THREE APPROACHES TO AUTOMATING TAXONOMY, WITH EMPHASIS ON THE ODONATA (DRAGONFLIES AND DAMSELFLIES)

by

WILLIAM ROBERT KUHN

A Dissertation submitted to the

Graduate School-Newark

Rutgers, The State University of New Jersey

In partial fulfillment of the requirements

for the degree of

Doctor of Biological Sciences

Graduate Program in

Ecology and Evolution

written under the direction of

Dr. Jessica Lee Ware

and approved by

_____

_____

_____

_____

_____

_____

Newark, New Jersey

October, 2016

Copyright notice

© 2016

William Robert Kuhn

ALL RIGHTS RESERVED

ABSTRACT OF THE DISSERTATION

Three approaches to automating taxonomy, with emphasis on the Odonata (dragonflies and damselflies)

By WILLIAM ROBERT KUHN

Dissertation Director:

Dr. Jessica Lee Ware

Taxonomy—the field charged with naming and classifying organisms—forms a foundation for biological research. An understanding of the species on Earth is needed for informing biodiversity research, conservation efforts, management strategies, and global policy. In recent decades, a 'taxonomic impediment' has arisen: there is an urgent need to know the millions of yet-undiscovered species, while funding for the science charged with this task, taxonomy, and the number of trained taxonomists are declining. This work aims to provide three software tools for taxonomists that allow them to work more efficiently and effectively, reducing this impediment.

First, a system for automatically landmarking images of specimens for geometric morphometric studies was introduced, which could greatly reduce the time required to manually landmark images for these studies while also increasing the possible sample size of such studies. The system's landmarking error, however, was extremely variable on test images of the wings of dragonflies and damselflies (Odonata), and was ultimately too large (300–500 px) to

compete with manual landmarking at this time. Second, a method was presented for automatically standardizing and extracting descriptive features from images of insect wings in order to quantify the appearance of the wings. The standardization method was successful in converting scans of odonate wings into consistently-formatted square images, automatically. Then, features describing the color, texture, and shape of the wings were able to be extracted, producing a small set of 663 coefficients that were able to distinguish between species. Finally, a system called Odomatic was presented and tested for automatically identifying Odonata to species from images of their wings, using the feature extraction method combined with machine learning techniques. Odomatic was able to make classifications between 32 species with expert-level (up to 92%) accuracy, making it useful for quickly identifying specimens.

The tools presented here will be deployed for use by odonate researchers through the website OdonataCentral.org, but will also be released as open-sourced Python scripts so that they can be customized to be implemented on other taxonomic groups. This work will enable taxonomists and other interested parties to make easier morphological comparisons and faster identifications.

Acknowledgements

This work would not have been possible without the love and support of my family, friends, peers, and mentors.

I thank the members of my dissertation committee. Thanks to Drs. Brooke Flammang, Michael May, and David Polly for your patience, encouragement, and support. To Dr. Gareth Russell, thank you for getting me interested in programming and pointing me toward the small, side project that ultimately blossomed into this full-blown dissertation work. To my advisor, Dr. Jessica Ware, thank you for your undying optimism and compliment sandwiches, your never-ending list of exciting research ideas, your unyielding support, and your friendship.

Thanks to my lab-mates and honorary lab-mates for their love, friendship, and constructive feedback: Drs. Melissa Sanchez-Herrera and Dominic Evangelista, Manpreet Kohli, Megan Wilson, Caroline DeVan, Jayshree Patel, Phil Barden, Dan Troast, Merlijn Jocque, and John Deyrup.

Thanks to Dr. John Abbott for getting me hooked on studying insects, and to Dr. Christopher Beatty for your mentorship during this project.

I graciously acknowledge the Rutgers and NJIT students who have helped me with this project by scanning odonate wings or working on related projects: Jeevitha Anthony, Brais Castro, Gretta Cevallos, Kimberly Chan, Vidya Devi, Kayla Drobnis, Sara Fari, Ioulia Furman, Meriem Hanna, Jack Kellogg, Lucianny Lantigua, Michael Lao, Adriana Morocho, Renato Nunez, Laila Salari, Arianne Wallace, and others. Thanks!

I would like to thank the students of Aim High Academy from 2012–2015 for collecting many of the New Jersey dragonfly and damselfly specimens used in this study and for letting me share my passion with you.

I thank my wonderful family. To my parents, Ann and Bill Kuhn, thank you for instilling in me a love for the natural world, and for your guidance, love and support over the years. To my brother, Andy Kuhn, it's really good to have you as a brother. To my husband, Aaron Collins, thank you for choosing to be with me, for listening to me whine, for supporting me and putting up with me during the most difficult parts of my graduate school experience, and for your love.

Finally, I would like to thank the dragonflies and damselflies that (unwittingly) sacrificed themselves to make this work possible. I hope that this work is worthy of your sacrifice.

Table of contents

Title page i

Copyright notice i

Abstract of the dissertation ii

Acknowledgements iv

Table of contents vi

List of tables ix

List of figures x

Chapter 1. Introduction **1**

1.1. References 3

Chapter 2. A tool for automatically landmarking wings of dragonflies and damselflies (Odonata) **5**

2.1. Abstract 5

2.2. Introduction 5

2.2.1. The pictorial structures model 8

2.2.2. A novel application of the PS model 9

2.3. Methods 10

2.3.1. Training data 10

2.3.2. Software package 11

2.3.3. Training a PS model 11

2.3.4. Applying a fitted PS model 14

2.3.5. Evaluating model performance 17

2.3.5.1. Parameter search 17

2.3.5.2. Effect of training sample size on landmarking error 19

2.3.5.3. Effect of dataset composition on landmarking error 19

2.4. Results 20

2.4.1. Parameter search 21

2.4.2. Effect of training sample size on landmarking error 22

2.4.3. Effect of dataset composition on landmarking error 23

2.5. Discussion 23

2.6. References 24

2.7. Tables and Figures 29

Chapter 3. A method for quantitatively comparing appearance of insect wings **45**
3.1. Abstract 45
3.2. Introduction 45
3.3. Methods 47
3.3.1. Image dataset 48
3.3.2. Feature extraction process 48
3.3.2.1. Image standardization 48
3.3.2.2. Feature extraction 52
3.3.3. Evaluating the feature extraction process 55
3.3.3.1. Measuring ‘discriminability’ 55
3.3.3.2. Feature performance 56
3.3.3.3. Effect of scanner model on feature discriminability 57
3.3.3.4. Effect of image distortion on feature discriminability 58
3.3.3.5. Features for discovery 59
3.4. Results 59
3.4.1. Image Standardization Performance 59
3.4.2. Feature Extraction Performance 60
3.4.3. Feature performance 60
3.4.4. Effect of scanner model on feature discriminability 61
3.4.5. Effect of image distortion on feature discriminability 62
3.4.6. Features for discovery 63
3.5. Discussion 64
3.6. References 66
3.7. Tables and Figures 70
Chapter 4. Odomatic: a system for automatically identifying Odonata from images of their wings **88**
4.1. Abstract 88
4.2. Introduction 88
4.3. Methods 95
4.3.1. The Odomatic system 95
4.3.2. Evaluating the performance of Odomatic 97
4.3.2.1. General parameter search 97

4.3.2.2. Taxonomic level 101
4.3.2.3. Number of classes 102
4.3.2.4. Best-case classifier model 102
4.4. Results 103
4.4.1. General parameter search 103
4.4.2. Taxonomic level 104
4.4.3. Number of classes 104
4.4.4. Best-case classifier model 104
4.5. Discussion 105
4.6. References 106
4.7. Tables and Figures 110
Conclusions **121**
Appendix A. Table of specimen localities **123**
Appendix B. Examples of odonate species used in this study **161**

List of tables

Chapter 2:

Table 1. Species included in dataset for this study 29

Table 2. The 11 landmarks used in this study 30

Table 3. Distribution of landmarking error by best-parameter models 31

Chapter 3:

Table 1. Composition of the testing dataset 70

Table 2. Descriptions of morphometric features 71

Table 3. Discriminability by feature set 72

Chapter 4:

Table 1. Summary of wing image dataset 111

Appendix A. Table of specimen localities 123

List of figures and plates

Chapter 2:

Figure 1. Examples of the 11 landmarks used in this study 32
Figure 2. Automatic landmarking process flowchart 33
Figure 3. Patch-based appearance representation example 34
Figure 4. The nine Gabor wavelet filters used for iconic representation of part appearance 35
Figure 5. Example of configuration model 36
Figure 6. Edge filtering 37
Figure 7. Appearance cost map demonstration 38
Figure 8. Demonstration of distance transform 39
Figure 9. Results of minimization 40
Figure 10. Results of grid parameter search 41
Figure 11. Effect of training sample size on landmarking error (RMSE) 42
Figure 12. Effect of dataset composition on landmarking error (RMSE) 43
Figure 13. Qualitative assessment of landmarking prediction 44

Chapter 3:

Figure 1. The 21 dragonfly and 9 damselfly species used in this study 73
Figure 2. Steps for detecting wings in an image 74
Figure 3. Properties of wings versus non-wings 75
Figure 4. Steps of the standardization process 76
Figure 5. Chromaticity transformation 77
Figure 6. Gabor wavelet transformation 78
Figure 7. Comparison of the relative sizes of original squares to reduced 'raw pixel' squares 79
Figure 8. Examples of image blurring and salt and pepper noise 80
Figure 9. How well do features distinguish odonate species? 81
Figure 10. How variable are features when images are acquired from different scanners? 82
Figure 11. How does blurring affect discriminability? 83
Figure 12. How does salt and pepper noise affect discriminability? 84
Figure 13. Which parts of the wings are most important for species discrimination according to chromaticity? 85

Figure 14. Which parts of the wings are most important for species discrimination according to GWT? 86

Figure 15. Map of wing importance for species discrimination according to chromaticity and GWT 87

Chapter 4:

Figure 1. Flowchart of automatic identification framework 115

Figure 2. Results of general parameter search 116

Figure 3. Effect of number of taxonomic level on classification accuracy 117

Figure 4. Effect of number of species classes on classification accuracy 118

Figure 5. Best-case classification accuracy 119

Figure 6. Confusion matrix for best model 120

Appendix B:

Plate 1. Anisoptera: Aeshnidae and Cordulegastridae 162

Plate 2. Anisoptera: Corduliidae 163

Plate 3. Anisoptera: Corduliidae (cont.) and Gomphidae 164

Plate 4. Anisoptera: Gomphidae (cont.) and Libellulidae 165

Plate 5. Anisoptera: Libellulidae (cont.) 166

Plate 6. Anisoptera: Libellulidae (cont.) 167

Plate 7. Anisoptera: Libellulidae (cont.) 168

Plate 8. Anisoptera: Libellulidae (cont.) 169

Plate 9. Anisoptera: Libellulidae (cont.) 170

Plate 10. Anisoptera: Libellulidae (cont.) and Macromiidae 171

Plate 11. Anisoptera: Macromiidae (cont.) 172

Plate 12. Anisoptera: Macromiidae (cont.) and Petaluridae; Zygoptera: Calopterygidae 173

Plate 13: Zygoptera: Calopterygidae (cont.), Coenagrionidae, Euphaeidae, Lestidae, Megapodagrionidae, and Polythoridae 174

Plate 14: Zygoptera: Polythoridae (cont.) 175

Plate 15: Zygoptera: Polythoridae (cont.) 176

Plate 16: Zygoptera: Polythoridae (cont.) 177

Chapter 1. Introduction

The biological field of taxonomy (and its parent, systematics) forms a foundation, indeed a “reference system”, upon which nearly all other biological research relies (Crisci 2006). Best known for providing species names, taxonomy also provides an infrastructure onto which we attach everything that is known about an organism, and allows us the ability to compare them in a consistent, meaningful way. Taxonomy is perhaps one of the oldest sciences, rooted in the collective human need to classify things in order to make sense of the world around us (MacLeod 2008). However, the field as we currently know it is grounded in the work of Carl von Linné (1735). In the nearly 300 years since, some 1.2 million of the world’s species have been described (Mora *et al.* 2011). But the products of taxonomy are much more than names: biological collections provide snapshots of historical biodiversity; taxonomic revisions update our understanding of the relationships among species; keys, checklists, and field guides make it possible for the knowledgeable and the novice to identify organisms; and taxonomic descriptions and monographs encapsulate our knowledge of an organism’s morphology, behavior, physiology, biogeography, etc. Indeed, taxonomic sciences enrich the human experience on Earth.

Taxonomy is more important now than ever before in light of the current “biodiversity crisis” (e.g., Koh *et al.* 2004). There are an estimated 8.7 million species on Earth, but only some 14% of them are known to science (Mora *et al.* 2011), and even fewer have been studied beyond simply being given a species name. A recent study of microbial diversity even suggests that there may be up

to 1 trillion species (Locey & Lennon 2016). At the same time, the work of the human species is causing unprecedented loss of habitat for our cohabitants (Brook *et al.* 2003) and is changing the global climate (e.g., Karl & Trenberth 2003). In what has been coined the “sixth mass extinction event” (e.g., Ceballos *et al.* 2015), some 50% of species are projected to become extinct in the next half-century (Pimm & Raven 2000; Thomas *et al.* 2004). It is therefore important to learn everything that we can about these species before they are lost.

Despite the dire need for taxonomic services, investment into this science as well as the number of trained taxonomic experts has been declining in recent decades (Godfray 2002; Gaston & O’Neill 2004; La Salle *et al.* 2009)—a phenomenon known as the “taxonomic impediment” (Hoagland 1996). Curiously, scientific and funding priorities are shifting away from taxonomy-related works toward efforts in other biological fields that rely on and benefit from taxonomic products (Carvalho *et al.* 2008). New tools are needed to allow taxonomists to do their work more efficiently and effectively.

The aim of this dissertation work is to provide a set of software tools to help taxonomists and others to describe the morphology of specimens from images. This work is not meant to imply that the taxonomist can be replaced by a computer program; but only meant to automate some tedious tasks, like landmarking and species identification, where computers excel. This means the human taxonomist can spend less time and effort on tedium and more of their energies on interesting taxonomic work, particularly alpha taxonomy—describing species and making taxonomic revisions.

In Chapter 2 of this work, methods from computer vision are applied to automatically locate specific homologous *landmarks* in images for comparative studies, by training a model with manually-labeled example images. In Chapter 3, I introduce a method for automatically describing insect wings, from images, based on their color, their texture and patterning, and their shape. This method encodes descriptive information from these images into a relatively small set of feature coefficients, which can be used to describe individuals for comparative studies. In Chapter 4, I combine this method with machine learning for automatic species identification, in which a system is trained to classify individuals to species (or other taxonomic levels) by training it with example images of those species. I test these tools on images of dragonflies and damselflies (Odonata), but aim for them to be adapted for other taxa as well. By providing these computational tools to taxonomists and others, I hope to reduce the taxonomic impediment.

1.1. References

Brook, B.W., Sodhi, N.S. & Ng, P.K.L. (2003). Catastrophic extinctions follow deforestation in Singapore. *Nature*, **424**, 420–426.

Carvalho, M.R. de, Bockmann, F.A., Amorim, D.S. & Brandão, C.R.F. (2008). Systematics must Embrace Comparative Biology and Evolution, not Speed and Automation. *Evolutionary Biology*, **35**, 150–157.

Ceballos, G., Ehrlich, P.R., Barnosky, A.D., García, A., Pringle, R.M. & Palmer, T.M. (2015). Accelerated modern human–induced species losses: Entering the sixth mass extinction. *Science Advances*, **1**, e1400253.

Crisci, J.V. (2006). One-dimensional systematist: perils in a time of steady progress. *Systematic Botany*, **31**, 217–221.

Gaston, K.J. & O'Neill, M.A. (2004). Automated Species Identification: Why Not? *Philosophical Transactions: Biological Sciences*, **359**, 655–667.

Godfray, H.C.J. (2002). Challenges for taxonomy. *Nature*, **417**, 17–19.

Hoagland, K.E. (1996). The taxonomic impediment and the convention on biodiversity. *Association of Systematics Collections Newsletter*, **24.5**, 61–62.

Karl, T.R. & Trenberth, K.E. (2003). Modern Global Climate Change. *Science*, **302**, 1719–1723.

Koh, L.P., Dunn, R.R., Sodhi, N.S., Colwell, R.K., Proctor, H.C. & Smith, V.S. (2004). Species Coextinctions and the Biodiversity Crisis. *Science*, **305**, 1632–1634.

La Salle, J., Wheeler, Q., Jackway, P., Winterton, S., Hobern, D. & Lovell, D. (2009). Accelerating taxonomic discovery through automated character extraction. *Zootaxa*, **2217**, 43–55.

von Linné, C. (1735). *Systema naturae; sive, Regna tria naturae: systematice proposita per classes, ordines, genera & species*. Haak.

Locey, K.J. & Lennon, J.T. (2016). Scaling laws predict global microbial diversity. *Proceedings of the National Academy of Sciences*, **113**, 5970–5975.

MacLeod, N. (2008). *Automated Taxon Identification in Systematics: Theory, Approaches and Applications*. CRC Press, London, UK.

Mora, C., Tittensor, D.P., Adl, S., Simpson, A.G.B. & Worm, B. (2011). How Many Species Are There on Earth and in the Ocean? *PLOS Biol*, **9**, e1001127.

Pimm, S.L. & Raven, P. (2000). Biodiversity: Extinction by numbers. *Nature*, **403**, 843–845.

Thomas, J.A., Telfer, M.G., Roy, D.B., Preston, C.D., Greenwood, J.J.D., Asher, J., Fox, R., Clarke, R.T. & Lawton, J.H. (2004). Comparative Losses of British Butterflies, Birds, and Plants and the Global Extinction Crisis. *Science*, **303**, 1879–1881.

Chapter 2. A tool for automatically landmarking wings of dragonflies and damselflies (Odonata)

2.1. Abstract

Landmarking is an essential task in the biological field of geometric morphometrics—the quantitative study of shape among organisms—but is also a time-consuming, manual undertaking, which can limit the size of a comparative study. In this study, a system was tested for automatically placing 11 landmarks on the fore- and hindwings of a particularly challenging group of insects: the dragonflies and damselflies (Odonata). The system used a pictorial structures model to learn the appearance and configuration of landmarks from training images to predict landmark locations in novel images. In order to compete with manual landmarking, the system would need to have a landmarking error of less than 10 px; however, the best model had an error of 300–500 px and the error was extremely variable across testing images. Thus, the system presented here was unable to compete with manual landmarking in its present form. I discuss possible reasons for this high error and ways to improve the system.

2.2. Introduction

In the field of comparative biology, geometric morphometrics (GMM) has become nearly ubiquitous in recent years for quantitatively comparing the shape of morphological structures across organisms (Adams *et al.* 2004). GMM has been used in a variety of organisms, from insects (Aytekin *et al.* 2007; Sadeghi *et al.* 2009; Outomuro *et al.* 2012; Sanchez Herrera *et al.* 2015) to fish (Clabaut *et*

al. 2007; Ibañez *et al.* 2007), and mammals (Caumul & Polly 2005; Cardini *et al.* 2007).

Landmarks are the foundation of GMM. These are coordinates representing the positions of salient, homologous morphological features. *Landmarking* (or *annotation*) is the act of placing landmarks on an image of a specimen and is most often performed manually, using software such as tpsDig2 (Rohlf 2005). This is a tedious and time-consuming process, requiring a user to point and click on the proposed location of each landmark in an image and to repeat this process for every specimen that is to be compared. Indeed, this process is so laborious that annotation time can limit the scale of comparative studies (Palaniswamy *et al.* 2010). This repetitive activity, however, lends itself to automation. Automating the landmarking process could greatly speed it up, allowing for studies using a greater number of landmarks and/or specimens, and could reduce subjectivity in placement of landmarks by human workers.

While landmarking is relatively straight-forward for humans to do, it is surprisingly difficult to create a computer program that can perform this task reliably and accurately. Most existing systems for automating the task of landmarking and other related computer vision problems tend toward human-centric applications, such as detecting and estimating the pose of human figures (Felzenszwalb & Huttenlocher 2005; Andriluka *et al.* 2009; Shotton *et al.* 2013), landmarking human faces (Felzenszwalb & Huttenlocher 2005; Zhou *et al.* 2009; Zhu & Ramanan 2012; Guo *et al.* 2013), and landmarking medical imagery like 3D CT scans (Liu *et al.* 2000; Fatemizadeh *et al.* 2003; Potesil *et al.* 2011). There

have been relatively few applications of automated landmarking toward non-human subjects. These include a semi-automated system (where some initial human supervision is required) for landmarking three-dimensional images like mammalian skulls (Bromiley *et al.* 2014); an automated system for tracking the legs of tarantulas across video frames (Hwang & Choi 2014, 2015); and an automated system for landmarking the wings of *Drosophila melanogaster* (Palaniswamy *et al.* 2010). The latter system was most relevant to this study. It was accurate—able to predict the location of landmarks with a 2-px accuracy—but was only developed for *D. melanogaster*, one single species that has one pair of clear wings. In this study, a system was designed for automatically landmarking the wings of numerous species of dragonflies and damselflies (the insect order Odonata).

Compared to *D. melanogaster* (i.e., Palaniswamy *et al.* 2010), odonates represent a greater challenge for automating annotation. Wing shape varies considerably across the order Odonata. The suborders Zygoptera (the damselflies) and Anisoptera (the dragonflies) are named for similarity or difference of the fore- and hindwings: in most Zygoptera, both pairs of wings share a similar shape, whereas in Anisoptera, the hindwings are larger than the forewings. Wing shapes can even vary among individuals at the family level: the dragonfly family Libellulidae, for example, contains a wide variety of wing shapes, from the expanded basal region in the hindwings of *Pantala* (Appendix B, Plate 9G–H) to the undulating forewings of *Zenithoptera* (Appendix B, Plate 10G). Differences in the pattern of the wing veins follow changes in wing shape (e.g.,

Garrison *et al.* 2006, 2010); thus, a single landmark may be found in markedly different locations across the wings of multiple odonate species (or even on the fore- and hindwings of the same individual). A landmarker (human or machine) must contend with these differences. Perhaps even more challenging though are the (sometimes elaborate) color patterns found in the wings of Odonata. While, many odonates have clear or lightly-tinted wings (e.g. Appendix B, Plate 1), where wing veins contrast well on a membranous background, the wings of other species have dark or metallic tinting, or contain stripes or spots (e.g. Appendix B, Plate 4E, H–J). In some cases, this coloring can obscure the contrast between veins and membrane, making it very difficult to appropriately place landmarks, even for a human observer. An automated system for landmarking odonate wings would have to overcome these challenges.

2.2.1. <u>The pictorial structures model</u>

Felzenswalb and Huttenlocher (2005) introduced a model for recognizing objects in images using *pictorial structures* (PS), which proved to be a simple, yet powerful and extensible model. The PS model is briefly described as follows. An object (in this case a wing containing landmarks) is represented by its appearance and configuration. The configuration of landmarks is represented by a graphical model, where vertices (*parts*) are connected by stretchable edges. The best location L^* for a set of n parts $\{v_1, \ldots, v_n\}$ is determined by minimizing the cost function,

$$L^* = \arg\min_{L} \left(\sum_{i=1}^{n} m_i(l_i) + \sum_{(v_i, v_j) \in E} dij(l_i, l_j) \right), \tag{1}$$

where $m_i(l_i)$ is the appearance cost of placing part i at pixel coordinates l_i and $dij(l_i, l_j)$ is the deformation cost incurred by placing parts i and j at locations l_i and l_j. The appearances of parts can be represented in several ways, two of which are described in the Methods. Appearance and configuration parameters are learned from training images and corresponding landmark annotations. Connections between parts are modeled as a minimum-spanning tree whose edges are chosen based on the connection quality between all pairs of parts, and which is anchored at an arbitrarily-chosen root part. The best location of the root in an image is informed by the quality of the locations of all parts in the tree, measured from the tips of the tree toward the root, and that best root location also informs the best locations of the other parts, from the root to the tips. This upward-downward algorithm, constrained by a tree-structure, is called dynamic programming and, in conjunction with distance transforms (Felzenszwalb & Huttenlocher 2012), allows the minimization in Equation 1 to be efficiently calculated. In fact, a single image can be sampled multiple times (i.e. when multiple instances of the same modeled object are present) with little additional computation. The specific representations of image appearance and part configuration are discussed below.

