selys (Odonata: Coenagrionidae)

Jose Martin Meléndez Quinto

For the first time, the last instar larva of *Argia inculta* is described. Its description is based on reared specimens from Lima, Peru (Lurin river). It differs from other Peruvian species of the genus because it has a single palpal seta (while *A. pulla* and *A. variegata* possess more than one), claviform setae on abdominal segments 6 to 10 (unlike *A. adamsi*, *A. difficilis*, *A. oculata*, and *A. translata*) and paraprocts nearly symmetrical in lateral view (differing from *A. cuprea*) with stout setae restricted to basal 1/4 of ventral margin (dissimilar to *A. extranea*). This species is native of Peru and Ecuador and inhabits backwaters of rivers.

Odonatological collection from the museum of the Instituto de Zoología Agrícola "Francisco Fernández Yépes" MIZA

Jenilee M. Montes-Fontalvo, Jürg De Marmels, Marco Gaiani, Quintin Arias, León A. Pérez-Gutiérrez & Jonathan Vivas

The museum of the Instituto de Zoología Agrícola "Francisco Fernández Yépes" (MIZA) belongs to Universidad Central de Venezuela and it is dedicated to the study of the tropical biodiversity. The museum is an important repository documenting tropical biodiversity; it boasts one of the most complete entomological collections. The Odonata collection from MIZA is especially rich and probably represents one of the more complete collections in Latin American. The collection includes material from North and South American including all described species known from Venezuela. The collection included material from Argentina, Australia, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Ecuador, Germany, Guatemala, Guyana, Italy, Japan, Mexico, Panamá, Perú, Switzerland, Swedish, Surinam, Thailand, United States of America, etc. The systematization of the collection began in 2012 with holotypes (123), all available online at [<http://www.miza-ucv.org.ve/>]. On-going curation has thus far recorded 1564 specimens, which represents about 30 % of the collection.

Taxonomy and delimitation of species in *Heteropodagrion* - *Mesagrion* complex (Megapodagrionidae) with description of two new species from Colombia

León Andrés Pérez Gutiérrez

The taxonomy of *Mesagrion* - *Heteropodagrion* complex is reviewed in order to establish species delimitation, and make decisions about the taxonomic status of recently discovered specimens. Based on analysis of molecular data in ITS and COI regions and morphological comparison I confirm that *Mesagrion* can maintain the level of monotypic genus. Moreover *H. croizati*, *H. sanguinipes* and *H. superbum* and two new possible species are validated at same level. The new species found in Choco



are close related to *H. superbum* and *H. croizati* and form a unstable clade topology in the analysis. Finally the results allow sustain species level for *H. sanguinipes* and *H. superbum* as lineages separated.

The position of the former Neotropical "Protoneuridae" within Coenagrionoidea, a morphological cladistic analysis.

Pablo Pessacq & Danielle Anjos dos Santos

Protoneuridae and Coenagrionidae familiar status has been recently challenged by molecular and morphological phylogenetic analysis. There is coincidence in these analyses in considering Coenagrionidae as a paraphyletic clade that would include Neotropical Protoneuridae and Pseudostigmatidae. The monophyly of the former is strongly suggested by wing synapomorphies, such as the rectangular discoidal cell and the subarcus position at or proximal to Rp-Ma bifurcation, and its position as a subfamily is suggested by molecular data. In order to analyze the position of Neotropical Protoneuridae within Coenagrionoidea, its monophyly and the relation of its members, we constructed a data matrix of 61 morphological characters and 37 taxa. *Philogenia cassandra* (Megapodagrionidae) was selected as outgroup, while two Platystictidae, one Isostictidae, five Platycnemididae (including three of the former Paleotropical Protoneuridae), twelve Coenagrionidae and 17 Neotropical Protoneuridae species were included as outgroup. Analyses were conducted using TNT program, a posteriori weighting was chosen using the command "implied weighting". The analysis produced two very similar trees that support the inclusion of Neotropical Protoneuridae within Coenagrionidae. However, its members are recovered as a polyphyletic clade, with *Proneura*, *Junix*, and *Phasmoneura* nesting within rounded frons Coenagrionidae, and the remaining genera as a monophyletic clade within angulate frons Coenagrionidae. This unexpected result is coincident with previous morphological and molecular analyses that divide Coenagrionidae (plus Protoneuridae and Pseudostigmatidae) in two major clades based on the frons shape. Jackknife resamplings do not support most groups. *Telebasis willinki* and *Nehalennia irene* are the sister group to core Protoneuridae, and *Microneura caligata* and *Idioneura ancilla* the basal Protoneuridae. As in previous analyses, *Protoneura* appears as a polyphyletic group, while *Roppaneura beckeri*, *Psaironeura remisa*, *Amazona ephipigera*, *Forcepsioneura sancta* and *Lamproneura lucerna* conform a monophyletic clade and are the more derivate genera.