2.2.2. <u>A novel application of the PS model</u>

In this study, the PS model was applied toward landmarking the wings of odonates, in order to test whether it could compete with manual landmarking. Automated landmarking has never yet been applied to this system, perhaps because of the previously-stated challenges: the differences in the shape and

color patterning across wings in Odonata that make this task difficult. However, the unique properties of the PS model, particularly its reliance on both the configuration of landmarks and on their appearance, may allow this model to overcome these challenges.

2.3. Methods

2.3.1. Training data

In my PS-based system for learning and predicting the locations of landmarks on images (outlined in Figure 2), a set of training images and manually annotated landmarks was used to train a model, then an additional set of images and corresponding landmarks was used to check the predicted landmark locations against manually-annotated (ground-truthed) landmarks. The system was trained and tested using 98 images of dragonfly and damselfly wings, comprising 36 species (1–16 images per species). These images were acquired by digitizing the dorsal side of the excised right fore- and hindwings of dried odonate specimens with a desktop scanner (Epson NX620, Epson America, California, USA) at 1,200 or 2,400 DPI. Training images were manually landmarked in the program *tpsDig2* (Rohlf 2005) with 11 landmarks on each wing by a human landmarker. These particular landmarks (described in Table 2 and shown on images of wings in Figure 1) were chosen because they are found in the wings of almost all species of Odonata and are fairly conspicuous so that a human worker, and presumably a computer program, could readily locate them. During analysis, each image was sampled twice: once for the forewing and once for the hindwing. This effectively doubled the size of the annotated image

dataset. To make the wings in images more uniform in scale and also reduce computation, images were converted to grayscale and were down-sampled to a specific image width, prior to analysis. The landmarks corresponding with each image were also down-scaled, proportionally. Several image widths were tested, and best results were achieved with 200 or 400-px widths. In addition, I tried preprocessing images using an edge filter with a Roberts' cross operator (Roberts 1965; Jones *et al.* 2001), which emphasizes edges in the image, such as wing veins (Figure 6).

2.3.2. Software package

Scripts for fitting and applying a PS model were written as a Python package called *autoLandmark*, which is available at http://www.crossveins.com/. This package utilizes the following libraries: OpenCV (Jones *et al.* 2001), the Python Imaging Library (PythonWare 2009), *scikit-image* (van der Walt *et al.* 2014), *NumPy* and *SciPy* (van der Walt *et al.* 2011), and *dt* (Bristow 2014) for image manipulation, *scikit-learn* (Pedregosa *et al.* 2011) for model configuration and testing, as well as *pandas* (McKinney 2010) and *matplotlib* (Hunter 2007).

2.3.3. Training a PS model

In the system, both the appearance of training images and the configuration of corresponding landmarks for those images were used to train a model (Figure 2). The model could then be applied to a novel image to predict the locations of the model and its respective landmarks on that image.

The appearance of each part was modelled by creating *templates* that describe what the part should "look like" based on the training images. Two

methods for calculating part templates were tested: a patch-based and an iconic representation. In the former representation, the region (or *patch*) of the image surrounding a landmark was taken from each training image; the template for that part was then calculated as the mean of all its training patches and normalized to have values spanning the range 0.0 to 1.0 (Fergus 2005). The size of the patch (and template) could be changed, and larger patches encapsulate more of the local image features surrounding each landmark, but at the expense of model generality (i.e., very large patches may capture mostly information that is specific to the training images, and would therefore be less helpful for searching novel images). In the iconic representation of part appearance, a set of image filters were applied to each training image. The multi-dimensional feature vector was then extracted from the filtered image at the coordinates for each of the image's training landmarks. This process was repeated for all training images and the normalized mean vector for each landmark across all images was taken as the template for that part. Nine Gabor wavelet filters were used (Figure 4), which were designed to closely mimic the nine Gaussian derivative filters used by Felzenswalb and Huttenlocher (2005). These filters were applied at three scales (σ = 1, 2, and 4), producing feature vectors of length 27 for each part.

Part configuration (i.e. how parts were arranged with respect to one another) was modeled as a set of edges E in a tree-structured graph and a set of parameters $c_{i,j} = (s_{i,j}, \Sigma_{i,j})$ where the ideal location of part i was the location of part j shifted by $s_{i,j}$. The ideal location of part i was represented as the location of part j shifted by $s_{i,j}$, but the configuration model was deformable so that

connection between parts i and j could be stretched or compressed, at a cost encoded in $\Sigma_{i,j}$. This cost could differ in the x- and y-directions, depending on the nature of the training data. The best set of edges E was determined by calculating the minimum-spanning tree (MST)—the graph which includes all parts as vertices, but with the smallest possible total edge weight (Cormen *et al.* 2009). The MST was calculated from an $n \times n$ matrix q of the "quality" of the connection between parts i and j, where $q_{i,j} = -\log\left(2\pi\, \Sigma_{i,j,x}\, \Sigma_{i,j,y}\right)$ (Fergus 2005). The MST could be navigated by first selecting an arbitrary part as its *root*. Any parts that were adjacent to the root in the tree were taken as its *children*, and this process was continued until all parts had been visited. The final parts of the tree, which had no children, were called the *tips*. Likewise, the *parent* of every part was determined from the tips to the children of the root (the root was parentless).

The configuration model is illustrated in Figure 5, which shows a minimum-spanning tree, with edges colored by their quality. Although the quality of connections was determined automatically, their configuration makes intuitive sense. Notice, for example, that the edge between parts 1 and 2, which are closely associated on the wing (see Figure 1) was relatively high quality, while the edge between parts 11 and 4, whose association on the wing is more ambiguous, was relatively low quality. The colored dots in Figure 5B show the relative position from the training landmarks of every part with respect to its parent, and the ellipses are the variance of this positional uncertainty. Notice the smaller uncertainty ellipse of part 2's location with respect to part 1, compared to the larger ellipse of part 4's location with respect to part 11. Also, notice that

some ellipses (e.g. part 4) show greater uncertainty in the x- than in the y-directions while others have similar uncertainty in both directions (e.g. part 8).

During wing-scanning, wings were not always perfectly horizontal in the digitized images. Some were rotated up to 15° clockwise or counter-clockwise from the horizontal (measured along the anterior margin of the wing). In order to account for this possible rotation when modelling wing appearance and configuration from the training images and therefore make the model more robust to rotation, I tried resampling the training images after rotating them (and their respective landmarks). The appearance and configuration of each image was sampled normally, then resampled after the image and landmarks were rotated slightly (between -15 and 15°). This rotational resampling was suggested in Felzenswalb and Huttenlocher (2005) and doubled the size of the training set.

2.3.4. Applying a fitted PS model

Once a PS model was trained, the appearance and configuration parameters were used to predict landmark locations on an image that was yet unseen by the model. This process comprised three main steps (Figure 2): calculating the cost based on appearance, performing the minimization, and sampling from the transformed response. Prior to further transformation, the image was converted to grayscale, resized to the same image width that was used in the training process, and possibly edge-filtered, (the same steps used during model training). Additionally, I tested slightly blurring the pre-processed novel image.

An *appearance cost map* for each part was calculated, based on the pre-processed novel image and part templates, where each pixel value was a cost of placing that part at that pixel location in the image. For the patch-based appearance representation, each part template was matched with the image using either OpenCV's normalized sum of squared differences (NSSD), normalized cross correlation (NCC), or normalized "CCOEFF" (NCCF) method for template matching (Bradski 2000) (Figure 7), giving a cost map where regions of the image that match the template most closely were given lower pixel values compared to poorer-matching regions, which receive higher values. For the iconic representation of appearance, the image was first transformed using the same Gabor wavelet filters that were applied to the training images. The Euclidean distance was then calculated between each 27-dimensional pixel in the transformed image and the 27-length feature vector for a part so that in the resultant map, the lowest values were for image pixels that most closely resemble that part. An appearance cost map was calculated for every part in the model.

Next, a minimization was performed, where each part's cost map was translated and distance transformed, recursively, from the parts at the tree's tips to the its root. Starting at any tip (part i) and given its parent (j), i's cost map was translated by $s_{i,j}$, and the edges of the cost map where padded as needed with high-valued (10^{200}) pixels, making the edges of the translated cost map non-ideal for part placement. A distance transform (DT) was then performed on the translated cost map using an algorithm by Felzenswalb and Huttenlocher (2012),

implemented for Python by Bristow (2014). Under the DT, the translated cost map was transformed into a “landscape” of paraboloid-shaped, overlapping craters (Figure 8). The bottoms of the craters were local minima from the map, their depths were dependent on pixel values at local minima (smaller values produced deeper craters), and their widths (in both the x- and y-directions) were determined by $1/\Sigma_{i,j}$. In this way, there was a smooth, gradual transition in pixel values from more ideal (local minima) to less ideal pixel locations. In addition to the distance-transformed landscape, the DT algorithm simultaneously produced a table giving the location of the nearest local minimum for every pixel in the landscape. The translation and DT were repeated recursively, working root-ward, producing *part response maps* (i.e. the landscapes) and *part locations maps* (i.e. the tables of locations) for every part in the MST. The *total response map* was taken as the sum of all part response maps and represented the best locations for the root. Figure 9 shows the translated, distance transformed version of the appearance cost maps in Figure 7, as well as the total response map (bottom right) for a sample image. Because the translation process sometimes seemed to crop out the ideal location for a part in the translated cost map, I tried adding additional padding (of 10 px, with values of 10^{200}) around each part’s appearance map prior to translation. Also, part appearance could be weighted over configuration by multiplying the translated cost maps by a scalar prior to distance transformation (Fergus 2005). I tested models with weighting values of 5 and 10.

The best locations of landmarks in each wing in the image were then predicted by sampling the results of the minimization. The best model location for

the first wing was represented by the location of the global minimum in the total response map. Specifically, this was the predicted optimal coordinates for the root in the image. Next, given a part i, a child of the root, and its parent j (in this case, the root), the coordinates from the jth part locations map at the predicted coordinates for j were taken and $s_{i,j}$ was added, giving the predicted coordinates for part i. This process was repeated recursively for the rest of the root's children, then their children, etc. until coordinates were predicted for all parts in the model. To resample the minimization results for the second wing, an area surrounding the global minimum in the total response map was first masked, then the location of the global minimum from this new response map was determined, and the steps above were repeated to calculate predicted coordinates for the remaining parts in the second wing.

2.3.5. Evaluating model performance

2.3.5.1. Parameter search

In order to determine the best combination of parameters for fitting the PS model to the images of odonate wings, I ran an exhaustive grid search over several possible parameters; however, to reduce the amount of time this search would take, I limited the parameters to those determined to be promising based on pilot testing. Specifically, I tested the following parameters: image/landmark down-sampling width (200 or 400 px), edge-filtering during image pre-processing (yes or no), part appearance representation (patch or iconic), root of tree (part 1 or 4), whether rotational resampling is used (yes or no), configuration-appearance weighting (5 or 10), degree of blurring prior to minimization (no

blurring or σ = 1), and amount of additional padding added to appearance cost maps prior to minimization (0 or 10 px around all edges). For patch-based appearance models, I tested the following additional parameters: patch size (7, 13, or 21 px square patches), template-matching method for calculating appearance cost maps (NSSD, NCC, or NCCF). There were a total of 1280 parameter combinations, and for each, a PS model was fit to 20 randomly selected images from the training data, then tested on another 20 randomly selected images. This was repeated 5 times. Since a “bad” set of training images can result in an otherwise “good” combination of parameters giving bad predictive performance, only the best 3 of those 5 replicates were used to score the combination (as in Palaniswamy *et al.* 2010). Replicates and combinations were scored by the mean of the root-mean-square error (RMSE; Bishop 2006) between each predicted and true landmark coordinate across all points in the set. RMSE can be taken as the amount of error, in pixels, in the automatic landmarking process.

In order to determine the best possible performance that can be expected from this system, I used the “best” combination of model parameters (i.e., the one with the lowest mean RMSE) to trained a model on half of the full dataset, then tested it on the other half. I repeated this for 10 replicates, then took the top 6 of 10 replicates, based on each replicates mean RMSE, and determined how many predicted coordinates, out of those 6 replicates were within different pixel distances from their true coordinates. I also qualitatively assessed the model

from the best replicate by manually inspecting several test images onto which the true and predicted landmarks were mapped.

2.3.5.2. Effect of training sample size on landmarking error (RMSE)

The effect of training a model with different numbers of training samples was tested by ranging the number of samples used to train models from 5 to 75 in increments of 5, while holding the number of testing samples to 20 other individuals. Training and testing samples were randomly selected, without replacement, from the full dataset. Models were trained using the best combination of parameters. This process was repeated for 10 replicates, and the best 6 out of 10 replicates were kept. Training set sizes were compared by the RMSE between predicted and true points across all replicates for each size. I expected that the variation in larger sets would more closely resemble the variation in the entire dataset; and thus, models trained on larger sets would have lower RMSE.

2.3.5.3. Effect of dataset composition on landmarking error

I tested the performance of models that were trained using the full dataset compared to subsets of the dataset based on morphology and taxonomy. Among the dragonflies in the dataset, 23 “clear-winged” species were chosen (see Table 1) as those where the wings veins clearly stood out against mostly-clear wing membrane, although several species may have slight amber or brown tinting at the base of the wings. I also chose two genera for which there were multiple species in the dataset: the clear-winged dragonfly genus *Macromia* (14 species in the dataset) and the colorful and polymorphic damselfly genus, *Polythore* (10

species). Finally, I chose the clear-winged dragonfly species, *Erythemis simplicicollis*, for which there were 16 individuals. Thus the datasets were as follows: the full dataset containing all odonates; clear-winged dragonflies, only; *Macromia* spp., only; *Polythore* spp., only; and *E. simplicicollis*, only. Using best parameter combination, a model was trained using 15 individuals from the set and tested using another 15 individuals. The training and testing sample size was set at 15 to control for training set size, since the smallest of these datasets contained 15 individuals, and thus 30 wings**.** This was repeated for 10 replications, each, and the worst 4 replications were dropped. I expected that reducing the diversity in appearance and configuration of landmarks among individuals would reduce landmarking error in a trained model (i.e., a model would perform best when individuals among the training and testing sets are more similar to one another). Because there appeared to be less diversity wing shape and coloration in the clear-winged dragonflies, I predicted that the clear-winged dragonflies would perform better than the full dataset or *Polythore* spp. dataset, which both contain individuals that vary significantly in both appearance and wing shape. In addition, I expected that the *Macromia* spp. and *E. simplicicollis* sets would perform at least as well as the clear-winged set, since their members were more similar to one another, compared to the other sets.

2.4. Results

I tested the system using 98 scanned and manually annotated images of odonate wings. The images were approximately 2,500–4,500 px in length and width, before down-sampling for analysis. It should be noted that predicted

landmarks were up-scaled back up the original scale of the image; therefore the landmarking error (RMSE, measured in pixels) described below was measured between full-scale true and full-scale predicted landmarks.

2.4.1. Parameter search

I ran a search for the best combination of 10 parameters, with 5 replicates each, then kept only the best 3 out of 5 replicates. Doing so reduced the mean RMSE among all 1280 combinations from 584.6 ± 462.1 px (mean ± SD) with all replicates to 529.3 ± 425.4 px after dropping the worst 2 replicates per combination. In the best combination, error ranged from 3.8–1972.3 px (237.4 ± 231.3 px). Of the best 50 combinations of parameters, 400-px down-sampling width was favored (36 out of 50 combinations), most (30) had no edge-filtering, the patch appearance representation predominated (43) over the iconic appearance model (although the best combination used the iconic representation), the choice of assigning parts 1 or 4 as the root of the tree-structured model was similar (26 and 24, respectively), rotational resampling (where images were randomly rotated by a small amount, then resampled during training) was not favored (32 ‘no’s), configuration-appearance weighting leaned toward 10 (34), blurring before minimization was not favored (23 ‘yes’s), and adding 10-px padding (as opposed to no padding) to the appearance cost maps prior to minimization was somewhat favored (28). Among the 43 combinations with the patch-based appearance model, a 7-px patch size was most favored (27 out of 43 combinations) followed by the 21-px patch size (10), and the NSSD method for template-matching was most favored (27) followed by the NCCF

method (12). The best combination of parameters had a mean RMSE of 237.5 (± 231.3) px, and had the following parameters: down-sampling width = 200 px, yes for edge-filtering, iconic representation for part appearance, root = 1, no for rotational resampling, configuration-appearance weighting of 10, $\sigma = 1$ for blurring, and no additional padding.

Using the best combination of parameters, models were trained using the full dataset. Mean RMSE among the best 6 of 10 replicates ranged from 422.5 (± 319.7) to 535.2 (± 392.6) px. Table 3 shows the distribution of RMSE values across all predicted points in the 6 best replicates. Unfortunately, even the best models did not perform well: only 8% of points were within 100 px of their target, and most (9,390 points) were more than 200 pixels away. Figure 13 shows some examples of landmark predictions made by the best model, which were loosely rated as “good”, “fair” and “poor” based on the mean per-wing RMSE for each image.

2.4.2. Effect of training sample size on landmarking error

I trained models with the best model parameters while varying the training sample size between 7 and 75, and keeping the number of testing samples at 20 (Figure 11). Sample size affected RMSE much less than expected and RMSE varied considerably within sample-size groups; however, there were significant differences in RMSE by sample size (ANOVA; df = 14 and 2625, $F = 39.86$, $p \ll 0.0001$). A Tukey HSD post-hoc test ($\alpha = 0.05$) showed that sample sizes 10 and 30 had significantly smaller RMSE (mean ± SD 331.0 ± 313.1 and 363.3 ± 330.1, respectively) than all other groups except sample size 25 (385.6 ± 343.4).

2.4.3. Effect of dataset composition on landmarking error

Dataset composition had a slightly more noticeable effect on RMSE than training sample size despite very high variance of RMSE (Figure 12). The *Macromia* spp. dataset showed significantly lower error than the other groups (ANOVA: df = 4 and 1975, $F = 190.7$, $p << 0.0001$; Tukey HSD, $\alpha = 0.05$; mean ± SD 339.6 ± 388.8 RMSE), while the *E. simplicicollis* dataset performed significantly worse than all the other sets (668.0 ± 583.0). Models trained with the full dataset, clear-winged dragonflies, and *Polythore* spp. sets did not perform significantly different from one-another, which is surprising, since—based on qualitative assessment—appearance and wing shape vary considerably more in the full dataset and *Polythore* set than among the clear-winged dragonflies.

2.5. Discussion

In this study, I tested a PS model for automatically landmarking images of the wings a challenging insect group: the Odonata. Such a system could be extremely beneficial for odonate researchers in that it would allow them to annotate images much faster and more objectively than is currently possible with manual landmarking. In order to compete with manual landmarking and be of use for GMM analysis, I estimated that the system's landmarking error would need to be less than ca. 10 px (the approximate width of the average wing vein in the image dataset); however, the best landmarking models had an error of 300–500 px. Indeed, I tested several methods for varying the landmarking model, for example, by different appearance representations and by resampling images with rotation, to improve it. As shown in Figure 13, the system performed

reasonably well on some images—but with extremely high variability in error—and very poorly on other images. It is unclear why there was such variability in the landmarking performance and, unfortunately, the system was not a viable replacement for manual landmarking at this time.

It may be possible to improve upon my system and thereby reduce landmarking error and the most effective way to do that would likely be to change the way in which part appearance is represented, which underlies the appearance model part of Felzenszwalb and Huttenlocher's (2005) PS model. The appearance representation must be able to generalize the appearance of a part and locate a preferably small number of candidate locations for this part in a novel image. Possible alternatives the patch-based and iconic representations that I tested in this study could be (a) the pairwise geometric histograms (Palaniswamy *et al.* 2010), which take into account the shape of edges in the image (this may be particularly useful for densely-veined wings), or (b) the ORB (Oriented FAST and Rotated BRIEF) algorithm for detecting image features (Rublee *et al.* 2011), which has been shown to be highly effective for matching parts of an object across images. Such alternatives might be able to better overcome the differences in wing shape and coloration across Odonata.

2.6. References

Adams, D.C., Rohlf, F.J. & Slice, D.E. (2004). Geometric morphometrics: ten years of progress following the 'revolution'. *Italian Journal of Zoology*, **71**, 5–16.

Andriluka, M., Roth, S. & Schiele, B. (2009). Pictorial structures revisited: People detection and articulated pose estimation. *IEEE Conference on Computer Vision and Pattern Recognition, 2009. CVPR 2009*, pp. 1014–1021.

Aytekin, M.A., Terzo, M., Rasmont, P. & Çağatay, N. (2007). Landmark based geometric morphometric analysis of wing shape in *Sibiricobombus* Vogt (Hymenoptera: Apidae: *Bombus* Latreille). *Annales de la Société entomologique de France (N.S.)*, **43**, 95–102.

Bishop, C. (2006). *Pattern Recognition and Machine Learning*. Springer, New York, NY.

Bradski, G. (2000). The OpenCV library. *Dr. Dobb's Journal of Software Tools*, **25**, 120–126.

Bristow, H. (2014). *Distance transforms of sampled functions*.

Bromiley, P.A., Schunke, A.C., Ragheb, H., Thacker, N.A. & Tautz, D. (2014). Semi-automatic landmark point annotation for geometric morphometrics. *Frontiers in Zoology*, **11**, 61.

Cardini, A., Jansson, A.-U. & Elton, S. (2007). A geometric morphometric approach to the study of ecogeographical and clinal variation in vervet monkeys. *Journal of Biogeography*, **34**, 1663–1678.

Caumul, R. & Polly, P.D. (2005). Phylogenetic and environmental components of morphological variation: skull, mandible, and molar shape in marmots (*Marmota*, Rodentia). *Evolution*, **59**, 2460–2472.

Clabaut, C., Bunje, P.M.E., Salzburger, W. & Meyer, A. (2007). Geometric morphometric analyses provide evidence for the adaptive character of the Tanganyikan cichlid fish radiations. *Evolution*, **61**, 560–578.

Cormen, T.H., Leiserson, C.E., Rivest, R.L. & Stein, C. (2009). *Introduction to Algorithms*, 3rd edn. MIT Press, Cambridge, MA.

Fatemizadeh, E., Lucas, C. & Soltanian-Zadeh, H. (2003). Automatic landmark extraction from image data using modified growing neural gas network. *IEEE Transactions on Information Technology in Biomedicine*, **7**, 77–85.

Felzenszwalb, P.F. & Huttenlocher, D.P. (2012). Distance transforms of sampled functions. *Theory of Computing*, **8**, 415–428.

Felzenszwalb, P.F. & Huttenlocher, D.P. (2005). Pictorial Structures for Object Recognition. *International Journal of Computer Vision*, **61**, 55–79.

Fergus, R. (2005). A simple parts and structure object detector. *ICCV 2005 short courses on Recognizing and Learning Object Categories*. URL http://web.eecs.umich.edu/~silvio/teaching/lectures/partsstructure.html [accessed 1 October 2014]

Garrison, R.W., von Ellenrieder, N. & Louton, J.A. (2010). *Damselfly Genera of the New World: An Illustrated and Annotated Key to the Zygoptera*. Johns Hopkins University Press, Baltimore, MD.

Garrison, R.W., von Ellenrieder, N. & Louton, J.A. (2006). *Dragonfly Genera of the New World: An Illustrated and Annotated Key to the Anisoptera*. The Johns Hopkins University Press, Baltimore, MD.

Guo, J., Mei, X. & Tang, K. (2013). Automatic landmark annotation and dense correspondence registration for 3D human facial images. *BMC Bioinformatics*, **14**, 232.

Hunter, J.D. (2007). Matplotlib: A 2D Graphics Environment. *Computing in Science Engineering*, **9**, 90–95.

Hwang, S. & Choi, Y. (2014). Pose estimation of small-articulated animals using multiple view images. *Proceedings of the International Conference on Computer Graphics, Visualization and Computer Vision*.

Hwang, S. & Choi, Y. (2015). Tracking the joints of arthropod legs using multiple images and inverse kinematics. *International Journal of Precision Engineering and Manufacturing*, **16**, 669–675.

Ibañez, A.L., Cowx, I.G. & O'Higgins, P. (2007). Geometric morphometric analysis of fish scales for identifying genera, species, and local populations within the Mugilidae. *Canadian Journal of Fisheries and Aquatic Sciences*, **64**, 1091–1100.

Jones, E., Oliphant, E. & Peterson, P. (2001). *SciPy: Open Source Scientific Tools for Python*.

Liu, J.-K., Chen, Y.-T. & Cheng, K.-S. (2000). Accuracy of computerized automatic identification of cephalometric landmarks. *American Journal of Orthodontics and Dentofacial Orthopedics*, **118**, 535–540.

McKinney, W. (2010). Data Structures for Statistical Computing in Python. *Proceedings of the 9th Python in Science Conference* (eds S. van der Walt & J. Millman), pp. 51–56.

Outomuro, D., Adams, D.C. & Johansson, F. (2012). The evolution of wing shape in ornamented-winged damselflies (Calopterygidae, Odonata). *Evolutionary Biology*, 1–10.

Palaniswamy, S., Thacker, N.A. & Klingenberg, C.P. (2010). Automatic identification of landmarks in digital images. *IET Computer Vision*, **4**, 247–260.

Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., THirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., Dubourg, V., Vanderplas, J., Passos, A., Cournapeau, D., Brucher, M., Perrot, M. & Duchesnay, E. (2011). Scikit-learn: machine learning in Python. *Journal of Machine Learning Research*, **12**, 2825–2830.

Potesil, V., Kadir, T., Platsch, G. & Brady, S.M. (2011). Personalization of pictorial structures for anatomical landmark localization. *Information Processing in Medical Imaging: Proceedings of the ... Conference*, **22**, 333–345.

PythonWare. (2009). *Python Imaging Library (PIL)*.

Roberts, L.G. (1965). Machine perception of three-dimensional solids. *Optical and Electro-Optical Information Processing* (eds J. Tippett, D. Berkowitz, L. Clapp, C. Koester & A. Vanderburgh), pp. 159–197. MIT Press, Cambridge, MA.

Rohlf, F.J. (2005). tpsDig, digitize landmarks and outlines, version 2.05. *Department of Ecology and Evolution, State University of New York at Stony Brook*.

Rublee, E., Rabaud, V., Konolige, K. & Bradski, G. (2011). ORB: An efficient alternative to SIFT or SURF. *2011 IEEE International Conference on Computer Vision (ICCV)*, pp. 2564–2571.

Sadeghi, S., Adriaens, D. & Dumont, H.J. (2009). Geometric morphometric analysis of wing shape variation in ten European populations of *Calopteryx splendens* (Harris, 1782) (Zygoptera: Odonata). *Odonatologica*, **38**, 343–360.

Sanchez Herrera, M., Kuhn, W.R., Lorenzo-Carballa, O., Harding, K.M., Ankrom, N., Sherratt, T.N., Hoffmann, J., Van Gossum, H., Ware, J.L., Cordero-Rivera, A. & Beatty, C.D. (2015). Mixed Signals? Morphological and Molecular Evidence Suggest a Color Polymorphism in some Neotropical *Polythore* Damselflies. *PLoS ONE*, **10**, e125074.

Shotton, J., Sharp, T., Kipman, A., Fitzgibbon, A., Finocchio, M., Blake, A., Cook, M. & Moore, R. (2013). Real-time human pose recognition in parts from single depth images. *Commun. ACM*, **56**, 116–124.

Walker, E.M. (1953). *The Odonata of Canada and Alaska*. University Press, Toronto.

van der Walt, S., Colbert, S.C. & Varoquaux, G. (2011). The NumPy Array: A Structure for Efficient Numerical Computation. *Computing in Science Engineering*, **13**, 22–30.

van der Walt, S., Schönberger, J.L., Nunez-Iglesias, J., Boulogne, F., Warner, J.D., Yager, N., Gouillart, E. & Yu, T. (2014). scikit-image: image processing in Python. *PeerJ*, **2**, e453.

Zhou, D., Petrovska-Delacrétaz, D. & Dorizzi, B. (2009). Automatic landmark location with a combined active shape model. *IEEE 3rd International Conference on Biometrics: Theory, Applications, and Systems, 2009. BTAS '09*, pp. 1–7.

Zhu, X. & Ramanan, D. (2012). Face detection, pose estimation, and landmark localization in the wild. *2012 IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pp. 2879–2886.

2.7. Tables and Figures

Table 1. **Species included in dataset for this study.**

Suborder: Family	Species	No. images	Clear-winged dragonfly?
Anisoptera: Aeshnidae	*Aphylla williamsonia*	1	yes
Anisoptera: Aeshnidae	*Basiaeschna janata*	2	yes
Anisoptera: Cordulegastridae	*Cordulegaster maculata*	2	yes
Anisoptera: Corduliidae	*Didymops transversa*	1	yes
Anisoptera: Corduliidae	*Epitheca princeps*	2	no
Anisoptera: Corduliidae	*Somatochlora minor*	1	yes
Anisoptera: Gomphidae	*Gomphaeschna furcillata*	2	yes
Anisoptera: Gomphidae	*Gomphus exilis*	1	yes
Anisoptera: Libellulidae	*Celithemis eponina*	16	no
Anisoptera: Libellulidae	*Erythemis simplicicollis*	16	yes
Anisoptera: Libellulidae	*Erythemis vesiculosa*	16	yes
Anisoptera: Macromiidae	*Macromia alleghaniensis*	1	yes
Anisoptera: Macromiidae	*Macromia annulata*	1	yes
Anisoptera: Macromiidae	*Macromia aureozona*	1	yes
Anisoptera: Macromiidae	*Macromia daimoji*	1	yes
Anisoptera: Macromiidae	*Macromia illinoiensis*	2	yes
Anisoptera: Macromiidae	*Macromia magnifica*	1	yes
Anisoptera: Macromiidae	*Macromia manchurica*	1	yes
Anisoptera: Macromiidae	*Macromia margarita*	1	yes
Anisoptera: Macromiidae	*Macromia moorei*	1	yes
Anisoptera: Macromiidae	*Macromia pacifica*	1	yes
Anisoptera: Macromiidae	*Macromia pinratani*	1	yes
Anisoptera: Macromiidae	*Macromia splendens*	1	yes
Anisoptera: Macromiidae	*Macromia taeniolata*	1	yes
Anisoptera: Macromiidae	*Macromia tillyardi*	1	yes
Zygoptera: Calopterygidae	*Calopterayx maculata*	1	no
Zygoptera: Polythoridae	*Polythore concinna*	1	no
Zygoptera: Polythoridae	*Polythore derivata*	1	no
Zygoptera: Polythoridae	*Polythore gigantea*	1	no
Zygoptera: Polythoridae	*Polythore mutata*	1	no
Zygoptera: Polythoridae	*Polythore neopicta*	1	no
Zygoptera: Polythoridae	*Polythore ornata*	8	no
Zygoptera: Polythoridae	*Polythore picta*	1	no
Zygoptera: Polythoridae	*Polythore procera*	1	no
Zygoptera: Polythoridae	*Polythore spaeteri*	1	no
Zygoptera: Polythoridae	*Polythore victoria*	8	no

Table 2. **The 11 landmarks used in this study.** Figure 1 shows examples of these landmarks on odonate wings.

Landmark No.	Description*
1	Anterior of arculus
2	Posterior of arculus
3	Nodus
4	Intersection of nodus and R
5	Proximo-anterior corner of pterostigma
6	Disto-anterior corner of pterostigma
7	Distal end of M_1
8	Distal end of M_2
9	Distal end of M_4
10	Distal end of Cu_1
11	Proximal end of Cu_1

*Wing venation names taken from Walker (1953).

Table 3. **Distribution of landmarking error by best-parameter models.** RMSE of all predicted versus true coordinates across the best 6 of 10 replicated models using the top-ranking set of parameters and trained/tested on the full dataset. The first line, for example is read like this: among all the 12,936 coordinates predicted by the best 6 models, 0 (or 0.00 cumulative percent of all the points) were within 3 px of their true coordinates.

Pixel range (RMSE)	No. points (non-cumul.)	Cumulative % of points
3	0	0.00
4	2	0.02
5	3	0.04
10	15	0.15
15	17	0.29
20	26	0.49
30	55	0.91
40	66	1.42
50	86	2.09
75	281	4.26
100	429	7.58
150	1,198	16.84
200	1,368	27.41
500	4,408	61.49
>500	4,982	100.00
Total points	**12,936**	

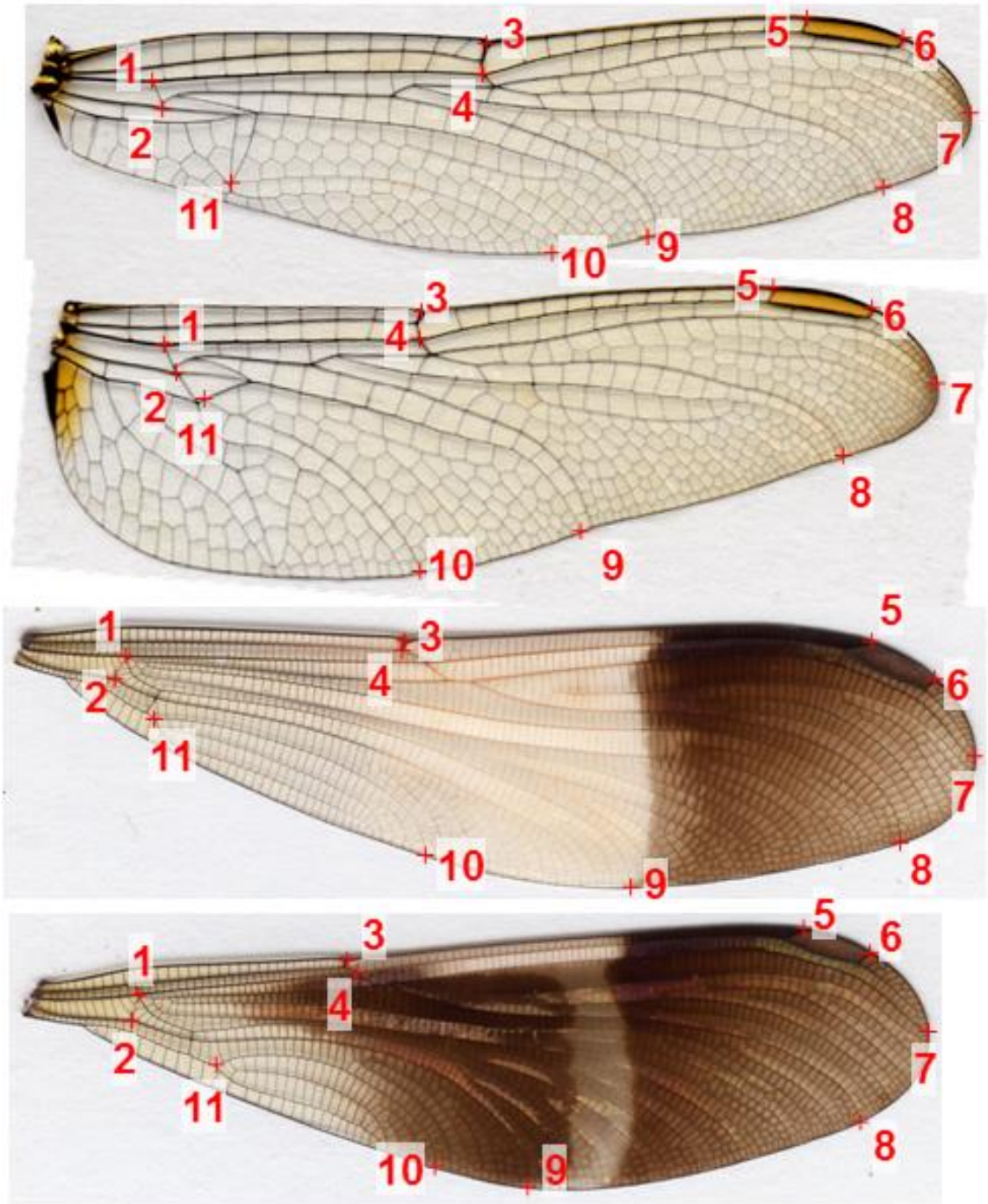

Figure 1. **Examples of the 11 landmarks used in this study.** See Table 2 for descriptions of landmarks.

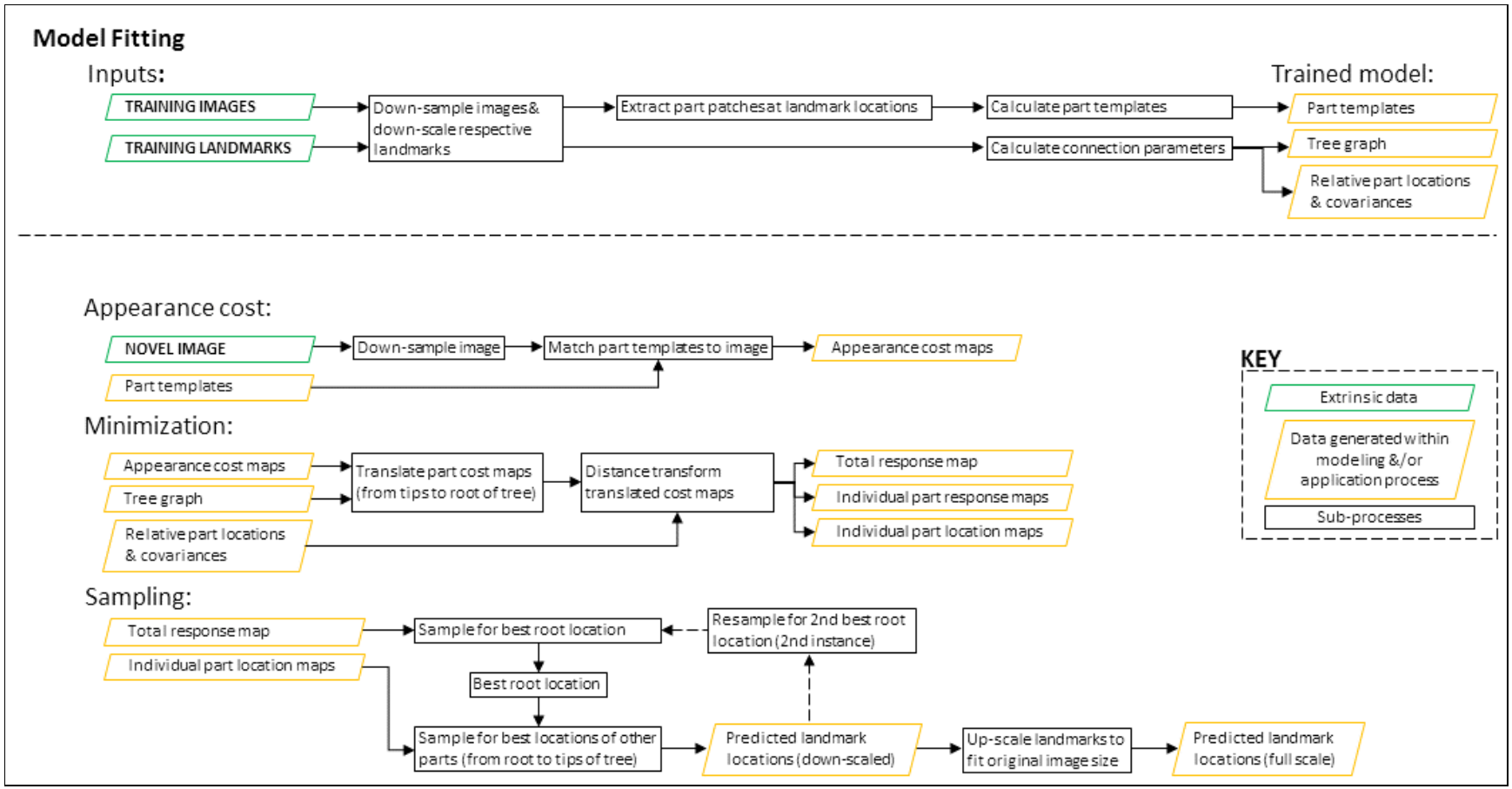

Figure 2. **Automatic landmarking process flowchart.** See Methods for further description.

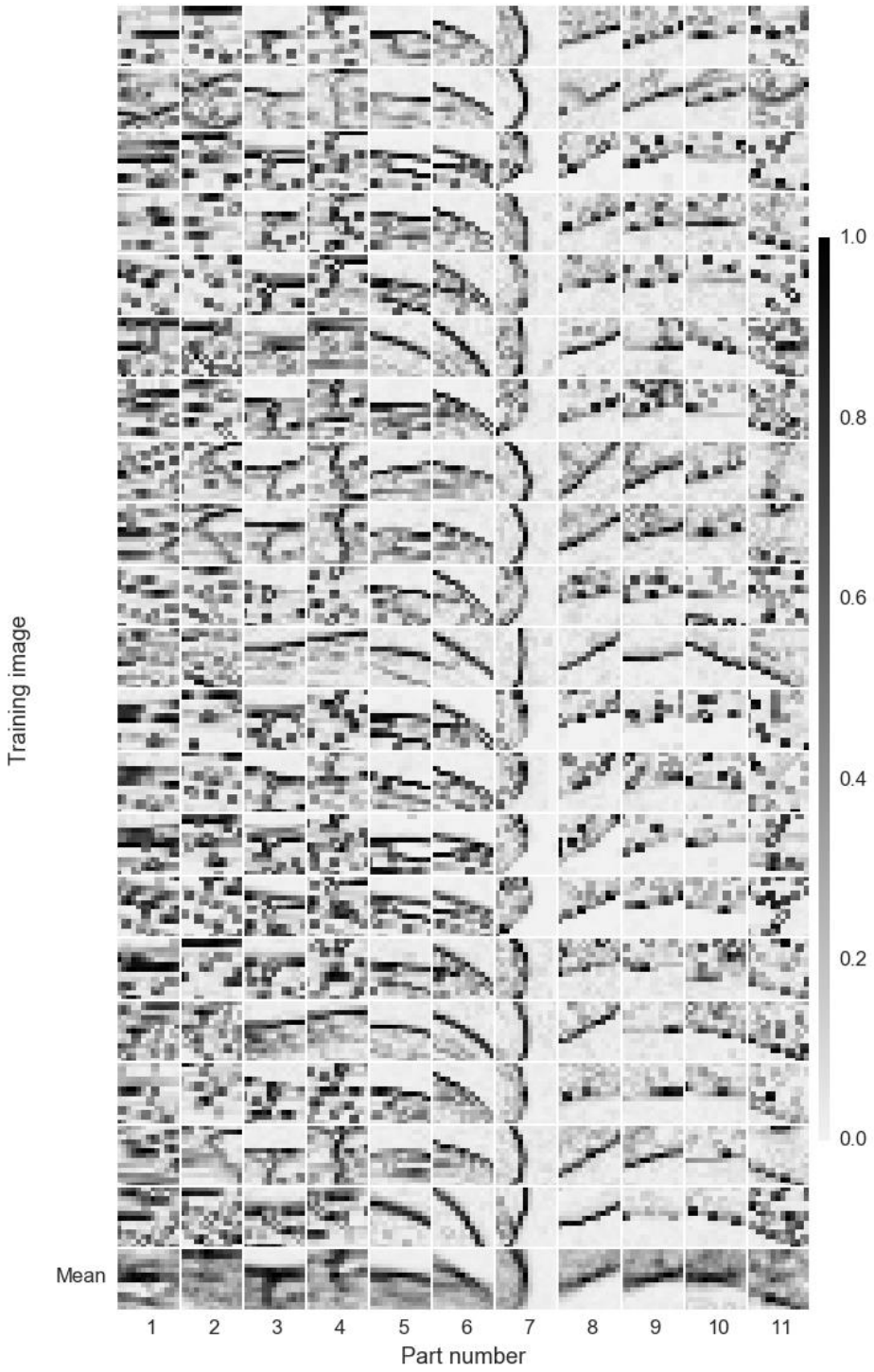

Figure 3. **Patch-based appearance representation example.** Part appearance in the Pictorial Structures model can be represented by taking patches of training images surrounding landmarks. Here patches of 20 randomly selected images are shown for each of the 11 model parts (rows). The bottom row is the normalized mean patch for each part which is taken as a template for what that part should “look like.” Note: edge detection was applied to images prior to extraction.

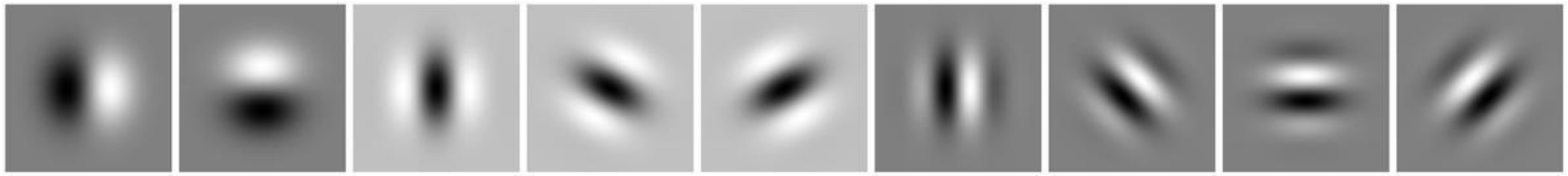

Figure 4. **The nine Gabor wavelet filters used for iconic representation of part appearance.** Part appearance can also be represented as iconic indices taken from filtered images. These nine filters were designed to mimic the nine Gaussian derivative filters used by Felzenszwalb and Huttenlocher (2005), and were used to filter images prior to extraction of iconic indices.