Damselflies of Patagonia, a phylogeographic study utilizing EPIC DNA and mitochondrial sequence markers

Pablo Pessacq, Seth M. Bybee, Taylor King, Preston Arnold, Danielle Anjos dos Santos & Mariana Morando.

We conducted the first phylogeographic study of Patagonian insects, for which we selected the two most widely distributed species of Odonata in the region: *Rhionaeshna variegata* (Aeshnidae)



and *Cyanallagma interruptum* (Coenagrionidae). First, we performed a preliminary analysis of nine populations of both species from most of their distribution range, and we sampled the nuclear genes H3 and 28S, and the mitochondrial genes 16S, COXI and COXII. While *R. variegata* showed no genetic structure, *C. interruptum* showed genetic structure for COXI/II and 16S. These results are consistent with a greater dispersal ability among aeshinds as compared with coenagrionids. Thus, we pursued further analyses for *C. interruptum*, for which we included eleven additional populations (20 populations and 54 specimens total) that cover most of its distributional range in Argentina. We performed network and phylogeographic analyses with the mitochondrial genes COXI/II and with the recently developed EPIC (exon-primed intron-crossing) nuclear genes PRMT, CDC5 and AgT. The mtDNA results show that *C. interruptum* consists of two major clades with considerable genetic differences, one distributed in the north (Northern Patagonia) and one in the south (central Patagonia). Individuals from a small area in between these two regions (southwestern Río Negro) have haplotypes recovered from both clades. This pattern is concordant with a separation of the ancestral population in the past and the posterior secondary contact in the intermediate localities. It is probable that events during the Pleistocene (glaciation cycles and associated changes in climate and/or other geological events) interrupted gene flow among northern and southern populations. The nuclear genes showed a high level of heterozygosity but low levels of genetic structure with no signals of geographic structure. The incongruence between the two types of markers allow us to elaborate two non-exclusive main hypotheses: 1) females may have lower dispersal capacity or high philopatry compared to males, 2) the temporal separation between the two populations was relatively brief providing enough time for mitochondrial markers to differentiate genetically, but not sufficiently long to be reflected by the more constrained evolutionary rates of the nuclear genes.

A first look at the phylogenetic relationships of *Forcepsioneura* and related genera (Coenagrionidae: Protoneurinae)

Ana Luiza Anes Pimenta, Ângelo Parise Pinto & Daniela Maeda Takiya

The six valid species of *Forcepsioneura* Lencioni are restricted to Brazil and difficult to identify based on morphological characters. Recently collected material from Rio de Janeiro, São Paulo, and Bahia States are morphologically similar to the type species, *F. garrisoni* Lencioni, but differ slightly in some aspects, which can be used to separate them into three morphotypes. A previous morphological phylogenetic analysis of the Protoneurinae, shows *Forcepsioneura* within a clade (i.e. *Roppaeneura*+), supported by the uncarinated antennifer and long and incurved lobes of the genital ligula, together with other five Neotropical genera: *Amazoneura* Machado, *Lamproneura* De Marmels, *Phasmoneura* Williamson, *Psaironeura* Williamson and *Roppaeneura* Santos. The aim of this study was to add molecular data to hypothesize phylogenetic relationships among *Roppaeneura*+ genera and *Forcepsioneura* species and help delimit the taxonomic units through an integrative approach of the putative *F. garrisoni* species complex. Parsimony and Bayesian analyses were performed using two molecular markers: cytochrome oxidase I (COI) and 16S rDNA. Taxon sampling include specimens of