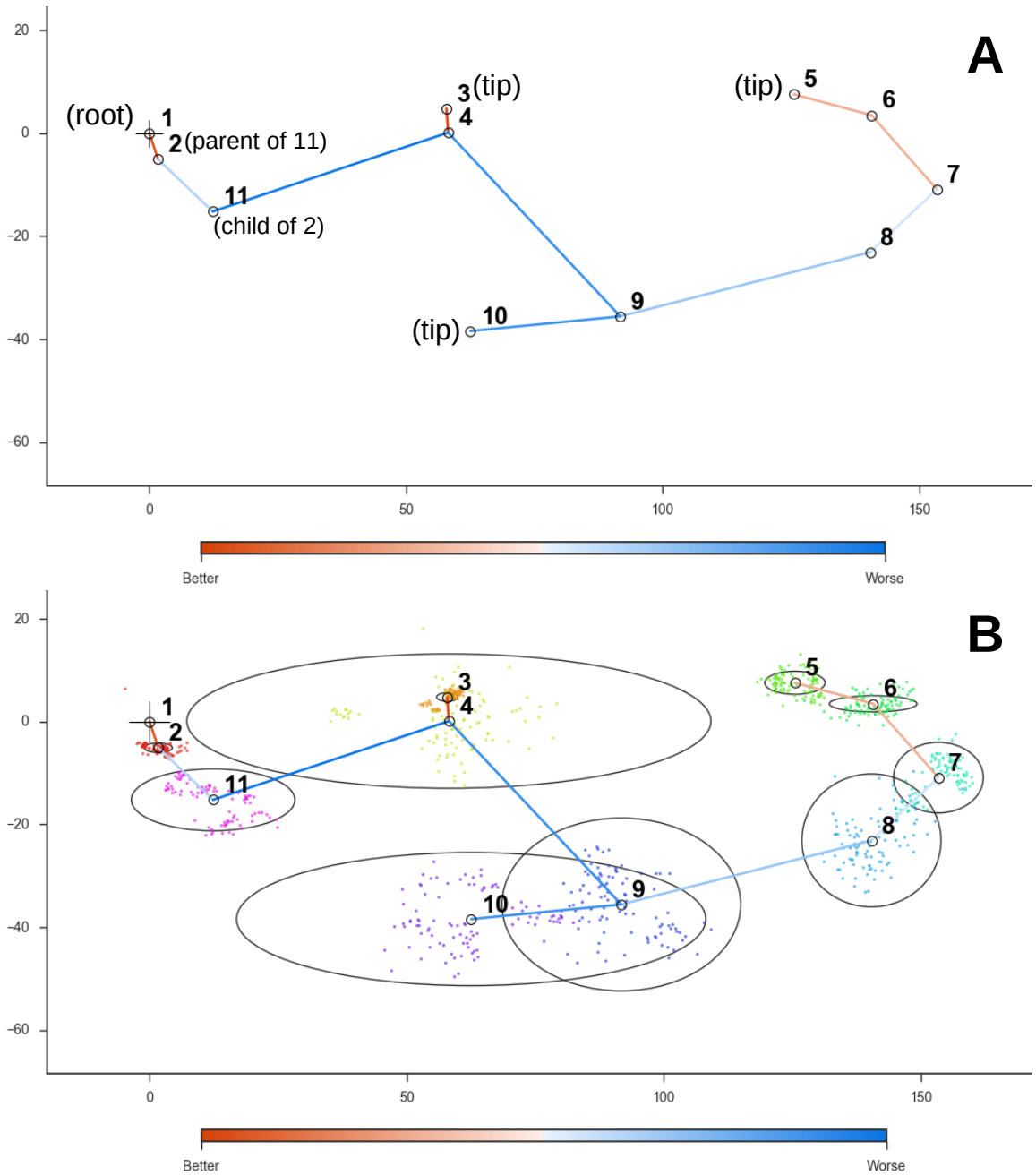

Figure 5. **Example of configuration model.** The configuration of parts in the Pictorial Structures model is represented in part by a minimum-spanning tree (MST) connecting all parts based on the quality of their connections in the training data. (A): an MST where connections are colored by quality. Here the model is rooted at part 1, and thus the tips of the tree are parts 3, 5, and 10. Parts have parents (e.g. 2 is the parent of 11) and children (e.g. 11 is the child of 2). (B): colored points indicate the position of each part relative to its parent; ellipses indicate the variance of the uncertainty in relative part location.

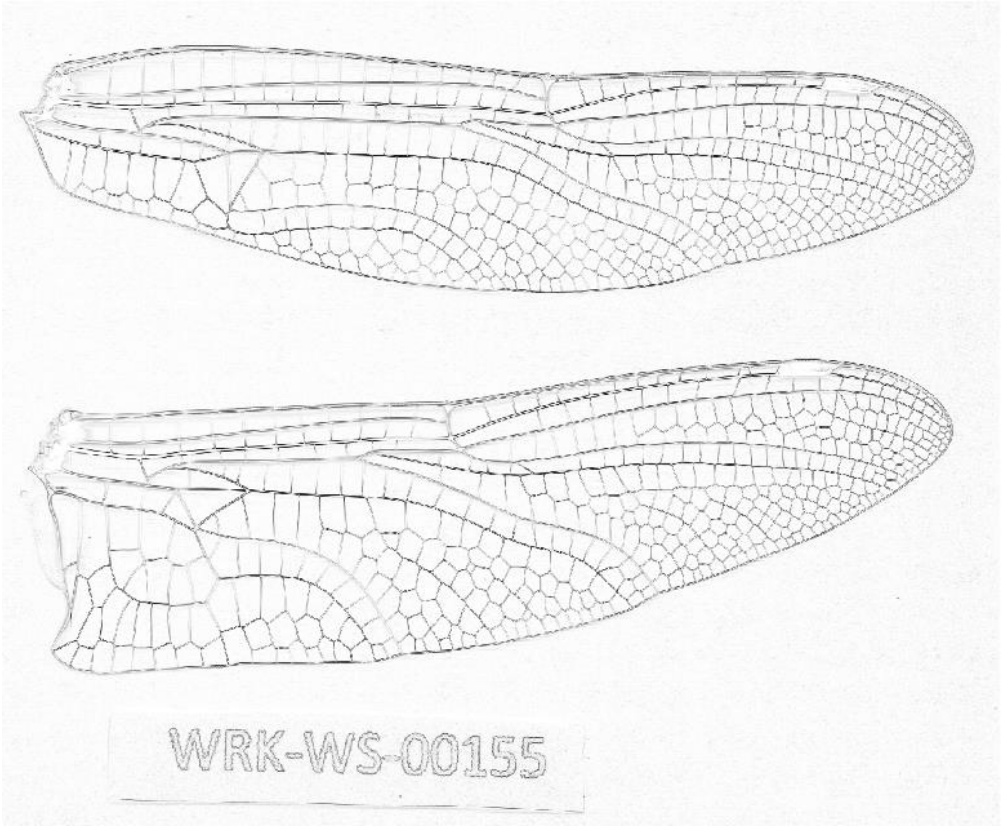

Figure 6. **Edge filtering.** A training image to which edge filtering has been applied using a Roberts' cross operator (σ=1; Roberts 1965; Jones *et al.* 2001).

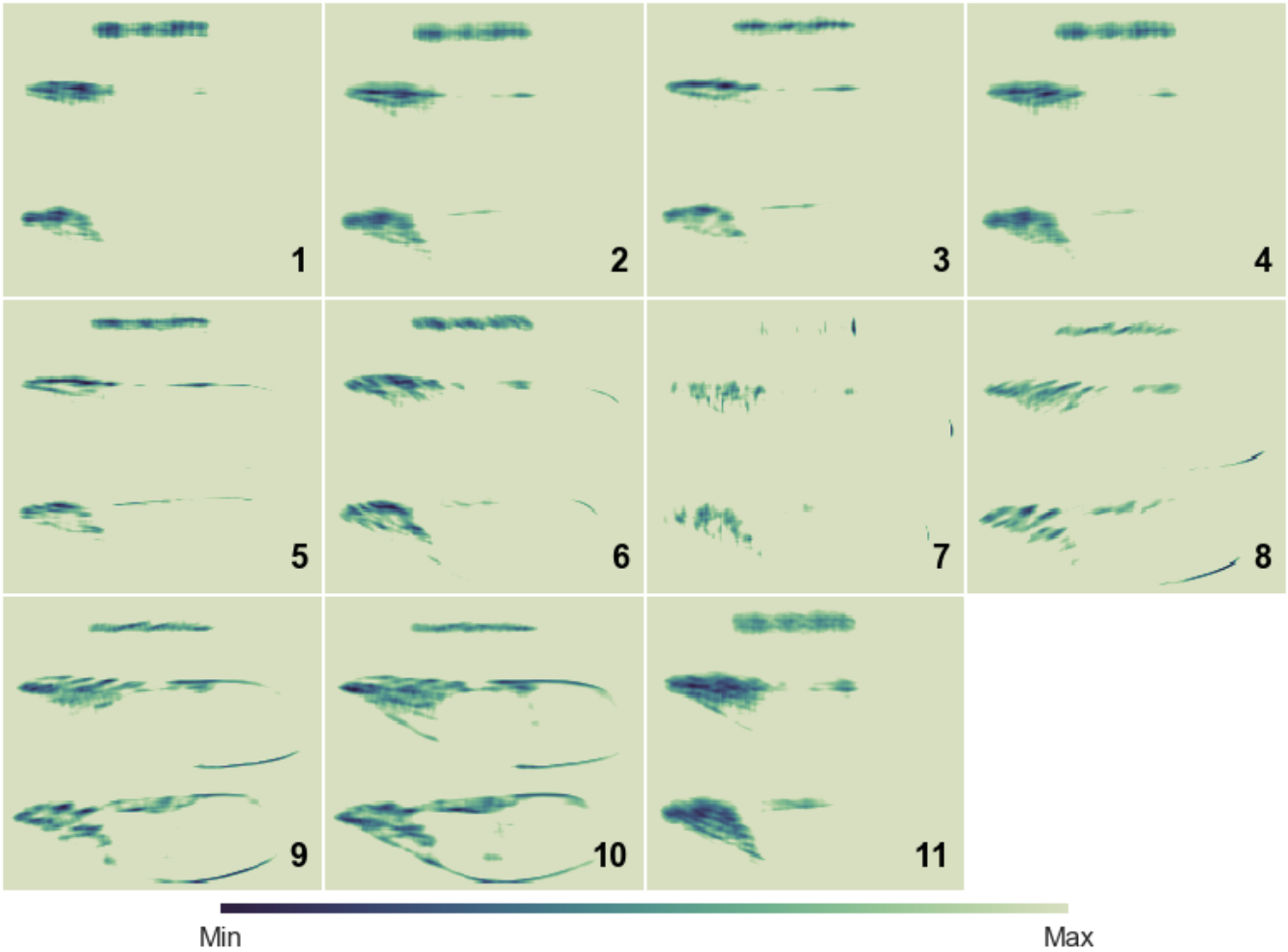

Figure 7**. Appearance cost map demonstration.** An appearance cost map, by part number (1–11), calculated by matching patch-based part templates (as in Figure 3) to a down-sampled image after applying edge detection. A lower cost is incurred for placing part i at the darker regions (smaller values) than lighter ones (larger values). Figure 1 shows part locations on wings.

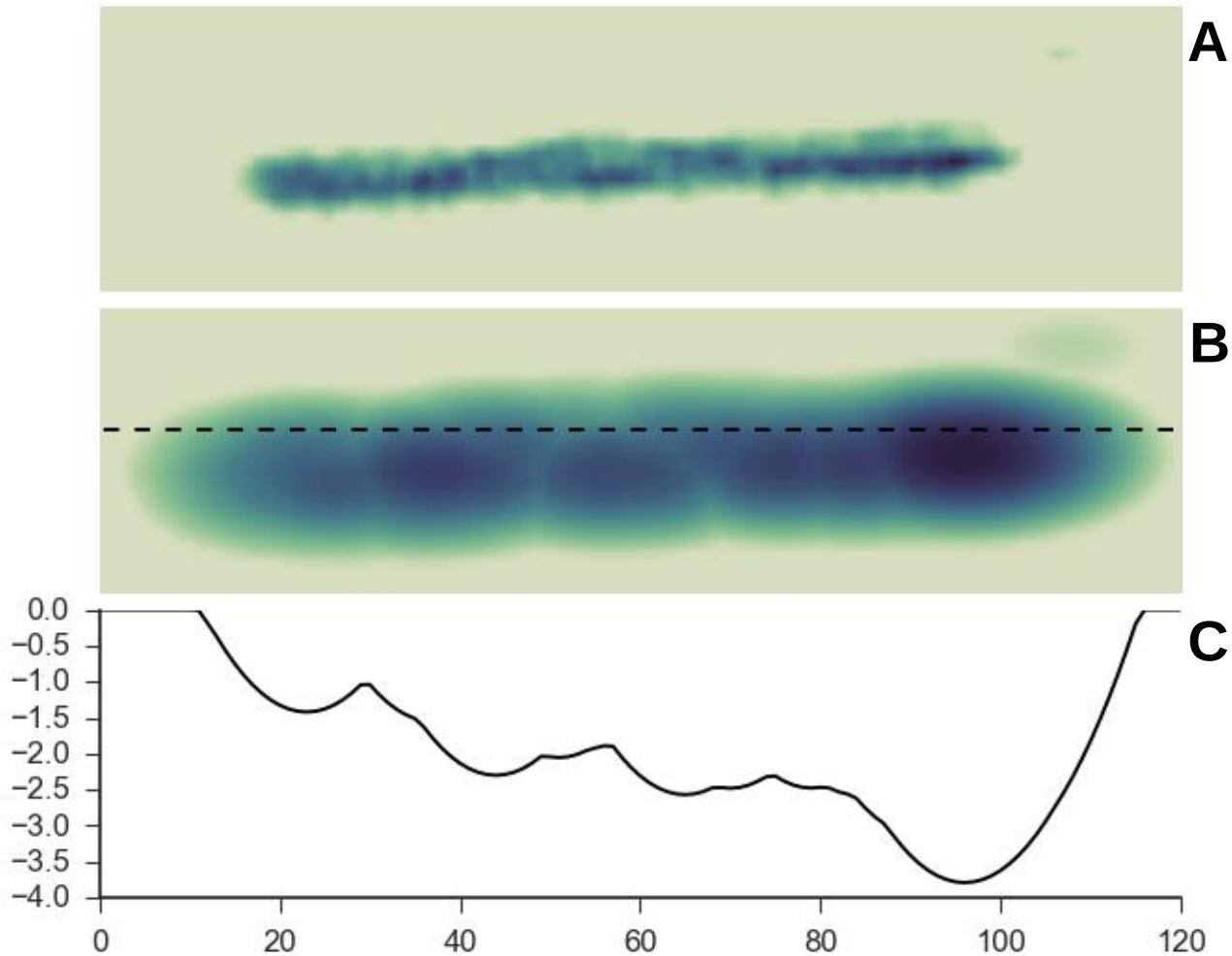

Figure 8. **Demonstration of distance transform.** An excerpt from an appearance map before (A) and after distance transformation (B). The values of image (B) under the dotted line are plotted in (C). Notice that (C) comprises overlapping, upward-opening parabolas and that the bottoms of these parabolas correspond to local minima (darker color) in the appearance map (A).

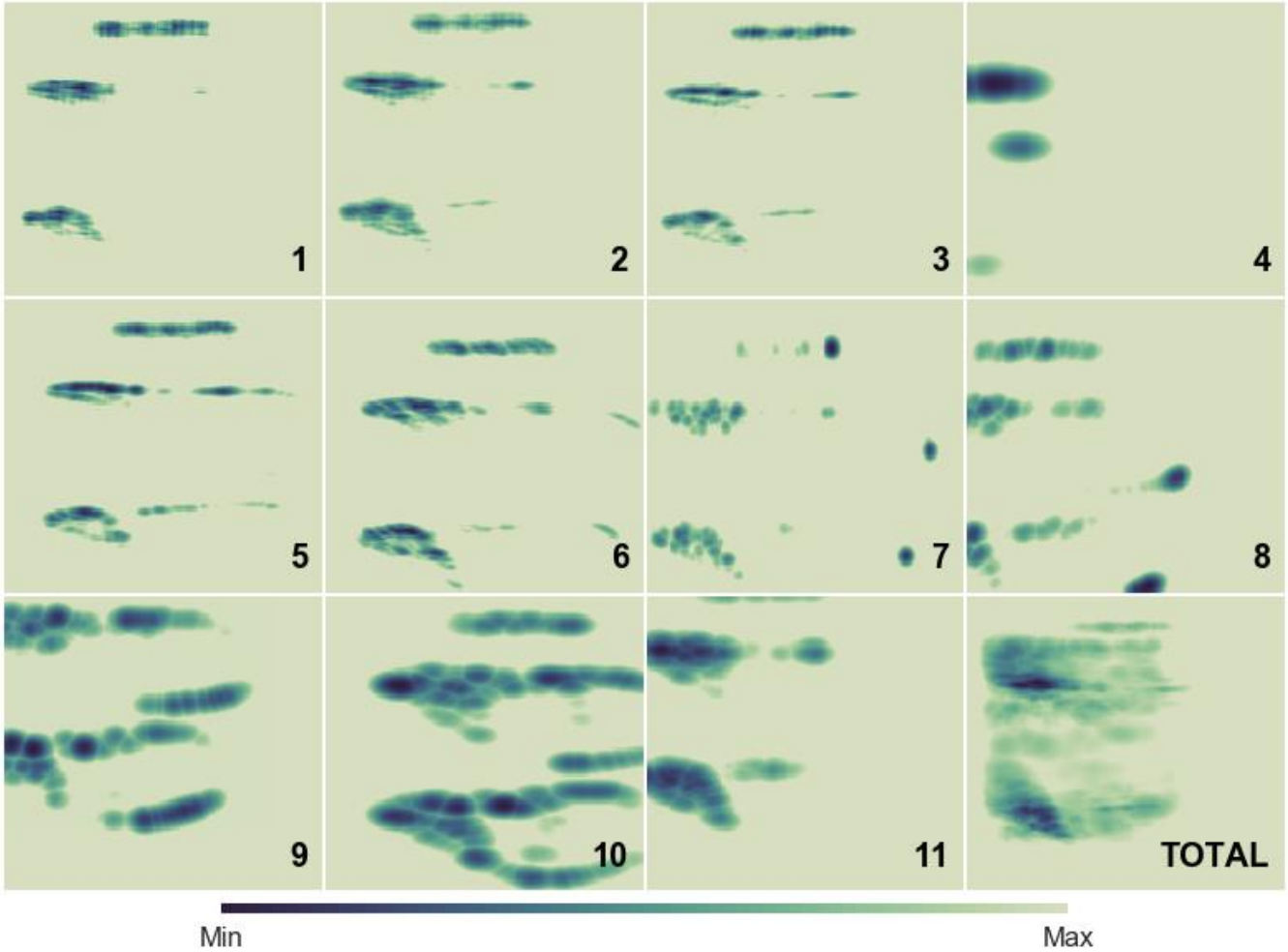

Figure 9. **Results of minimization.** Part response maps (1–11), as well as the total response map (bottom right) based on the appearance cost map in Figure 7. The part response maps are the result of translating and distance transforming each parts appearance cost map (Figure 7), and the total response map is the sum of the part response maps, indicating the best location for the root of the Pictorial Structures model. See Methods text for details.

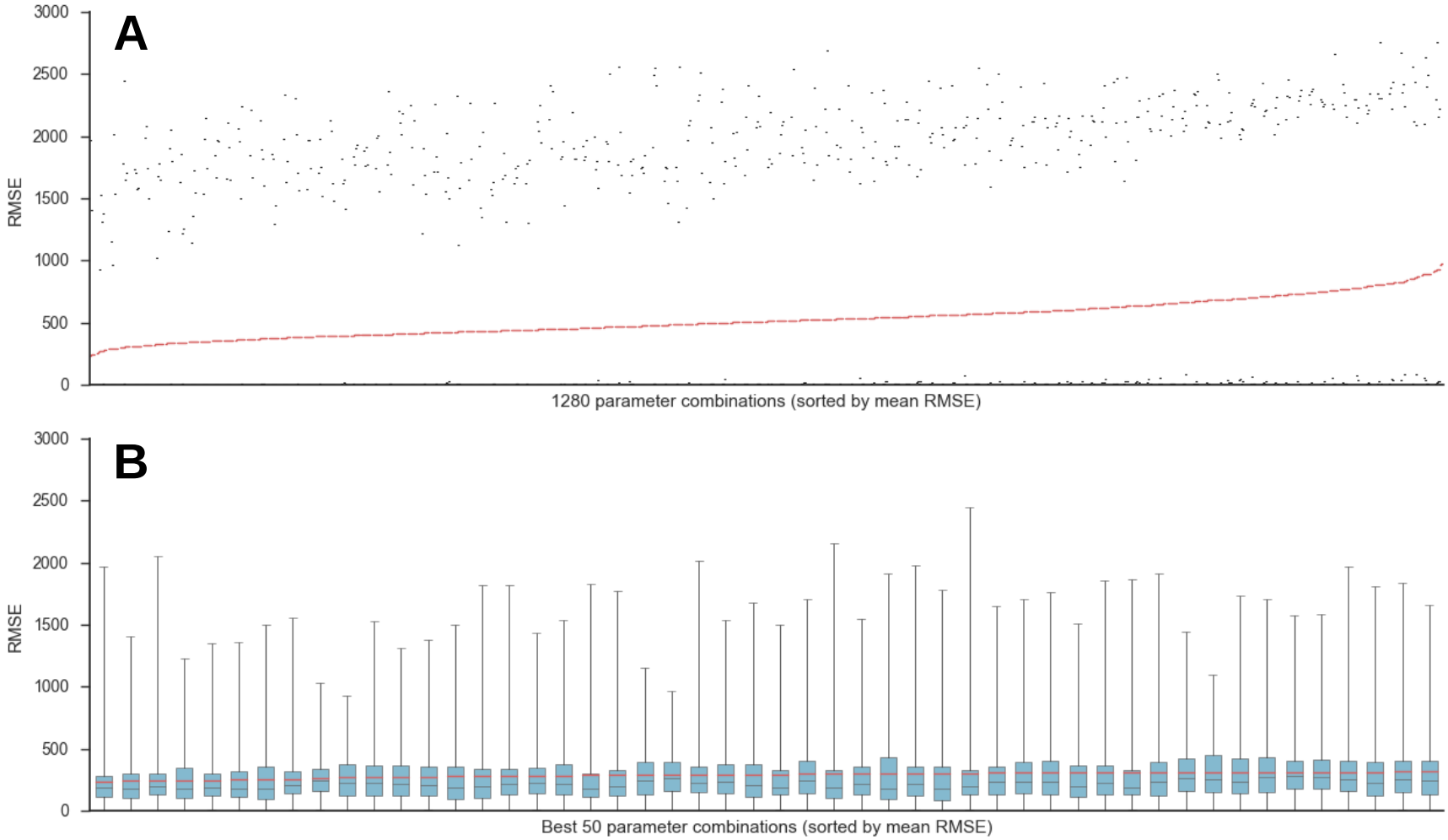

Figure 10. **Results of grid parameter search**. (A): plot of mean RMSE (red) and 95% CI (black) for all 1280 parameter combinations. (B): box plots of best 50 combinations (first 50 combinations from left in A); box is interquartile range with median (black line) and mean (red line); whiskers are 95% CI.

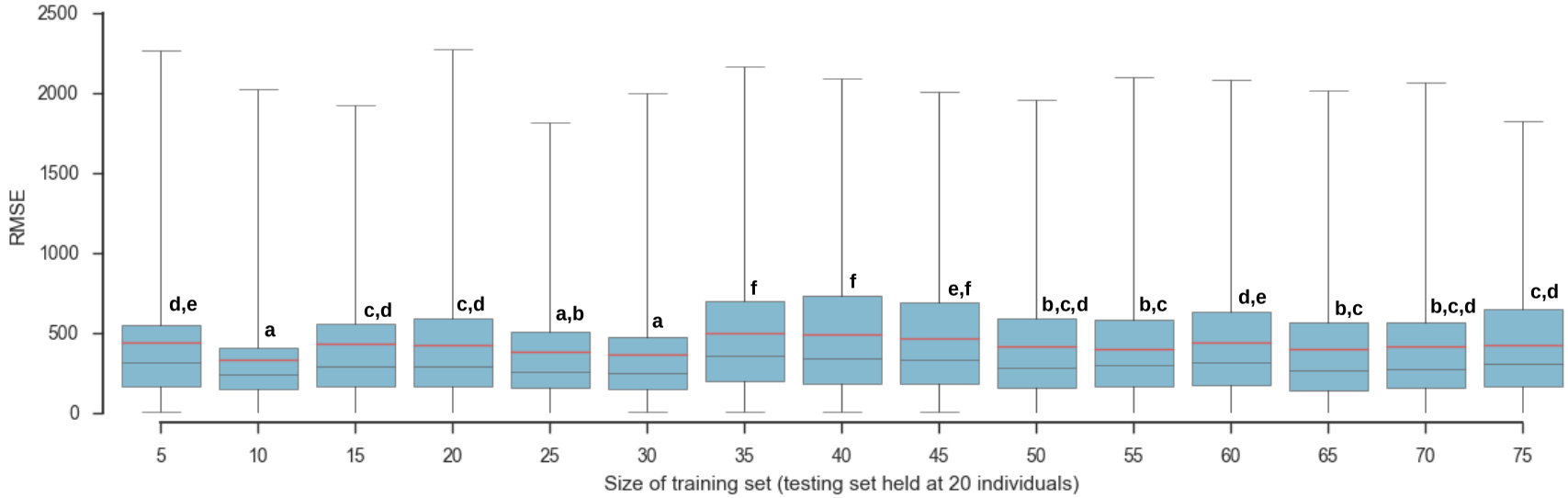

Figure 11. **Effect of training sample size on landmarking error (RMSE).** Models were trained using the best combination of parameters, and with training sets with 5 to 75 individuals, then tested with 20 individuals. Here is shown RMSE for best 6 of 10 replicates. Letters are statistically significant grouping from pairwise Tukey HSD tests ($\alpha = 0.05$) following ANOVA (df = 14 & 2625, $F = 39.86$, $p << 0.0001$).

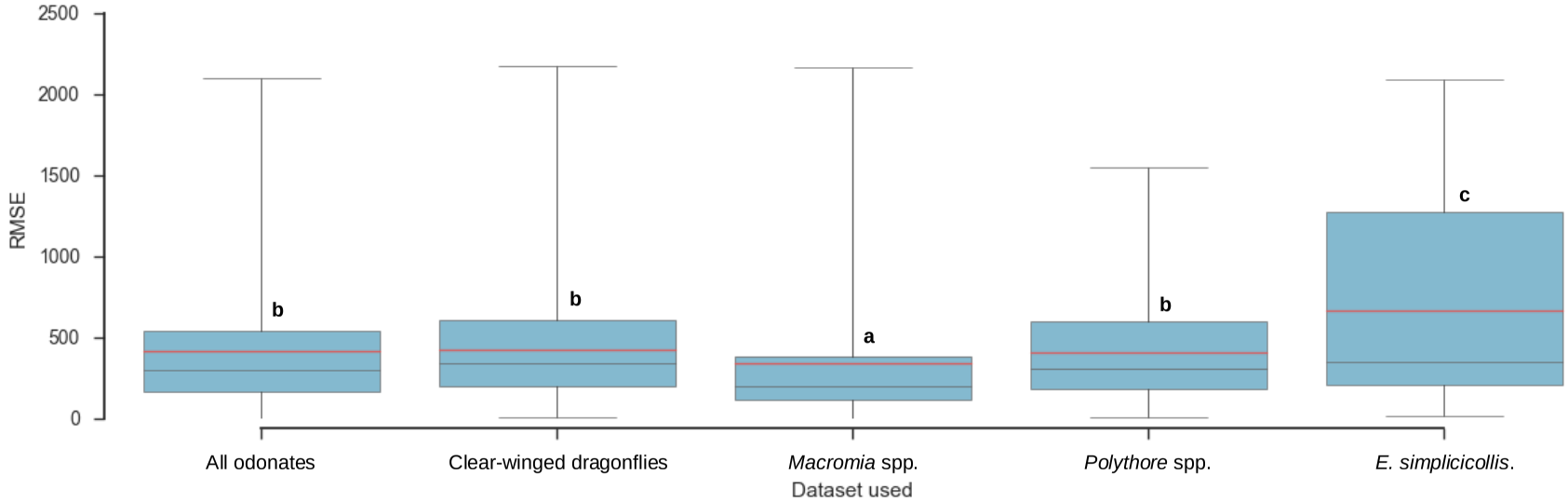

Figure 12. **Effect of dataset composition on landmarking error (RMSE).** Models were trained using the best combination of parameters, and trained and tested with individuals taken from 5 datasets: all odonates (the full dataset); clear-winged dragonflies, only; *Macromia* spp., only; *Polythore* spp., only, and *Erythemis simplicicollis* individuals, only. See Methods text for more details. Here is shown RMSE for best 6 of 10 replicates. Letters are statistically significant grouping from pairwise Tukey HSD tests ($\alpha = 0.05$) following ANOVA (df = 4 & 1975, $F = 190.7$, $p << 0.0001$).

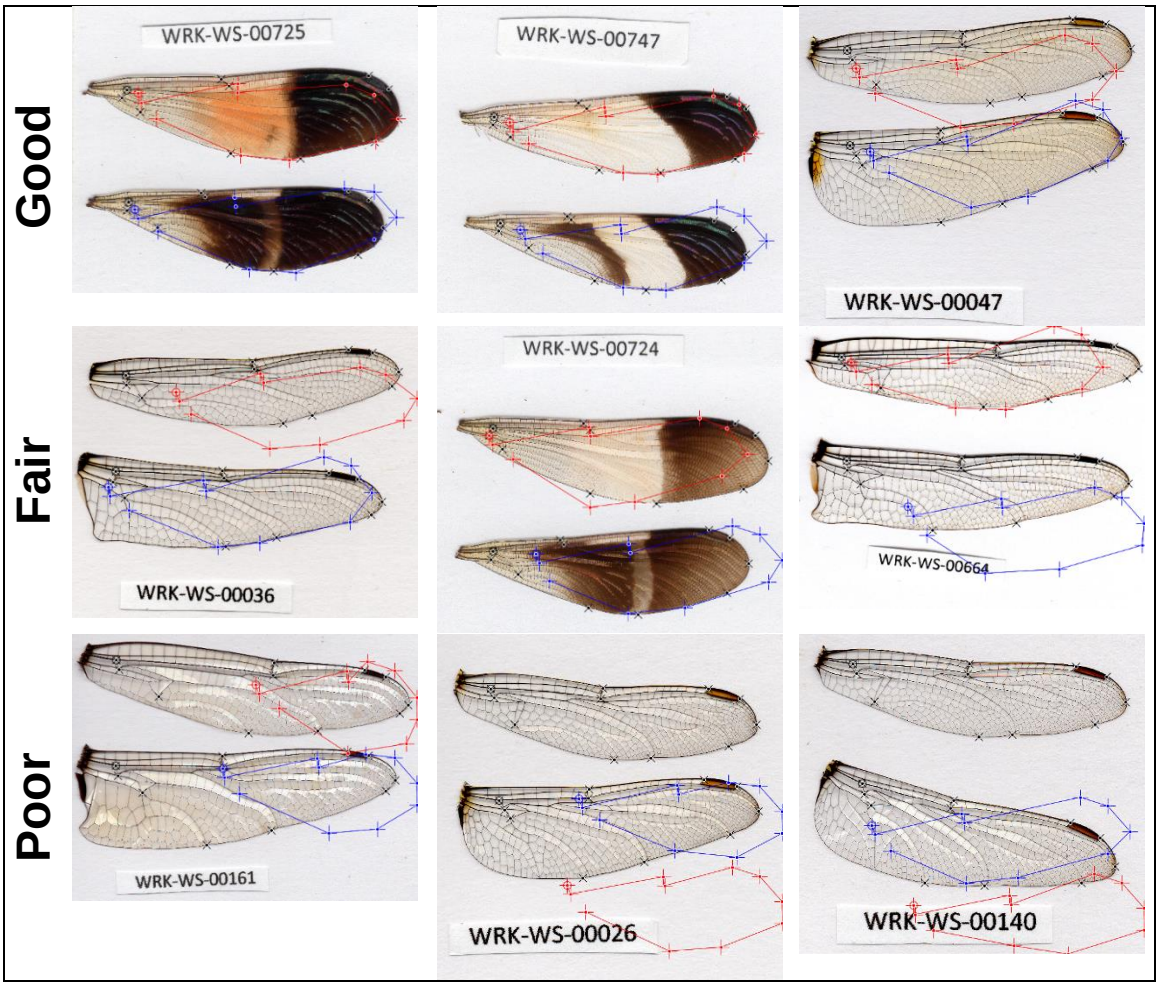

Figure 13. **Qualitative assessment of landmarking prediction.** Selected testing images with true landmarks (black “x”s) and model-predicted landmarks (red “+”s for forewing, blue for hindwing) are shown here, sorted roughly by landmarking quality. Root parts have a circle around them. Predictions were made by the best 10 models (see Methods text for details).

Chapter 3. A method for quantitatively comparing appearance of insect wings

3.1. Abstract

Images of biological specimens represent a largely-untapped source of information that can be used for comparative studies, but new computational infrastructure is needed to extract biologically relevant features from complex, noisy images. Here, a method was presented for extracting 663 quantitative features from images of insect wings relating to the color (chromaticity analysis), texture (Gabor wavelet transformation), and shape (morphometric analysis) of those wings, and an image standardization method as preprocessing to feature extraction. The standardization method was successful in converting scans of wings into standardized square images, which could then be used to consistently compare the appearance of those wings. Features extracted from those standardized images were informative enough to be used to discriminate between dragonfly and damselfly species. The methods presented here allow researchers to quantify appearance for comparative studies, and are also applicable for species identification.

3.2. Introduction

Imagery of Earth's flora and fauna is increasingly ubiquitous. This is due, in part, to recent efforts to digitize large museum collections (e.g., National Science Foundation's Integrated Digitized Biocollections, iDigBio.org), as well as the successes of citizen science initiatives (e.g., iNaturalist.org), OdonataCentral.org, BugGuide.net), digital specimen repositories (e.g.,

MorphBank.net), and even images from social sharing sites like Flickr (flickr.com). These digital data represent a largely-untapped resource containing a wealth of traits about the morphology and ethology of species. They range from photographs of live specimens in their natural habitat (*in situ* images) to images of decades or centuries-old preserved specimens. There is a need for computational infrastructure to translate this imagery into biologically-meaningful information (e.g. Beaman & Cellinese 2012).

Presented here is a procedure for converting images of insect wings into coefficients (i.e., features) describing their color, texture, and shape, which will bolster the cyberinfrastructure needed to turn digital specimen images into data. In this paper, I (1) describe three types of features and the methods for extracting them from images, (2) evaluate the utility of these features for distinguishing between the wings of dragonfly and damselfly species, and (3) demonstrate how they can aid in the discovery of taxonomically-interesting morphological characters.

I chose to work with insect wings for several reasons. They are two-dimensional and contain species-specific morphological information in the form of venation and color patterns, and elements of shape. Additionally, wing appearance and shape have been the primary features used in many comparative studies of insects, including Odonata (Waage 1979; Córdoba-Aguilar 2002; Gao *et al.* 2007; Hassall & Thompson 2009; Sadeghi *et al.* 2009; Schultz & Fincke 2009; Outomuro *et al.* 2012; Johnson *et al.* 2013), Hymenoptera (Weeks *et al.* 1999b; Schroder *et al.* 2002; Baylac *et al.* 2003;

Tofilski 2004, 2008; Hall 2011), Lepidoptera (Mayo & Watson 2007; Le-Qing & Zhen 2010, 2012), Diptera (Weeks *et al.* 1999a; Vaňhara *et al.* 2007; Lu *et al.* 2011), and Hemiptera (Zhao *et al.* 2010). Aspects of wing morphology, particularly patterns of wing venation, are one of the major defining characters used to distinguish taxa among the insect order Odonata (dragonflies and damselflies) (e.g., Garrison *et al.* 2006, 2010); however, venation has been suggested to suffer from convergence among taxa in this group (e.g. Wootton & Newman 2008). I will show that the present method circumvents this potentially convergent venation by focusing more on the *gestalt*, or overall appearance, of the wings.

3.3. Methods

In the procedure, images are first transformed into a consistent, standardized format, and then three separate analyses are performed to encode descriptive coefficients from the standardized images (as in Sanchez Herrera et al., 2015). These coefficients are herein referred to as *features*, and the coefficients produced by any one of the analyses are collectively called a *feature set*. All analyses were written in Python and use *SciPy* (Jones *et al.* 2001) and *scikit-image* (van der Walt *et al.* 2014) libraries for image manipulation, and the *scikit-learn* library (Pedregosa *et al.* 2011) for dataset analysis. They have been incorporated into a package called *autoID* (described in Chapter 3), which is available for download from http://www.crossveins.com.

3.3.1. Image dataset

I tested the procedure using 1,187 images of the wings of 21 dragonfly and 9 damselfly species collected from North and South America (14–94 individuals per species). These species are listed in Table 1 and examples of their wings are shown in Figure 1. Individuals were digitized by excising the right fore- and hindwings from each specimen and scanning their dorsal side with a flatbed scanner (Epson NX620, Epson America, California, USA) at 1,200 or 2,400 DPI; wings were excised to simplify their detection in images (see below). All wings were scanned with a paper label containing a specimen-specific code, and some were additionally scanned with a millimeter scale and color standard (Figure 2A). Images were down-sampled from their original size (2500–4500 px wide) to 650 px in width prior to analysis to reduce the computation required to process them.

3.3.2. Feature extraction process

In this section, the process for converting images into descriptive coefficients is described. This is a two-step process, where images are first standardized, and the features are extracted from them.

3.3.2.1. Image standardization

Scanned images must first be standardized so that wings can be consistently compared across individuals (e.g., for all individuals, the tip of the forewing needs to be located in the same region of the standardized image). The standardization procedure (illustrated in Figure 4) produces a square image with black background, where the forewing and hindwings span the top and bottom

halves of the image, respectively (Figure 4F). The square shape of the standardized image was a requirement of the Gabor wavelet transformation part of the feature extraction (see below), and an image size of 512×512 px was chosen as a compromise between image detail and computational efficiency (larger images contain more detail but at the expense of greater computational cost for manipulating them). There are six steps of the standardization process: wing detection, image separation, rotation, rescaling, and padding, and square assembly.

Wing detection. In order for the rest of the standardization process to function, wings in the image must be reliably located and delineated from the background—a non-trivial task. This requires an algorithm that is general enough to account for variability in the shape, size and condition of wings, as well as difference in lighting conditions across imaging devices, while specific enough to distinguish wings from labels and other objects in an image. All large objects in the image are first located, and then use the shape and texture of these objects is used to determine which of them are wings. To detect objects, images are converted from color to grayscale and inverted so that the background is black and foreground objects are white. Adaptive thresholding is then applied using a 5-px block size; this essentially detects edges in the image, but does so in a way that enables better handling of differences in lighting across the image, such as shadows, compared to a global thresholding approach. A hole-filling transformation is applied to fill in any black “holes” that are surrounded by white edges. Small objects (those smaller than 0.2% of the total image area) are then

removed, since they typically represent noise in the image. The image is now composed of white objects of various sizes, representing silhouettes of the wings, labels, and varying sized patches of noise in the image, on a black background. The objects that are most likely to be wings are determined based on two standard shape measurements—solidity and aspect ratio (van der Walt *et al.* 2014)—and two novel measures: edginess and perimeter solidity. Possible values of these measurements range from 0.0 to 1.0 except for aspect ratio, whose maximum can exceed 1.0. Solidity is calculated as the ratio of an object's area to the area of its convex hull; an object with a solidity equal to 1.0 has a perimeter that is completely convex and lacking invagination, whereas an object with a solidity close to 0.0 is extremely invaginated in shape. Insect wings are mostly convex in shape and so tend to have a solidity >0.7. The aspect ratio is calculated as the ratio of an object's height to its width. All wings are assumed to have a maximum aspect ratio of 0.5 (i.e., have a width that is at least twice the height); this is based on general Odonata wing morphology and has been shown to be true in preliminary data. "*Edginess"* was devised to estimate the prevalence of edges (such as wing veins) in a given patch of an image. To calculate edginess, the Canny edge detection algorithm (Canny 1986) is first applied to the grayscaled image with $\sigma = 0.5$, revealing detected edges as white pixels on a black background. An object's edginess is the number of edge pixels contained in the region of the image represented by that object divided by its pixel area. Because wing veins register as edges, wings tend to have relatively high edginess scores (ca. >0.15), compared to non-wing objects. The final measure,

perimeter solidity, measures the degree of smoothness of an object's perimeter and is calculated as the perimeter of the object's convex hull divided by its actual perimeter (which is always larger than or equal to the convex hull perimeter). Objects with very jagged edges tend to have values <0.4, while values are higher (ca. >0.8) in smooth-edged objects like wings. Figure 3 shows the distributions of solidity, edginess, and perimeter solidity for representative wing and non-wing objects from some of the test images. The wing-detection algorithm (Algorithm 1) takes an image, img, which contains wings, and a variable, n, indicating the number of wings present in img, and it outputs a binary mask the same size as img, where wing pixels are white on a black background (Figure 2G, Figure 4B). In the algorithm, the block size for adaptive thresholding is increased in increments of 14 px until a set of n objects are found that adhere to the constraints placed on solidity, aspect ratio, edginess, and perimeter solidity.

$\boldsymbol{Procedure}$ $GetWingMasks(img, n)$: $t_s = min$ threshold for solidity (0.7)
$t_s = min$ threshold for solidity (0.7)
$t_e = min$ threshold for edginess (0.15)
$t_{ps} = min$ threshold for perimeter solidity (0.4)
$bs = 5\ px$

1. $\boldsymbol{While}$ some max number of iterations has not been exceeded:
2. Binarize img by applying grayscaling, inverting, adaptive thresholding with block size bs, and then hole filling. Remove objects smaller than 0.2% of total image size.
3. Morphologically label binary image, then measure solidity, aspect ratio, edginess, and perimeter solidity for every object in labeled image.
4. Define i as the indices of all objects with solidity $\geq t_s$ and aspect ratio ≤ 0.5.
5. $\boldsymbol{If}$ i contains fewer than n items, increase block size by 14 px and $\boldsymbol{goto}$ 1.
6. Descending-order sort i by objects' edginess and remove all but first n objects.
7. $\boldsymbol{If}$ min edginess of $i \geq t_e$ and min perimeter solidity of $i \geq t_{ps}$, $\boldsymbol{break}$.
8. $\boldsymbol{Else}$, increase thresholding bs by 14 px and $\boldsymbol{goto}$ 2.
9. $\boldsymbol{Return}$ mask containing only objects in i.

Algorithm 1. Pseudocode for an algorithm that selects wing-like objects from an image img, containing excised wings and return a mask of them, given an *a priori* number of wings in the image, n. See Figure 2 for visual explanation.

Image separation. Individual wings can then be extracted one-by-one from the original image by multiplying the original image by a mask containing only the silhouette of the wing of interest. Two images were obtained by doing this for both wings in the output mask, each image containing one masked wing (Figure 4C–D). The upper-most wing is assumed to be the forewing and the lower, the hindwing. The extra black background around each image is then cropped.

Image rotation. Next, wings are reoriented so that their anterior edge (costal margin) is approximately horizontal. This is done by fitting a linear regression to the pixel coordinates representing the top-most pixels of a wing. The image is then rotated by the arctangent of the slope of that regression to reorient it (Figure 4E). The bases and tips of the wings in the image dataset used here are often tattered, which can cause over- or under-estimation of the slope. To prevent this, the proximal and distal 5% of the length of the wing (along its longitudinal axis) are ignored for the linear regression.

Image rescaling and padding, and square assembly. The reoriented wing images are re-cropped so that the wing spans the entire width and height of the image, and are resized, proportionally, to be 512-px wide. Black padding is added to the bottom of each resized image to make it 256-px in height. The two 512×256-px images are assembled into one 512-px square, so that the top and bottom halves contain the fore- and hindwings, respectively (Figure 4F).

3.3.2.2. Feature extraction

Once the images are converted to a consistent, standardized form, they can be compared. One way to do this would be to compare pixel values across

images; however, the standardized images are too large for this: each 3-channel, 512×512-px image contains 786,432 features. In preliminary work, I found that comparing more than a small number of such feature vectors of this size is computationally prohibitive. Also, many of the features in such vectors, such as pixels that are black across all standardized images, would not be informative, as they do not vary across individuals. Instead, each standardized image is encoded into a much shorter, 663-length vector, which describes aspects of the shape, color, and texture of the wings in the image, through (a) morphometric analysis, (b) chromaticity analysis, and (c) Gabor wavelet transformation.

Morphometric analysis. The shapes and relative sizes of wings are described using 15 measurements (listed in Table 2). These measurements were chosen based on observations of how the silhouettes of pilot-study wings vary in shape between species. All measurements can be consistently and automatically calculated from masks of the fore- and hindwings in standardized square images without the need for a scale; all measurements are unit-less (ratios, slopes, etc.).

Chromaticity analysis. Information describing local wing coloration is also extracted from standardized square images. Images are first converted from the RGB (red, green, blue) color space to chromatic coordinates (CCs). The benefits of this color conversion are two-fold: the effect of inconsistent lighting across images is reduced, which is helpful for comparing images that were digitized with different imaging devices, and the correlation between pixel values in the red, green, and blue channels is removed (Gillespie *et al.* 1987; Woebbecke *et al.*

1995; Sonnentag *et al.* 2012). CCs are calculated from RGB pixel values using the transformations,

$$r = \frac{R}{R+G+B},\ g = \frac{G}{R+G+B},\ \text{and}\ b = \frac{B}{R+G+B}, \quad (1)$$

where *R*, *G*, and *B* are a pixel's original intensity values and *r*, *g*, and *b* are the transformed values. After transformation, the mean and standard deviation of 23 image regions are calculated from each of the image's three color channels, producing a 128-length feature vector (23 regions × 3 channels × 2 measures (mean and SD)). Image regions are sampled in the following order: the whole square, upper and lower halves, square quarters, and square sixteenths of the image. Means, then standard deviations, are calculated from each region for the *r*-channel, *g*-channel, and *b*-channel. This image-sampling scheme was inspired by the local color sampling used by Le-Qing and Zhen (2012) and the hierarchical scheme for Gabor wavelet sampling in Russell *et al.* (2007; described below).

Gabor wavelet transformation. The texture and patterning of each standardized image are captured through a Gabor wavelet transformation (GWT) applied to the grayscaled image. GWTs are used in many image processing applications, including optical character recognition, fingerprint and iris recognition, and image compression (Daugman 1988; Weldon *et al.* 1996), since the wavelets closely follow the operation of cells of visual cortex in mammals (Daugman 1980). By applying Gabor wavelets—which are essentially image filters—at different rotations and scales over an image, the scale and directionality of edges and patterns in the image can be encoded. For example, a GWT of the wings of *Celithemis eponina* (Figure 1, 2nd row, 1st column) at a

large scale might capture information about the stripes in the wings or their general shape, whereas a small-scaled GWT might capture information about the wing venation. In the GWT, six Gabor wavelets—the real and imaginary components of the wavelet each at three rotations (0°, 120°, and 240°)—are applied iteratively to 85 regions of the image (Figure 6A): the entire square image, square quarters, square 16ths, and square 64ths of the image (Russell *et al.* 2007) (Figure 6B). In this manner, information is extracted at four scales, yielding 510 coefficients per image (2 components × 3 rotations × 85 regions).

3.3.3. Evaluating the feature extraction process

3.3.3.1. Measuring 'discriminability'

The ability of different feature sets to discriminate between species—*discriminability*—can be compared using Mahalanobis distance (MD) and classification accuracy. Given a set of feature coefficients taken from several individuals, each belonging to one of two species, the MD between those species is a covariance-adjusted measure of the distance between their centroids (reported in standard deviations; Mardia *et al.* 1979). The MD tells how much the multi-dimensional point clouds representing those two species overlap with one another, and is defined as $D = \sqrt{(\bar{x}_1 - \bar{x}_2)' \boldsymbol{S_u}^{-1} (\bar{x}_1 - \bar{x}_2)}$ where $\boldsymbol{S_u}$ is the pooled, unbiased covariance matrix $\boldsymbol{S_u} = n_1 \boldsymbol{S_1} + n_2 \boldsymbol{S_2} / (n_1 + n_2 - 2)$, and n_1 and n_2 are the group sample sizes. For a given feature set, the principal components (PCs) of the set were first calculated; then using the first 10 PCs, the MD between each unique pair of species was calculated. For the 30 odonate species used in this study, there were 435 unique species pairs. Classification accuracy was

measured using a nearest neighbor (NN) approach in a leave-one-out (LOO) scheme: species centroids were calculated from a dataset where one individual has been left out. That individual was then predicted to belong to the species whose centroid was closest to it (measured in Euclidean distance). For each feature set, the process was repeated so that a species designation was predicted for every individual. Accuracy was calculated as the proportion of individuals in each species that were correctly classified.