Lestoidea, Dispaironeurinae, core- and ridged-face Coenagrionidae, eight Protoneurinae genera, and nine specimens of *Forcepsioneura*, summing up 27 terminal taxa. DNA was extracted from a leg, with DNEasy blood and tissue kit (Qiagen). Additional sequences were obtained from Genbank. *Forcepsioneura* was supported as monophyletic in all analyses with high support, however species relationships were not consistently recovered or had low support. The *F. garrisoni* species complex was recovered as monophyletic in the Bayesian, but paraphyletic in the parsimony analysis, and included at least two undescribed species. Analyses of molecular data do not recover *Roppaneura*+, the ridged-face clade, neither Protoneurinae as monophyletic, and relationships between genera are not congruent. These results are, in part, due to low taxon and gene sampling. This preliminary analysis is so far the largest molecular sampling of Protoneurinae genera and *Forcepsioneura* species, but future plans include the increase of taxon and character sampling and addition of morphological data, to clarify the relationships of Protoneurinae and *Forcepsioneura* species.

Biodiversity of Odonata of Rio Piedras, an urban area of San Juan, Puerto Rico

Alonso Ramírez & Pablo E. Gutiérrez-Fonseca

Puerto Rico is becoming progressively urban. The islands economy changed from agricultural to industrial in the 1940s and secondary forest has been increasing along with the size of urban areas, altering freshwater ecosystems. Here we present a survey of the Odonata fauna of a highly urban watershed in Puerto Rico. The Rio Piedras drains the metropolitan area of San Juan, the capital and largest city, a densely urbanized section with almost half of its area (49%) covered by impervious surfaces. We sampled different habitats within the Rio Piedras and registered a total of 20 species of Odonata, 36% of all Puerto Rican species. Odonata explore habitats ranging from moderately urban areas (sub-watersheds with 12.9% impervious area) to the completely channelized streams in highly urbanized sub-watersheds. Some species were expected habitat generalists or inhabitants of open areas, like *Erythrodiplax umbrata* and *Erythemis vesiculosa*. However, we also found species that are often related with less disturbed areas, like *Protoneura viridis* and *Telebasis vulnerata*. Overall, urban areas of Puerto Rico support an important proportion of the Odonata fauna of the island and deserve attention. Urban riparian areas are potentially important habitats in supporting Odonata populations.

Preliminary assessment of Odonata diversity and conservation in Avellaneda city, Buenos Aires, Argentina

Lía Ramos, Federico Lozano, Alejandro del Palacio & Javier Muzón

Understanding the mechanisms by which urbanization processes affect biodiversity, in particular how the biota responds to alteration of their habitats, is crucial to integrating the environment in proper urban planning. Here we selected Avellaneda, an important town located



the main urban center of Argentina, in order to provide the first preliminary assessment of the diversity of Odonata of urban wetlands in the country. The objectives of this study were to: 1- compile an inventory of the Odonata fauna; 2- determine the species associations with urban development and their conservation status; and 3- assess species replacement along a latitudinal gradient on the occidental margin of the Rio de la Plata. A total of seven localities were sampled: five within Avellaneda, one to the north: Delta del Paraná (DP) and one to the south: Reserva Natural Punta Lara (RNPL), with an approximate separation distance of 70 km. Samplings were made between December and March of 2013 to 2015 following the qualitative and quantitative methods used with Odonata. Biodiversity was quantified using the Shannon & Weaver index. The Jaccard similarity index and Cody index were used to compare the dissimilarity between areas, and the Nuorteva index was used to estimate the degree of synanthropy of species. Twenty species were recorded for Avellaneda. *Brachymesia herbida* was recorded for the first time for Buenos Aires Province. The results show a greater species replacement between Avellaneda and the other areas compared to DP and RNPL. These results are evidence of the degree of impoverishment of Avellaneda compared to the other surveyed areas. Avellaneda is more similar to RNPL, the area on the south, than to DP. This contradicts the hypothesis that diversity of aquatic insects should decrease gradually from north to south because of the influence of the Paraná river. However, the greater similarity of Avellaneda to RNPL shows the effect of the urban agglomeration, located between DP and Avellaneda, which interrupts the continuity of favorable habitats. Within Avellaneda, the results show a decrease in density and diversity with an increase in anthropic influence. *Brachymesia herbida* and *B. furcata* were registered only in those localities with the least anthropic influence which are within a closed landfill in which restoration measures have been taken since 2004. This could indicate a high capacity for recovery of biodiversity only when conservation actions to improve environmental quality and heterogeneity are performed. The synanthropy index (SI) could only be estimated in six species: *Ischnura fluviatilis* has the highest SI (40.85) while *Brachymesia furcata* the lowest (-13.25). Even though the SI could only be quantified for the most abundant species, complementary samplings inferred that *B. herbida*, *Oxyagrion terminale*, and *Argentagrion ambiguum* could be considered asynanthropic.