3.3.3.2. Feature performance

Discriminability was compared among seven feature sets (described below); all but one of the sets were derived using all 1,187 dragonfly and damselfly individuals. The first four sets were derived from the descriptive features: morphometric, chromaticity, and GWT features, and a concatenation of all three sets; and an additional three sets—developed for comparison to the former sets—were as follows. In order to compare the effect of converting images to CCs before sampling in the chromaticity analysis, a feature set called “RGB” was taken using the chromatic analysis procedure except that the square images were left as untransformed RGB pixel values (not converted to CCs) before extraction. In addition, discriminability was measured with two “raw pixel” feature sets composed of the concatenated pixel values of the standardized squares directly into feature vectors. As previously stated, the 3-channelled 512×512-px squares are prohibitively large to compare across all individuals, so in the first raw pixel set, squares were down-sampled to 75×75 px and then concatenated, giving a 16,875-length feature vector per individual. For a second,

similar dataset, 10 individuals were randomly selected from each species (300 individuals, total), and then squares from those individuals were down-sampled to 125×125 px and concatenated to produce vectors containing 46,875 features. I refer to the latter two feature sets as “raw-pixel sets”. Figure 7 depicts the relative size and amount of detail in original and down-sampled versions of square image examples. Discriminability was compared between feature sets with an ANOVA ($\alpha = 0.05$) and Tukey HSD post hoc test ($\alpha = 0.05$) (Quinn & Keough 2009). I hypothesized that the descriptive features would discriminate species equally well or better than the raw-pixel features, while encoding images into much smaller sets of features. I also predicted that chromaticity features would discriminate at least as well as RGB features.

3.3.3.3. Effect of scanner model on feature discriminability

To determine how feature extraction was affected by the use of multiple scanners to digitize wings in a dataset, five individual dragonflies (of species *Celithemis eponina*, *Erythemis vesiculosa*, *Erythrodiplax umbrata*, *Miathyria marcella*, and *Perithemis tenera*) were digitized with four consumer-grade desktop scanner models: Dell P713W (Dell Inc., Texas, USA), Epson NX625, Epson Perfection V500, and Epson WF-2630. To account for intra-scanner variability, individuals’ wings were scanned three times with each scanner and were shifted slightly on the scanner glass between scans. The *P. tenera* and *E. vesiculosa* individuals were exceptions: their wings were broken during scanning and were therefore only scanned twice on the Epson WF-2630. In order to measure which features varied the most across scanners, the procedure in the

previous section was repeated, giving seven feature sets to compare. These sets were derived from all 58 images, and pairwise MDs were calculated between scanners rather than species. Since illumination and colorimetric sensors vary between image scanner models (Sharma *et al.* 1998), I hypothesized that, among these feature sets, chromaticity would vary the most in images of the same object digitized with different scanners. Since conversion of an image from the RGB to the chromatic color space should standardize color across different lighting conditions (Gillespie *et al.* 1987), I expected that the RGB feature set (which was not transformed into CCs) would produce higher pairwise MDs between scanners (i.e., vary more) than the chromaticity feature set, and that the morphometric and GWT sets would produce similar MDs between scanners.

3.3.3.4. Effect of image distortion on feature discriminability

Standardized images were distorted with Gaussian blurring or salt-and-pepper noise, then chromaticity and GWT features were extracted from them, in order to test the effect of image distortion on feature discriminability. (Morphometric coefficients were not extracted as the morphometric feature extraction process requires standardized images to be pristine.) A subset of 300 standardized squares (10 randomly selected individuals per species) were used, and Gaussian blurring was applied to the wings with $\sigma = 0$ (no blurring), 1, 2, or 4 (heavy blurring; Figure 8, top row), followed by feature extraction. Similarly, salt-and-pepper noise, where random pixels are changed to white or black (Boncelet 2000), was applied in varying degrees to the same image subset and followed by feature extraction. Noise was added with $t = 0$ (no noise added), 0.01, 0.05, and

0.1 (lots of added noise; Figure 8, top row), where *t* is a threshold value that governs the probability that a given pixel will be changed to salt-and-pepper noise (the probability of its turning to white or black was 1:1). Discriminability was compared between feature sets with an ANOVA ($\alpha = 0.05$) and Tukey HSD post hoc test ($\alpha = 0.05$). I hypothesized that both chromaticity and GWT features derived from unaltered images would discriminate species better than those derived from distorted images.

3.3.3.5. Features for discovery

The sampling schemes used for extracting chromaticity and GWT features—where each feature was derived from a specific region of the square images—potentially allowed for taxonomically interesting characters to be discovered in the wings. The *F*-statistic, which measures discriminative information by comparing between-group to within-group variance (Quinn & Keough 2009), was calculated for each chromaticity and GWT feature using species as the grouping variable. These values were then mapped back onto the portion of the square image to which each feature corresponded. This allowed the fore- and hindwings to be visualized based on the importance of different regions of the wings for discriminating odonate species.

3.4. Results

3.4.1. Image Standardization Performance

Image preprocessing was successful—where the fore- and hindwings were both detected and correctly transformed into a standardized image—for all 1,187 scans of dragonfly and damselfly wings used in this study (preprocessing

failures from pilot data are discussed below). The time required for image preprocessing range widely from 4.02–53.78 s per image (22.81 ± 10.56 s, mean ± SD) on an ASUS N550JV laptop computer with a quad-core 2.40 GHz processor and 8 GB RAM (ASUS Computer International, California, USA). Most (ca. 95%) of that time was spent on wing detection (21.59 ± 10.45 s) and the remaining steps were very fast (1.22 ± 0.36 s). Between 1 and 3 iterations of Algorithm 1 were required to preprocess images and the average time per iteration was 11.70 ± 4.50 s.

Failures in image preprocessing were recorded for other pilot specimen analyses not included here, and occurred when the algorithm either failed to detect wings that were present in the image or reported non-wing objects to be wings. These failures reflect the difficulty of developing a perfect wing-detection algorithm and warrant further work to improve upon Algorithm 1.

3.4.2. Feature Extraction Performance

Morphometric, chromaticity, and GWT features were extracted from the standardized square images. Feature extraction took 4.50–12.78 s per image (8.16 ± 2.10 s). Since the feature extraction process is not computationally complex, it its per-image timing could likely be reduced to <1 s, given further optimization of the scripts governing the process.

3.4.3. Feature performance

Discriminability in the form of mean pairwise MD and nearest neighbor classification accuracy was measured for the seven feature sets (Table 3, Figure 9). Pairwise MDs ranged widely between 1.04 (highly overlapping species

centroids) to 101.26 standard deviations (highly divergent centroids), and species classification accuracy ranged from 0.00 (consistent misclassification) to 1.00 (perfectly accurate classification). Means were significantly different in both MDs (ANOVA, df = 6 & 3039, $F = 124.23$, $p < 0.0001$) and accuracies (df = 6 & 204, $F = 25.99$, $p < 0.0001$). Morphometry and GWT produced the smallest mean MDs, performing statistically worst (Tukey HSD, $\alpha = 0.05$), while the large, 125×125 raw-pixel set performed best. None of the other sets differed statistically from one another. The lowest classification accuracy was also attained with the morphometry set, while the 75×75 raw-pixel set performed statistically better than the chromaticity and combined feature sets. Interestingly, the chromaticity and combined sets were equivalent in both mean pairwise MD and mean accuracy; this may indicate that the chromaticity features provided the most discriminating information among all of the descriptive features (further discussed in ‘Features for discovery’ below). Overall, these findings indicate that the feature sets provided a similar level of discriminability compared to the features comprising concatenated pixel values (i.e. the raw-pixel sets), with the exception of morphometric features. In addition, the chromaticity features performed equally as well as RGB features.

3.4.4. Effect of scanner model on feature discriminability

Images acquired from four desktop scanners were compared in terms of the pairwise MDs between scanners using each of the seven feature sets (Figure 10). Between-scanner MD varied from 0.73 (low variability) to 23.68 (highly variable). The sets ranked as follows in terms of mean pairwise MD:

morphometry (1.12 ± 0.29), 125×125 raw pixels (1.24 ± 0.24), 75×75 raw pixels (1.26 ± 0.24), GWT (3.64 ± 2.54), chromaticity (3.92 ± 1.31), morphometry, chromaticity and GWT combined (3.92 ± 1.31), and RGB (12.26 ± 8.01). The RGB set had significantly greater between-scanner MD (ANOVA, df = 6 & 35, F = 7.21, p = 0.0005; Tukey HSD, α = 0.05) than any of the other feature sets. This was consistent with the prediction that the RGB features would vary more between scanners than the chromaticity features, and suggests that the transformation of standardized square images from RGB to CC color space before sampling reduced the effect of variability among scanners.

3.4.5. Effect of image distortion on feature discriminability

Blurring (Figure 11) and salt-and-pepper noise (Figure 12) were added in various degrees to standardized square images and the subsequent effects on chromaticity and GWT features were measured in terms of pairwise MD and classification accuracy. Small, but significant, differences were seen in pairwise MD for both chromaticity (ANOVA; df = 3 & 3039, F = 18.46, p << 0.0001) and GWT (F = 6.79, p = 0.0002) sets given blurring and in GWT (df = 3 & 3039, F = 17.73, p << 0.0001) sets with salt-and-pepper noise. No significant differences were seen elsewhere. Surprisingly and contrary to the prediction that distortion would decrease the discriminability of features, the effects of both blurring and salt-and-pepper noise—even in the most extreme (i.e. σ = 4 or t = 0.1)—were not appreciable. This may be due to the nature of the feature extraction schema for chromaticity and GWT features: specifically, that each feature was derived from a large region of the image, rather than from an individual pixel, so that small

perturbances in some of a region's pixels would be unlikely to have a large effect on features derived from that region.

3.4.6. Features for discovery

F-statistics were used to visualize the importance of different regions of the standardized squares for species discrimination based on the chromaticity (Figure 13, Figure 15A) and GWT (Figure 14, Figure 15B) feature sets. Because the morphometric features were not sampled in such a mappable way, they were not included in this analysis. For the chromaticity features, *F*-statistics ranged from 2.14 to 1023.06, while GWT statistics ranged from 0.67 to 846.81. Features with lower *F*-statistics were worse at discriminating species than those with higher statistics. Of the 20 overall most-informative features, 14 were chromaticity and 6 were GWT features. All 20 are derived from part or all of the lower left quadrant of the standardized square images, which corresponds to the proximal half of the hindwing. As seen in Figure 1, this region of the hindwing was quite variable in patterning, color, and particularly in shape, although it is possible that the image mask (i.e., the black background around the wing) of this part of the standardized square images contributed as much or more to the information in this region of the image than the color or texture of the image. The 20 most-conserved features were all from the GWT set, and were mostly in the very bottom of the standardized image, which was probably a consistent black among all individuals; however, the fourth and fifth of these were in the nodus of the hindwing (in the 120°-rotated, imaginary wavelet) and near the arculus of the forewing (in the 240°-rotated, imaginary wavelet), respectively. This was

surprising considering the apparent variability of these regions and warrants further investigation.

3.5. Discussion

In this chapter, a procedure was presented for summarizing the rich visual information contained in imagery of insect wings into a relatively small number (663) of descriptive feature coefficients for comparative analysis. The novel contributions of this work are three-fold: (1) an algorithm for reliably detecting wings in an image was introduced, (2) a method for converting images of wings into a standardized format was described, and (3) novel feature sets were introduced, which capture the shape, color, and texture of the wings, along with a method for extracting them from images. The wing detection method was shown to be reliable, successfully detecting wings in all images of odonate wings that were used in this study. Using the wing detection algorithm, the image standardization procedure was able to successfully convert images to standardized squares, from which features could be extracted. I demonstrated that the chromaticity and GWT features captured discriminating information from images equally as well as features derived from raw image pixels, but while requiring only a fraction of the number of features. It was also shown that converting the standardized images into chromaticity coordinates during chromaticity analysis increased the stability of features from images taken across multiple scanning devices. The chromaticity and GWT features were shown to be robust against distortion of the standardized images. In addition, the sampling

method for taking chromaticity and GWT features allowed the most discriminating regions of wings to be discovered.

Taken together, the methods presented here allow for the quantification of wing appearance—a property which is typically difficult to measure. In fact, these methods have already been used by Sanchez-Herrera (2015) to quantitatively compare the appearance of *Polythore* damselfly wings. In that study, feature coefficients extracted from wing images were not only used to discriminate between species, but were also used as continuous morphological characters in a phylogenetic reconstruction. In this way, these methods provide a new tool for morphological phylogenetics and taxonomy, allowing morphological characters to be automatically extracted from images (as in La Salle *et al.* 2009), which can then be used for reconstructing phylogenies or for species description. The stability of the chromaticity and GWT features from image taken across multiple imaging devices is particularly advantageous as it allows a comparative study to include imagery acquired from imaging devices at different insect collections.

These methods need not be limited to quantifying appearance of wings in Odonata. This procedure should work equally well on other taxa, particularly other insect groups, and other morphological structures, with the limitations that the structures must be relatively two-dimensional (like wings), that it must be possible to image them in a consistent manner, and that the standardization procedure presented here (or an alternative procedure) must be able to transform the images into a consistent, comparable square format.

3.6. References

Baylac, M., Villemant, C. & Simbolotti, G. (2003). Combining geometric morphometrics with pattern recognition for the investigation of species complexes. *Biological Journal of the Linnean Society*, **80**, 89–98.

Beaman, R.S. & Cellinese, N. (2012). Mass digitization of scientific collections: New opportunities to transform the use of biological specimens and underwrite biodiversity science. *ZooKeys*, 7–17.

Boncelet, C. (2000). 4.5 - Image Noise Models A2. *Handbook of Image and Video Processing (Second Edition)* (ed A. Bovik), pp. 325–335. Communications, Networking and Multimedia. Academic Press, Burlington.

Canny, J. (1986). A computationalapproach to edge detection. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, **PAMI-8**, 679–698.

Córdoba-Aguilar, A. (2002). Wing pigmentation in territorial male damselflies, *Calopteryx haemorrhoidalis*: a possible relation to sexual selection. *Animal Behaviour*, **63**, 759–766.

Daugman, J.G. (1988). Complete discrete 2-D Gabor transforms by neural networks for image analysis and compression. *IEEE Transactions on Acoustics, Speech, and Signal Processing*, **36**, 1169–1179.

Daugman, J.G. (1980). Two-dimensional spectral analysis of cortical receptive field profiles. *Vision Research*, **20**, 847–856.

Gao, Y., Song, H., Tian, X. & Chen, Y. (2007). Identification algorithm of winged insects based on hybrid moment invariants. *The 1st International Conference on Bioinformatics and Biomedical Engineering*, 531–534.

Garrison, R.W., von Ellenrieder, N. & Louton, J.A. (2010). *Damselfly Genera of the New World: An Illustrated and Annotated Key to the Zygoptera*. Johns Hopkins University Press, Baltimore, MD.

Garrison, R.W., von Ellenrieder, N. & Louton, J.A. (2006). *Dragonfly Genera of the New World: An Illustrated and Annotated Key to the Anisoptera*. The Johns Hopkins University Press, Baltimore, MD.

Gillespie, A.R., Kahle, A.B. & Walker, R.E. (1987). Color enhancement of highly correlated images. II. Channel ratio and ‘chromaticity’ transformation techniques. *Remote Sensing of Environment*, **22**, 343–365.

Hall, C.J. (2011). *An Automated Approach to Bee Identification from Wing Venation*. Masters thesis, University of Wisconsin, Madison, WI.

Hassall, C. & Thompson, D.J. (2009). Variation in wing spot size and asymmetry of the Banded Demoiselle *Calopteryx splendens* (Harris, 1780). *Journal of the British Dragonfly Society*, **25**, 7–15.

Johnson, L., Mantle, B.L., Gardner, J.L. & Backwell, P.R.Y. (2013). Morphometric measurements of dragonfly wings: the accuracy of pinned, scanned and detached measurement methods. *ZooKeys*, **276**, 77–84.

Jones, E., Oliphant, E. & Peterson, P. (2001). *SciPy: Open Source Scientific Tools for Python*.

La Salle, J., Wheeler, Q., Jackway, P., Winterton, S., Hobern, D. & Lovell, D. (2009). Accelerating taxonomic discovery through automated character extraction. *Zootaxa*, **2217**, 43–55.

Le-Qing, Z. & Zhen, Z. (2010). Auto-classification of insect images based on color histogram and GLCM. *Seventh International Conference on Fuzzy Systems and Knowledge Discovery*, **6**, 2589–2593.

Le-Qing, Z. & Zhen, Z. (2012). Automatic insect classification based on local mean colour feature and supported vector machines. *Oriental Insects*, **46**, 260–269.

Lu, W., Lingwang, G. & Zuorui, S. (2011). Research on landmark extraction technology in identification of fruit flies (Diptera: Tephritidae). *2011 Seventh International Conference on Natural Computation*, **3**, 1681–1685.

Mardia, K.V., Kent, J.T. & Bibby, J.M. (1979). *Multivariate Analysis*. Academic Press, Reading, MA.

Mayo, M. & Watson, A.T. (2007). Automatic species identification of live moths. *Knowledge-Based Systems*, **20**, 195–202.

Outomuro, D., Adams, D.C. & Johansson, F. (2012). The evolution of wing shape in ornamented-winged damselflies (Calopterygidae, Odonata). *Evolutionary Biology*, 1–10.

Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., THirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., Dubourg, V., Vanderplas, J., Passos, A., Cournapeau, D., Brucher, M., Perrot, M. & Duchesnay, E. (2011). Scikit-learn: machine learning in Python. *Journal of Machine Learning Research*, **12**, 2825–2830.

Quinn, G.P. & Keough, M.J. (2009). *Experimental Design and Data Analysis for Biologists*. Cambridge University Press, New York, NY.

Russell, K.N., Do, M.T., Huff, J.C. & Platnick, N.I. (2007). Introducing SPIDA-web: wavelets, neural networks and internet accessibility in an image-

based automated identification system. *Automated Object Identification in Systematics: Theory, Approaches, and Applications* (ed N. MacLeod), pp. 131–152. CRC Press, New York, NY.

Sadeghi, S., Adriaens, D. & Dumont, H.J. (2009). Geometric morphometric analysis of wing shape variation in ten European populations of *Calopteryx splendens* (Harris, 1782) (Zygoptera: Odonata). *Odonatologica*, **38**, 343–360.

Sanchez Herrera, M., Kuhn, W.R., Lorenzo-Carballa, O., Harding, K.M., Ankrom, N., Sherratt, T.N., Hoffmann, J., Van Gossum, H., Ware, J.L., Cordero-Rivera, A. & Beatty, C.D. (2015). Mixed Signals? Morphological and Molecular Evidence Suggest a Color Polymorphism in some Neotropical *Polythore* Damselflies. *PLoS ONE*, **10**, e125074.

Schroder, S., Wittmann, D., Drescher, W., Roth, V., Steinhage, V. & Cremers, A.B. (2002). The new key to bees: automated identification by image analysis of wings. *Pollinating Bees - The Conservation Link Between Agriculture and Nature* (eds P. Kevan & V.L. Imperatriz Fonseca), pp. 209–216. Ministry of Environment, Brasilia, Brazil.

Schultz, T.D. & Fincke, O.M. (2009). Structural colours create a flashing cue for sexual recognition and male quality in a Neotropical giant damselfly. *Functional Ecology*, **23**, 724–732.

Sharma, O., Trussell, H.J. & Vrhel, M.J. (1998). Optimal nonnegative color scanning filters. *IEEE Transactions on Image Processing*, **7**, 129–133.

Sonnentag, O., Hufkens, K., Teshera-Sterne, C., Young, A.M., Friedl, M., Braswell, B.H., Milliman, T., O'Keefe, J. & Richardson, A.D. (2012). Digital repeat photography for phenological research in forest ecosystems. *Agricultural and Forest Meteorology*, **152**, 159–177.

Tofilski, A. (2004). DrawWing, a program for numerical description of insect wings. *Journal of Insect Science (Ludhiana)*, **4**, 1–5.

Tofilski, A. (2008). Using geometric morphometrics and standard morphometry to discriminate three honeybee subspecies. *Apidologie*, **39**, 558–563.

Vaňhara, J., Muráriková, N., Malenovský, I. & Havel, J. (2007). Artificial neural networks for fly identification: A case study from the genera *Tachina* and *Ectophasia* (Diptera, Tachinidae). *Biologia*, **62**, 462–469.

Waage, J.K. (1979). Reproductive character displacement in *Calopteryx* (Odonata: Calopterygidae). *Evolution*, **33**, 104–116.

van der Walt, S., Schönberger, J.L., Nunez-Iglesias, J., Boulogne, F., Warner, J.D., Yager, N., Gouillart, E. & Yu, T. (2014). scikit-image: image processing in Python. *PeerJ*, **2**, e453.

Weeks, P.J.D., O'Neill, M.A., Gaston, K.J. & Gauld, I.D. (1999a). Automating insect identification: exploring the limitations of a prototype system. *Journal of Applied Entomology*, **123**, 1–8.

Weeks, P.J.D., O'Neill, M.A., Gaston, K.J. & Gauld, I.D. (1999b). Species–identification of wasps using principal component associative memories. *Image and Vision Computing*, **17**, 861–866.

Weldon, T.P., Higgins, W.E. & Dunn, D.F. (1996). Efficient Gabor filter design for texture segmentation. *Pattern Recognition*, **29**, 2005–2015.

Woebbecke, D.M., Meyer, G.E., Von Bargen, K. & Mortensen, D.A. (1995). Color indices for weed identification under various soil, residue, and lighting conditions. *Transactions of the ASAE*, **38**, 259–269.

Wootton, R.J. & Newman, D.J.S. (2008). Evolution, diversification, and mechanics of dragonfly wings. *Dragonflies and Damselflies: Model Organisms for Ecological and Evolutionary Research* (ed A. Cordoba-Aguilar), pp. 261–274. Oxford University Press, New York, NY.

Zhao, S., Ding, W. & Liu, D. (2010). Technical Note: Extraction of wing venation characteristics by image analysis. *Transactions of ASABE*, **53**, 1–4.

3.7. Tables and Figures

Table 1. **Composition of the testing dataset.** The 1,187 images from 30 odonate species used in this study are listed here by species.

Suborder	Family	Species	No. individuals
Anisoptera	Aeshnidae	*Aeshna juncea*	26
		Basiaeschna janata	18
	Gomphidae	*Gomphus vastus*	15
	Corduliidae	*Epitheca cynosura*	68
	Macromiidae	*Macromia illinoiensis*	31
	Libellulidae	*Celithemis elisa*	15
		Celithemis eponina	66
		Erythemis peruviana	20
		Erythemis simplicicollis	94
		Erythemis vesiculosa	52
		Erythrodiplax fervida	92
		Erythrodiplax umbrata	19
		Leucorrhinia intacta	24
		Libellula incesta	42
		Libellula luctuosa	43
		Pachydiplax longipennis	50
		Pantala flavescens	39
		Pantala hymenaea	48
		Perithemis tenera	29
		Plathemis lydia	43
		Tramea lacerata	17
Zygoptera	Calopterygidae	*Calopteryx maculata*	16
		Hetaerina occisa	71
	Polythoridae	*Polythore concinna*	14
		Polythore derivata	47
		Polythore gigantea	19
		Polythore mutata	16
		Polythore neopicta	52
		Polythore ornata	48
		Polythore victoria	53
TOTAL:	**7 families**	**30 species**	**1,187**

Table 2. **Descriptions of morphometric features.** These 15 measurements were taken from standardized 512×512-px, square images which were masked so that only the silhouette of each wing was present. FW = forewing; HW = hindwing.

Measurement	Description
1. Wing area ratio	Ratio of pixel areas of FW to HW
2. FW elongation	1 – ((FW major axis length) / (FW minor axis length))
3. HW elongation	1 – ((HW major axis length) / (HW minor axis length))
4. FW anterior-posterior ratio	Ratio of pixel areas of upper to lower halves of FW
5. HW anterior-posterior ratio	Ratio of pixel areas of upper to lower halves of HW
6. FW proximal-distal ratio	Ratio of pixel areas of proximal to distal halves of FW
7. HW proximal-distal ratio	Ratio of pixel areas of proximal to distal halves of HW
8. FW slope of thickness	Slope of line that best fits a plot of wing thickness (in px), measured along the length of the FW
9. HW slope of thickness	Slope of line that best fits a plot of wing thickness (in px), measured along the length of the HW
10. FW widest ratio	Ratio of distance (in px) from base of FW wing to its thickest portion along major axis, to FW wing length (in px)
11. HW widest ratio	Ratio of distance (in px) from base of HW wing to its thickest portion along major axis, to HW wing length (in px)
12. FW tip upper curvature	Coefficient of x^3 component of third-order polynomial fit to upper half of distal 40% of FW (i.e. degree of curvature of upper half of FW tip)
13. FW tip lower curvature	Coefficient of x^3 component of third-order polynomial fit to lower half of distal 40% of FW (i.e. degree of curvature of lower half of FW tip)
14. HW tip upper curvature	Coefficient of x^3 component of third-order polynomial fit to upper half of distal 40% of HW (i.e. degree of curvature of upper half of HW tip)
15. HW tip lower curvature	Coefficient of x^3 component of third-order polynomial fit to lower half of distal 40% of HW (i.e. degree of curvature of lower half of HW tip)

Table 3. **Discriminability by feature set.**

	Pairwise Mahalanobis distance[b] between species (n = 435 spp. pairs)			**Nearest neighbor classifier accuracy for each species (n = 30 spp.)**		
Feature Type[a]	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**	**Min**	**Max**
Morphometry	11.57 ± 7.35	1.04	30.17	0.42 ± 0.22	0.00	0.97
Color (chromaticity)	15.54 ± 8.66	2.01	42.72	0.74 ± 0.15	0.47	1.00
Gabor wavelet transform	12.80 ± 8.80	1.29	61.72	0.79 ± 0.17	0.45	1.00
Combined (M, C, & G)	15.54 ± 8.66	2.01	42.72	0.74 ± 0.15	0.47	1.00
Color (RGB)	17.05 ± 9.43	2.26	53.75	0.81 ± 0.14	0.52	1.00
75×75 raw pixels	17.23 ± 8.44	2.03	40.87	0.87 ± 0.10	0.65	1.00
125×125 raw pixels	27.53 ± 14.75	2.49	101.26	0.86 ± 0.17	0.20	1.00

[a] Calculations for all feature types were done using 1,187 individuals, except for '125×125 raw pixels', which was performed on a subset of 300 individuals (10 randomly selected per species).

[b] MD was calculated from the first 10 principal components of each feature set and measured pairwise between each species and all other species other than itself.

Figure 1. **The 21 dragonfly and 9 damselfly species used in this study.** Forewings (top) and hindwings (bottom) are shown for male examples of each species.

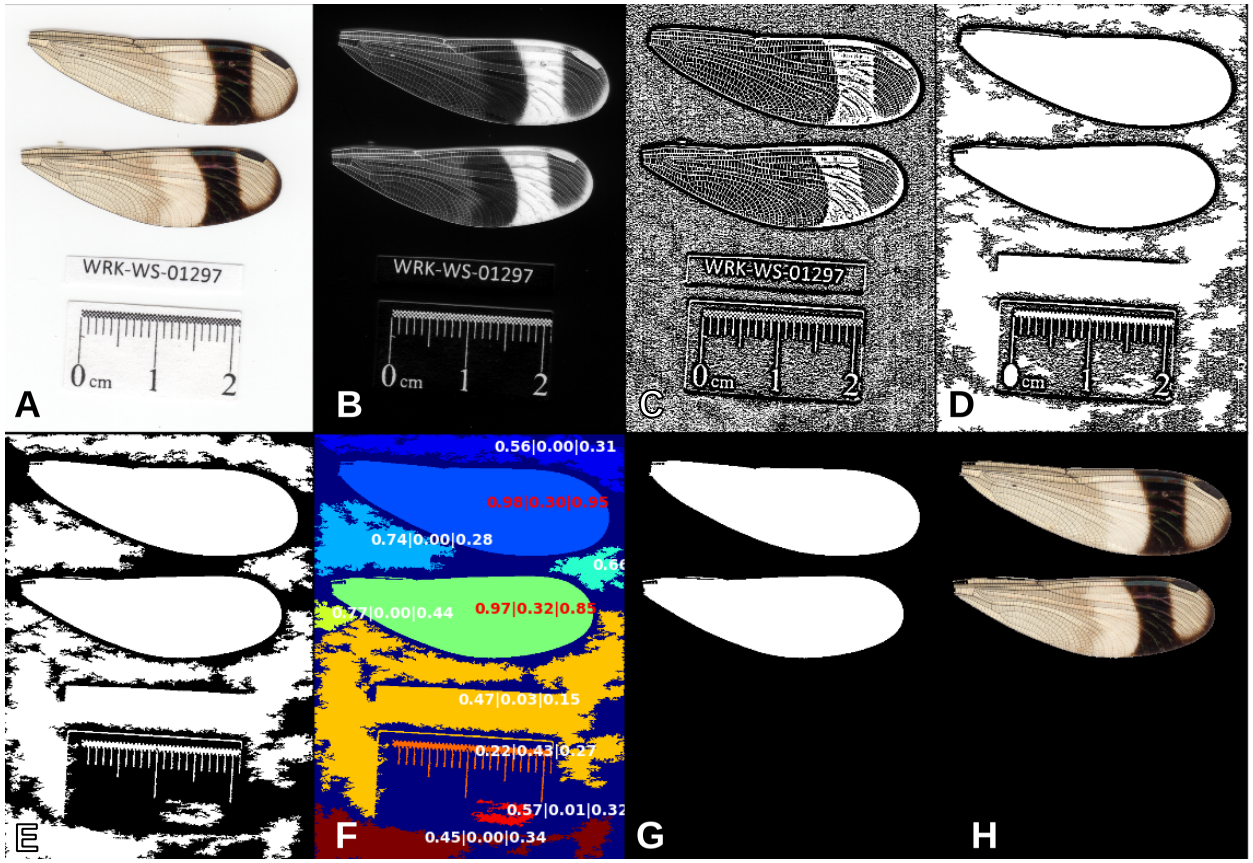

Figure 2. **Steps for detecting wings in an image.** An image (A) is converted to grayscale and color-inverted (B), then adaptive thresholding is applied (C), followed by a filling transformation (D), and removal of noisy objects (E) to produce a binary image containing blobs representing different objects in the image. These objects are then tested to determine which are most likely to be wings (F), producing a mask (G), which can then be applied to the original image to remove its background (H). Measurements in F are solidity, edginess, and perimeter solidity for each blob in image, including wings (in red text; see text for description of these measures).

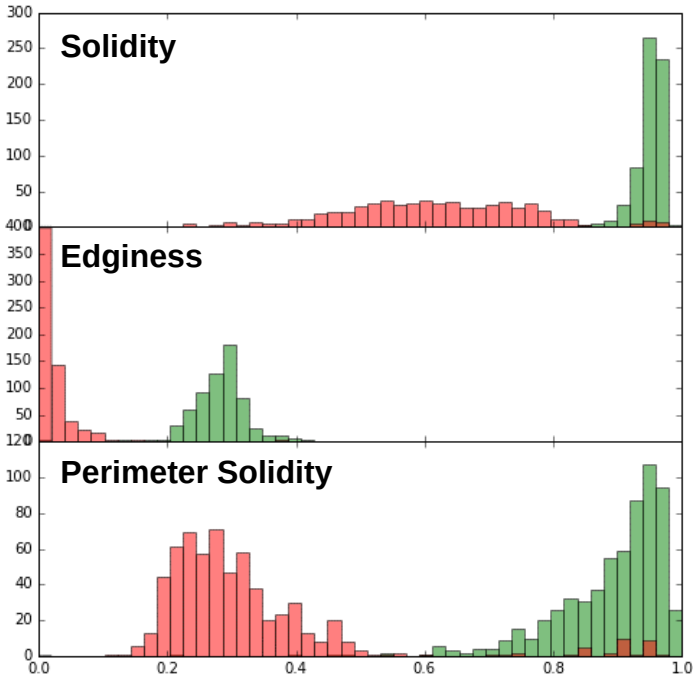

Figure 3. **Properties of wings versus non-wings.** Histograms show solidity, edginess, and perimeter solidity of wing (green) and non-wing (red) objects from a sample of 318 images, which first were binarized as in Figure 2A–E.

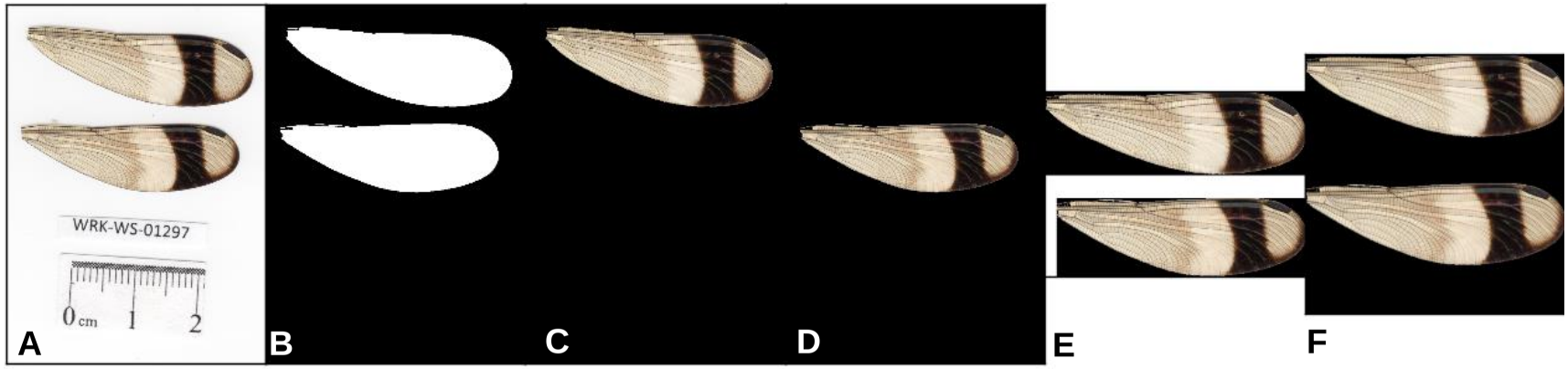

Figure 4. **Steps of the standardization process**: original image (A), wing detection (B; see Fig. 1), wing extraction (C,D), wing reorientation (E), and the completed square after wing rescaling and padding (F).

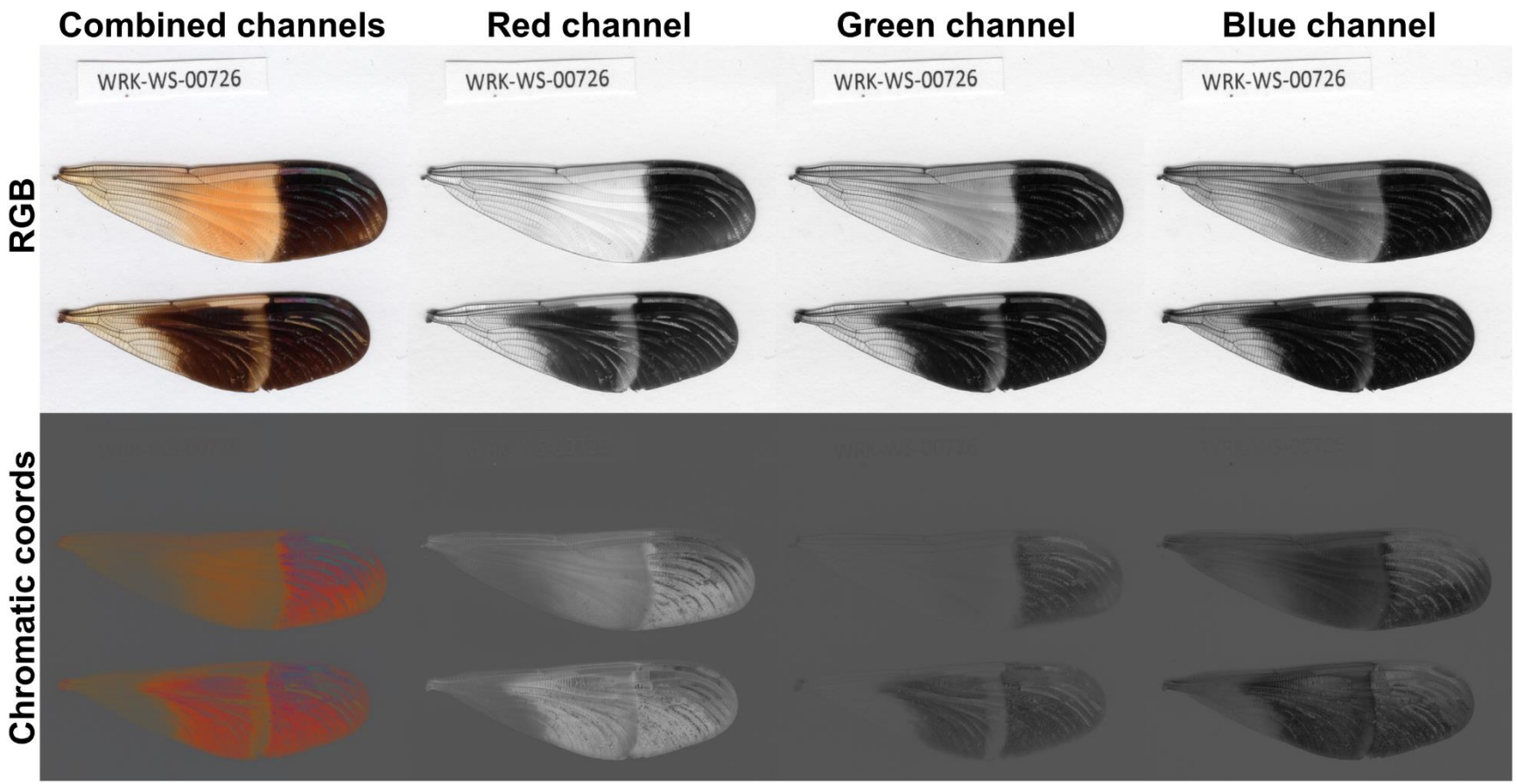

Figure 5. **Chromaticity transformation.** An example image (top row) and its chromaticity coordinates (bottom row). Each row shows the combined channels on the left, followed by the separate red, green, and blue channels.

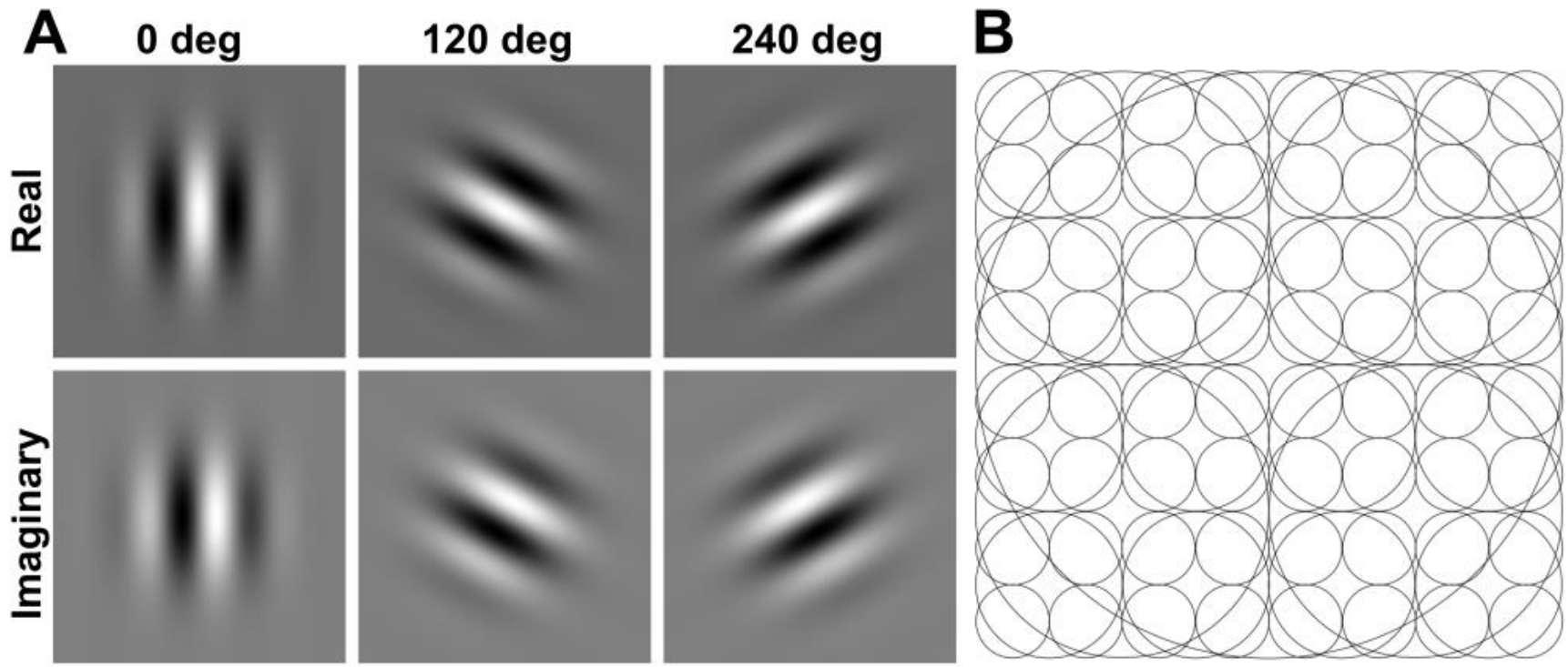

Figure 6. **Gabor wavelet transformation.** For the Gabor wavelet transformation, 6 wavelets (real and imaginary configurations × 3 angles; A) are applied iteratively to parts of the underlying square, grayscaled image at 4 different scales (represented as circles in B).

Figure 7. **Comparison of the relative sizes of original squares to reduced 'raw pixel' squares.** Shown are 512, 125, and 75-pixel square images for raw pixel analysis for *Celithemis eponina* (top) and *Polythore gigantea* (bottom).

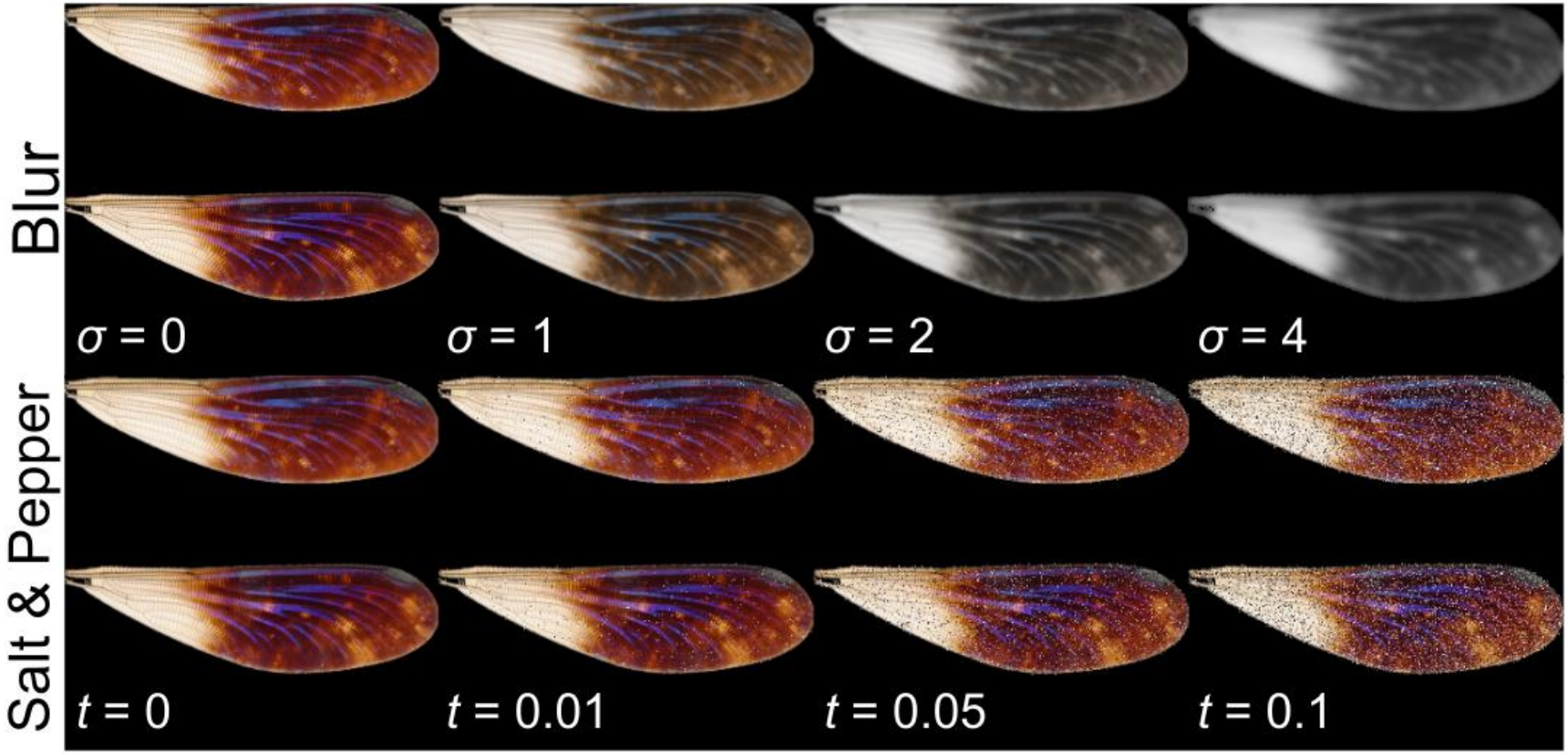

Figure 8. **Examples of image blurring (top row) and salt and pepper noise (bottom row).** *σ* and *t* indicate amount of blurring or addition of salt and pepper noise, respectively, from none on the left to more on the right.