Optimization of DNA extraction protocol for insects in the order Odonata

Camila Rippel, Silvana Sawostjanik, Mahia Ayala & Horacio L. Walantus

Obtaining good quality, unpolluted DNA is essential for the application of any molecular technique. In contrast to other insects, there are no published DNA extraction protocols for dragonflies that are both efficient and inexpensive. The objective of this study was to obtain a DNA extraction protocol for insects in the order Odonata. The insects were collected in the adult stage, in fortnightly samples from July to November 2014, in the city of Posadas, Misiones. Taxonomic identification was performed according to the keys proposed by Garrisson et al. (2006-2010). The study was carried out with the species *Oxyagrion* sp. and *Argentagrion ambiguum* from the family Coenagrionidae (Odonata: Zygoptera), and *Oligoclada* sp. from the family Libellulidae (Odonata:



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Anisoptera), because these were the most abundant. The thoracic muscle was used for the insulation of the whole genetic material. A modified DNA extraction protocol for mosquitoes proposed by Gaillard & Strauss (1990) was used. First, the tissue was macerated in 500 µl of extraction buffer (0.5 M EDTA; 1 M Tris-HCl pH 8.25; 2% SDS, 1 M Saccharose) and 5 µl proteinase K. Then it was incubated in dry bath for 20 minutes at 65 °C. 120 µl of 4M Potassium Acetate was added for protein precipitation. The homogenized was placed on ice for 10 minutes and centrifuged at 12000 rpm for 10 minutes. After recovering the supernatant which contained DNA, 35µl of 4M Sodium Acetate and 1000 µl of absolute ethanol were added, and it was then incubated for 10 minutes at room temperature with the purpose of getting a good precipitation of the DNA. Next, it was centrifuged for 20 minutes at 12000 rpm. The obtained pellet was dried in a thermostated bath for 20 minutes at 37 °C and resuspended in 50 µl ddH₂O. In order to verify the integrity of the extracted nucleic acid, a 1% agarose gel electrophoresis was performed. It was possible to obtain good quality DNA that was amplifiable by using proposed primers for "Barcode". Being able to draw on techniques that do not compromise the safety of lab personnel and are also simple and inexpensive constitutes an advantage for the evolution of research methodologies.

Life cycle and emergence pattern of *Argia joergenseni* Ris 1913 (Coenagrionidae, Zygoptera) in a stream from Yungas mountain forest (Tucumán, Argentina)

José S. Rodríguez, Carlos Molineri & Daniel dos Santos

Argia Rambur (Coenagrionidae) is a diverse genus found in the New World. They inhabit lotic or semilotic environments, but a few species occur in lentic habitats. *Argia joergenseni* breeds in streams across the Yungas Cloud Forest and other ecoregions from Argentina and Bolivia. In Tucumán it is the most frequent and abundant species of damselfly. The aim of this study was to investigate the life cycle and emergence pattern of *A. joergenseni* in one protected stream reach of this province. "Las Conchas" is a third-order stream flowing through a Biological Reserve and is surrounded by Yungas forest. Larvae were collected weekly using a Surber sampler (0.09 m², pore size 1 mm) from April 1994 to April 1996. Head capsule width in dorsal view, and body length (without caudal lamellae) were measured under a stereo microscope using an ocular micrometer. Six size-classes were defined to classify the 920 specimens collected, and the relative frequency of each class was studied through the sampling period. Mature larvae were present during most of the studied period, indicating a rather constant emergence of adults that was corroborated with observations in the field. Immature larvae (size-classes 1 and 2) were dominant from March (end of the rainy period) to August (end of winter low temperatures). Larger nymphs became dominant at the end of the winter and beginning of spring, coincidently with raising temperatures. More than one cohort developed simultaneously, a winter cohort reaching larger body sizes (emergency at size-class 6), and a summer cohort emerging at smaller size-classes (class 5 or even 4). Life cycle duration and its dependence on temperature is discussed.



Diversity and characterization of Odonates of the Colombian side of the Guiana Shield, Puerto Carreño, Vichada and Mitu, Vaupes.

Melissa Sánchez-Herrera, Adriana Morocho & Emilio Realpe

Despite their popularity, the fauna of some South American countries is still poorly known. The recent publication of new taxonomic keys and books had increased the encounter of new species in Colombia. However, there are still unexplored areas in this country. The Guiana Shield is one of the three cratons of South America including the Amazon rainforest and the Andes Cordillera. It is the oldest formation dating back to the Precambrian eon. This shield extends from Guyana, Surinam, French Guiana, Venezuela, Brazil and Colombia. Despite the small portion of it that belongs to Colombian territory, it is in an strategic position due to their closeness to the Amazon region and the Andes mountains. This study compiles the dragonflies and damselflies the first inventory of the northern most location of the Colombian side, Puerto Carreño and Mitu. This information will start to fill the gaps of the Colombian and South American biodiversity

Odonata diversity in an Atlantic Forest fragment at Porto Seguro, state of Bahia, Brazil

Karina Schmidt Furieri & Keyla Vieira Da Cruz

The Atlantic Forest (AF) domain presents high levels of diversity. However, the fragmentation of this bioma has reached its maximum, remaining only 12% of the pristine vegetation. This intense anthropic interference have increased risks of species extinction. Despite of the strong deforestation process, AF persists as one of the world's higher biodiversity areas, which reinforces its importance in targets of conservation politics. The south region of the Bahia state is located at the so called Central Corridor of Atlantic Forest, which is considered an endemism centre (Bahia Refugium). Members of Odonata, which present terrestrial adults and aquatic larvae, are generalist predators and show a high diversity in tropical domains, including AF. Dragonflies are strongly affected by physical-chemical conditions of aquatic habitats and they can be used as water quality indicators. The aims of this work were: to present a checklist of Odonata with emphasis on rare species and/or species at risk of extinction; to characterize the richness of this group at family and species level in this fragment of AF at Trancoso, Porto Seguro municipality, Bahia state, northern Brazil. Dragonflies were collected in the rivers "Barra", "Do Norte" and "Das Éguas", in their marshes and in terrestrial bromeliads surrounded. Qualitative (active search) and quantitative samples were performed to estimate the species richness (JackKnife of first order). A total of 26 species belonging to 23 genera and nine families were found, including water quality indicators genera, such as *Heteragrion*, *Hetaerina* and *Aceratobasis cornicauda*, an species at risk of extinction (Brazilian MMA 2014 red list). It was estimated the occurrence of 38 to 58 dragonflies species. The conservation of forest fragments assuring feasible site for reproduction contributes significantly to the conservation of local population of dragonflies.



Advances in the analysis of stomach contents of dragonflies, intended to determine the species consumed

Noelia M. Schröder, Camila Rippel & Leonardo H. Walantus

Most dragonflies are considered generalists predators, but we can assume that they do not eat randomly. It is common to find Diptera, such as culicids, that are vectors of diseases in their diet. However, the studies referred to the potential of adult dragonflies as biological control agents are scarce in the region, and they may prove to be an efficient vector control with a low risk to the environment. The stomach content analysis provides information about the diet of an organism enabling the study of its trophic interactions. However, observing the structures that are undigested and identify in them taxonomic characters that allow recognition of the prey is not an easy task and requires training. The purpose of this study, which is in early stages, is developing a protocol to identify the remains of culicids in the diet of adult odonates under laboratory conditions. Initially, we tried to identify structures of mosquitoes with taxonomic value that could be recognized in the digestive tract. To this end, we captured adults of Anisoptera in the city of Posadas, Misiones and identified them at genus level. They were held in the laboratory inside plastic containers at 70% humidity conditions for 24 hours without receiving any food, in order to empty the digestive tract. Then, adults were fed with adult culicids and specimens were dissected. In the analysis of stomach contents by optical microscope, we differentiate legs fragments, bristles and scales both of wings and legs. The latter have longitudinal ribs, clearly marked and easily identifiable in the stomach contents. So these structures were compared in the different culicids in order to check if this could be used to identify species. We were able to differentiate culicids at genus level. 4 genera that abound in the area (*Culex*, *Aedes*, *Anopheles* and *Psorophora*) were identified in the stomach content. But we also compare scales of *Mansonia*, *Coquillettidia* and *Aedeomya* examining specimens from the collection of the research center directly by microscope. The 7 genera analyzed showed differences in the number of ribs, size and shape of the scales that will be useful in the study of trophic interaction between dragonflies and culicids. Molecular techniques should be used to confirm the results.



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