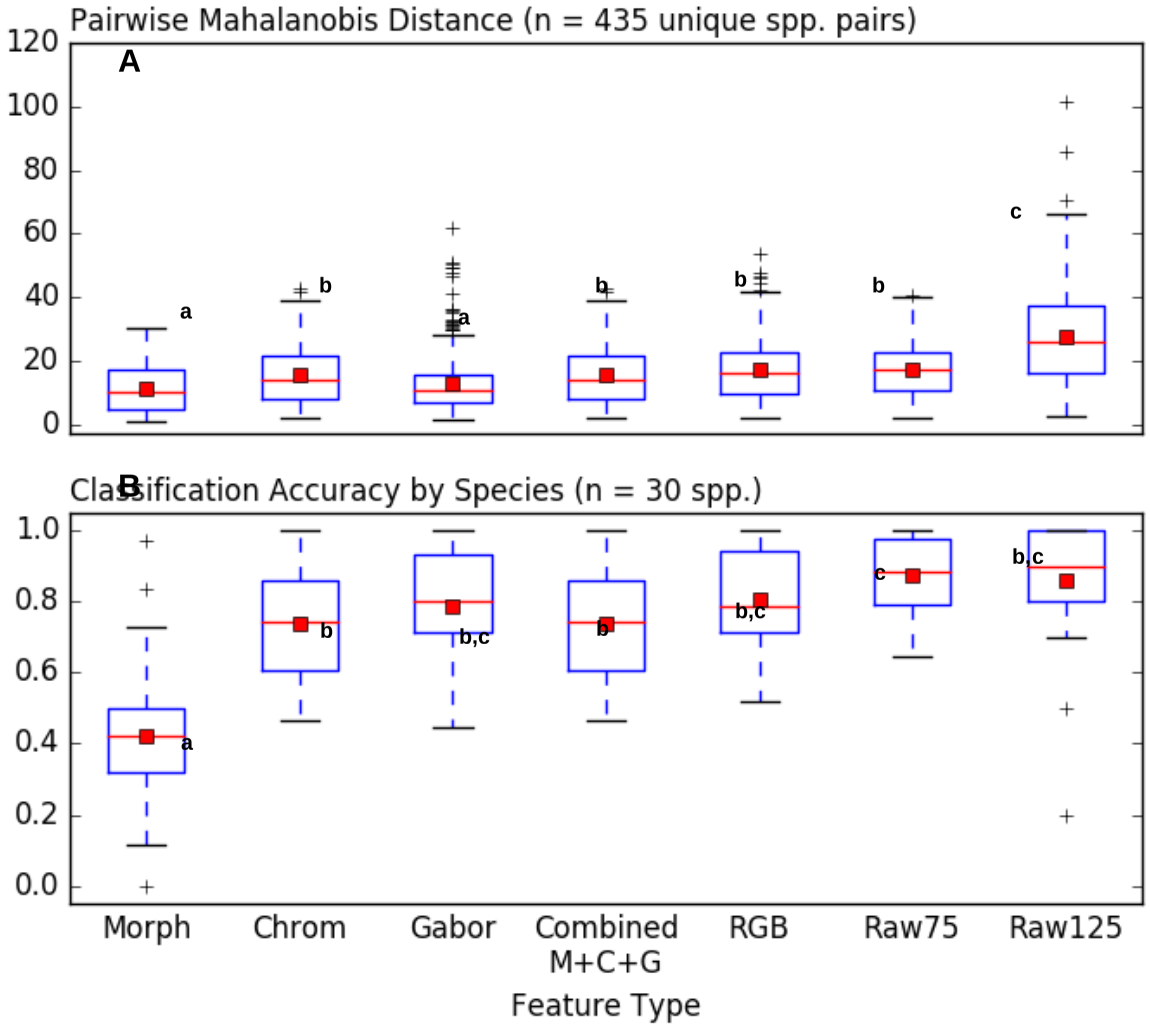

Figure 9. **How well do features distinguish odonate species?** Unbiased Mahalanobis distance (MD, measured in standard deviations) was calculated for each of 435 unique species pairs (A). A larger MD indicates better discrimination between species. Classification accuracy (B) was measured using a nearest neighbor classifier trained in a leave-one-out scheme for every individual. Seven feature sets were compared (see Methods for details): morphometric (Morph), chromaticity (Chrom), GWT (Gabor), concatenated Morph, Chrom, and Gabor, RGB-colorspace chromaticity (RGB) features, and 75×75-px (Raw75) and 125×125-px (Raw125) concatenated squares. All 1187 individuals were used except in Raw125 where only 300 individuals were used (10 randomly selected per species). Boxplots: red square, mean; red line, median; blue box, 1st & 3rd quartiles; black lines, 95% confidence interval; plus signs, outliers. Lowercase letters are statistically significant groupings from pairwise Tukey HSD tests ($\alpha = 0.05$) following ANOVAs (distance: df = 6 & 3039, $F = 124.23$, $p < 0.0001$; accuracy: df = 6 & 204, $F = 25.99$, $p < 0.0001$).

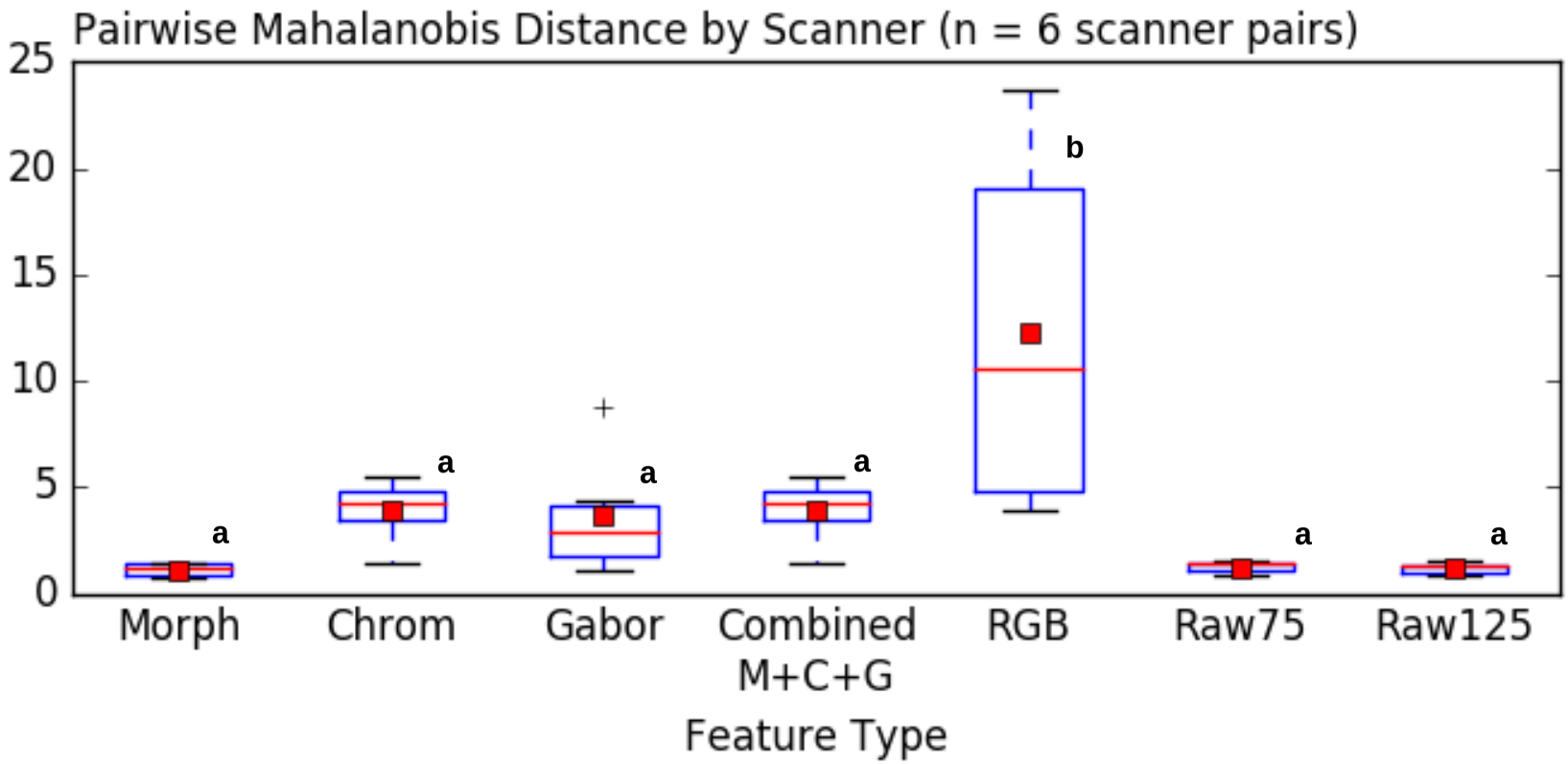

Figure 10. **How variable are features when images are acquired from different scanners?** MD was calculated pairwise for 4 scanners (6 unique scanner pairs), from seven feature sets (see Methods for details): morphometric (Morph), chromaticity (Chrom), GWT (Gabor), concatenated Morph, Chrom, and Gabor, RGB-colorspace chromaticity (RGB) features, and 75×75-px (Raw75) and 125×125-px (Raw125) concatenated squares. Letters are statistically significant grouping from pairwise Tukey HSD tests ($\alpha = 0.05$) following ANOVA (df = 6 & 35, $F = 7.21$, $p = 0.0005$).

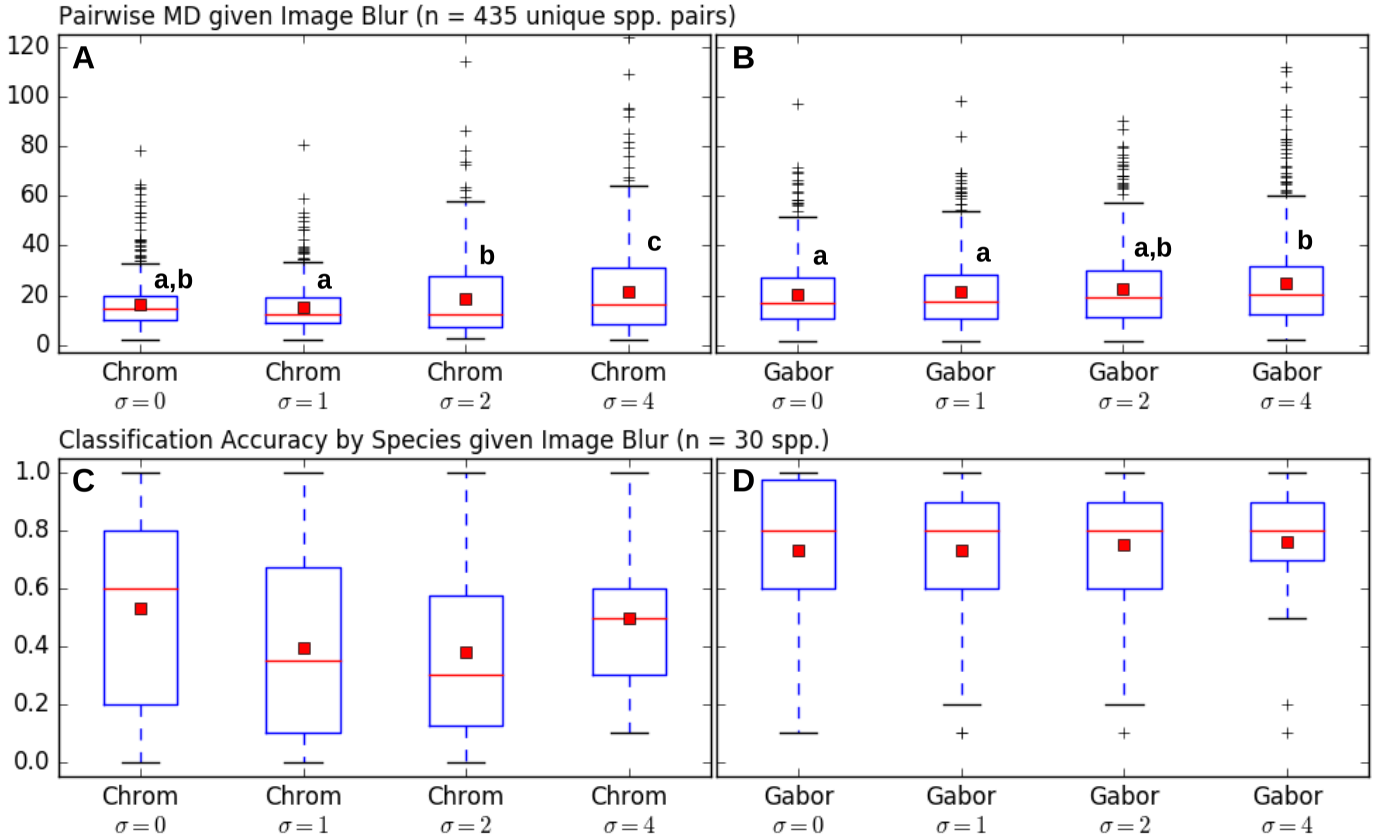

Figure 11. **How does blurring affect discriminability?** Chromaticity (A,C) and Gabor features (B,D) were calculated from square images that were blurred by $\sigma = 0$ (no blur) to $\sigma = 4$ (very blurred). 300 individuals were used (10 per species). A–B: MD was calculated pairwise for each of 435 unique species pairs; lowercase letters in A and B are statistically significant groupings from pairwise Tukey HSD tests ($\alpha = 0.05$) following ANOVAs (distance: df = 3 & 3039, chromaticity [$F = 18.46$, $p << 0.0001$], GWT [$F = 6.79$, $p = 0.0002$]. C–D: per-species classification accuracy was measured using a nearest neighbor classifier trained in a leave-one-out scheme for every individual; ANOVAs showed no significant differences among accuracy from chromaticity (df = 3 & 204, $F = 1.74$, $p = 0.16$) or GWT ($F = 0.13$, $p = 0.94$) sets.

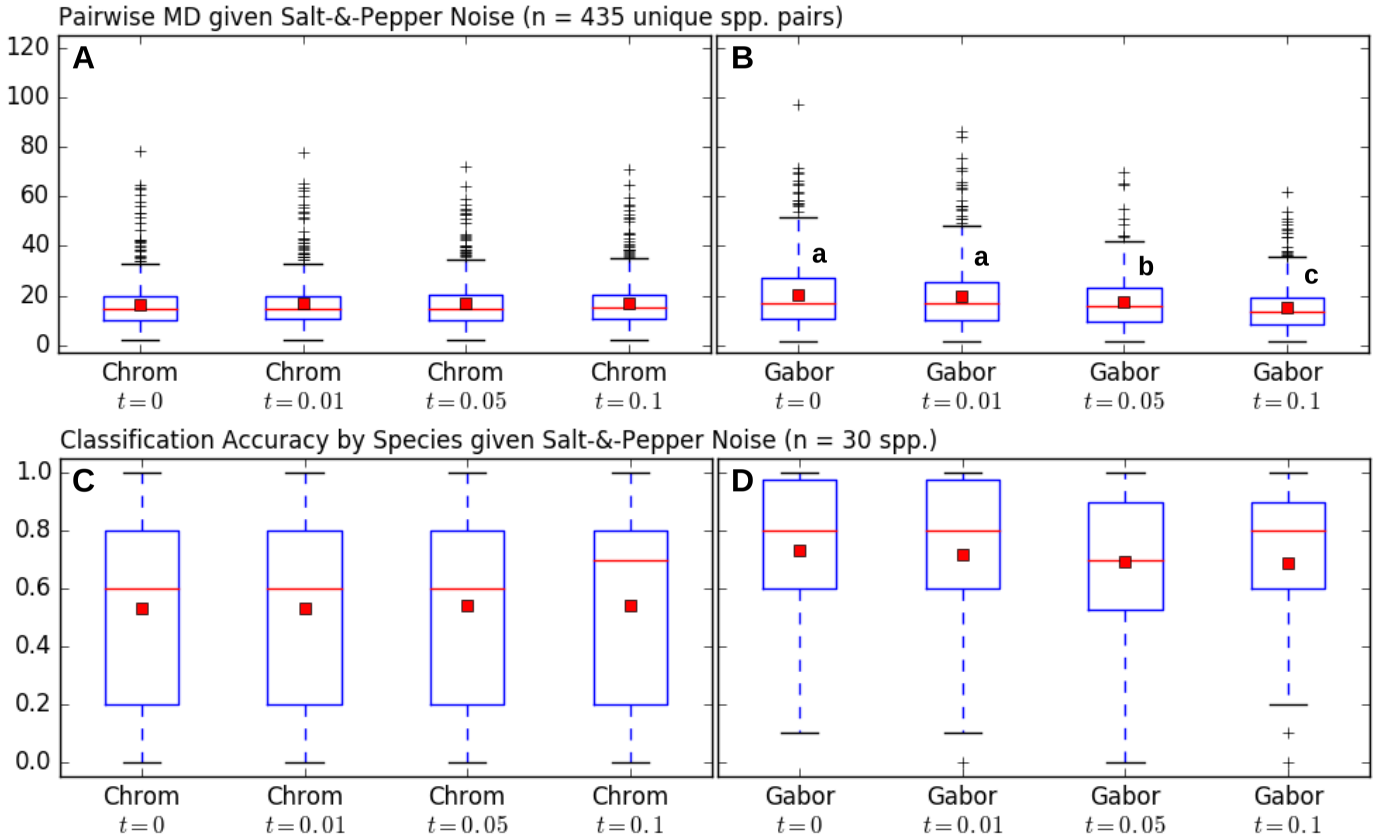

Figure 12. **How does salt and pepper noise affect discriminability?** Chromaticity (A,C) and Gabor features (B,D) were calculated from square , where the threshold for adding noise ranged from $t = 0$ (no noise added) to $t = 0.1$ (lots of noise added). 300 individuals were used (10 per species). A–B: MD was calculated pairwise for each of 435 unique species pairs, ANOVAs showed no differences among chromaticity sets (df = 3 & 3039, $F = 0.19$, $p = 0.91$), but significant differences between GWT sets (df = 3 & 3039, $F = 17.73$, $p << 0.0001$); lowercase letters in B are statistical groupings from pairwise Tukey HSD test ($\alpha = 0.05$). C–D: per-species classification accuracy was measured using a nearest neighbor classifier trained in a leave-one-out scheme for every individual; ANOVAs showed no significant differences among accuracy from chromaticity (df = 3 & 204, $F = 0.00$, $p = 1.00$) or GWT ($F = 0.16$, $p = 0.93$) sets.

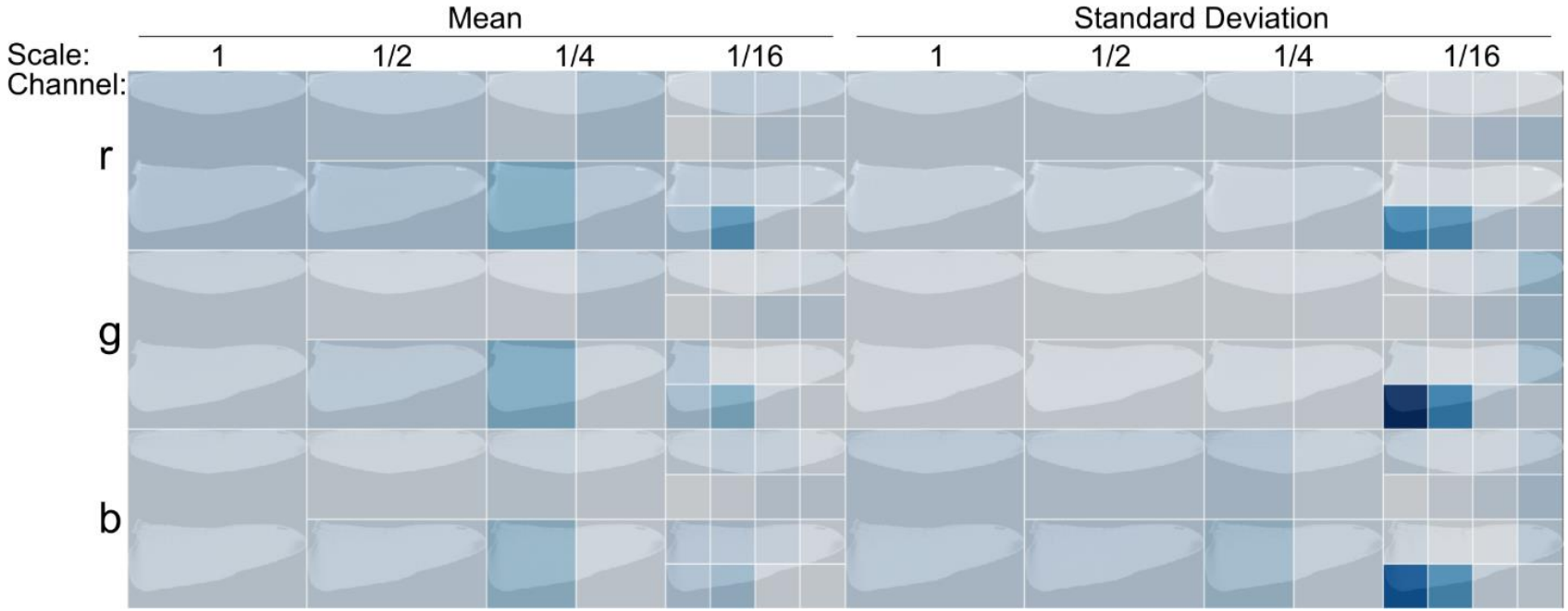

Figure 13. **Which parts of the wings are most important for species discrimination according to chromaticity?** Chromaticity features are represented visually over an example set of wings (*Pantala flavescens*). The area covered by each feature is represented as a square, and squares are colored by the *F*-statistic for that feature (darker blue = higher *F*-statistics; *F*-statistics calculated using species as a grouping variable).

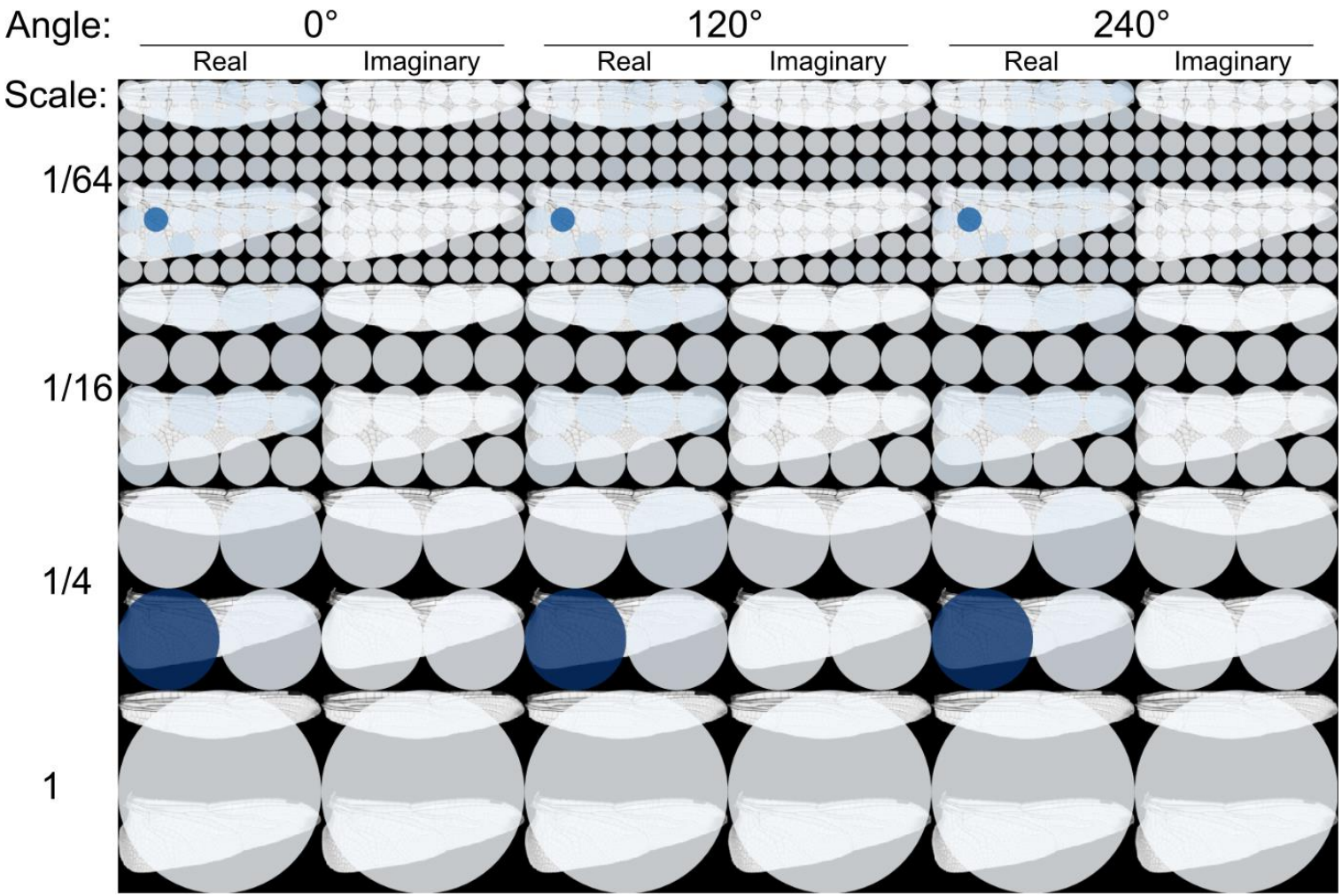

Figure 14. **Which parts of the wings are most important for species discrimination according to GWT?** GWT features are represented visually over an example set of wings (*Pantala flavescens*). Each circle represents a circular Gabor wavelet corresponding to a feature. Circles are colored by the *F*-statistic for that feature (darker blue = higher *F*-statistics; *F*-statistics calculated using species as a grouping variable).

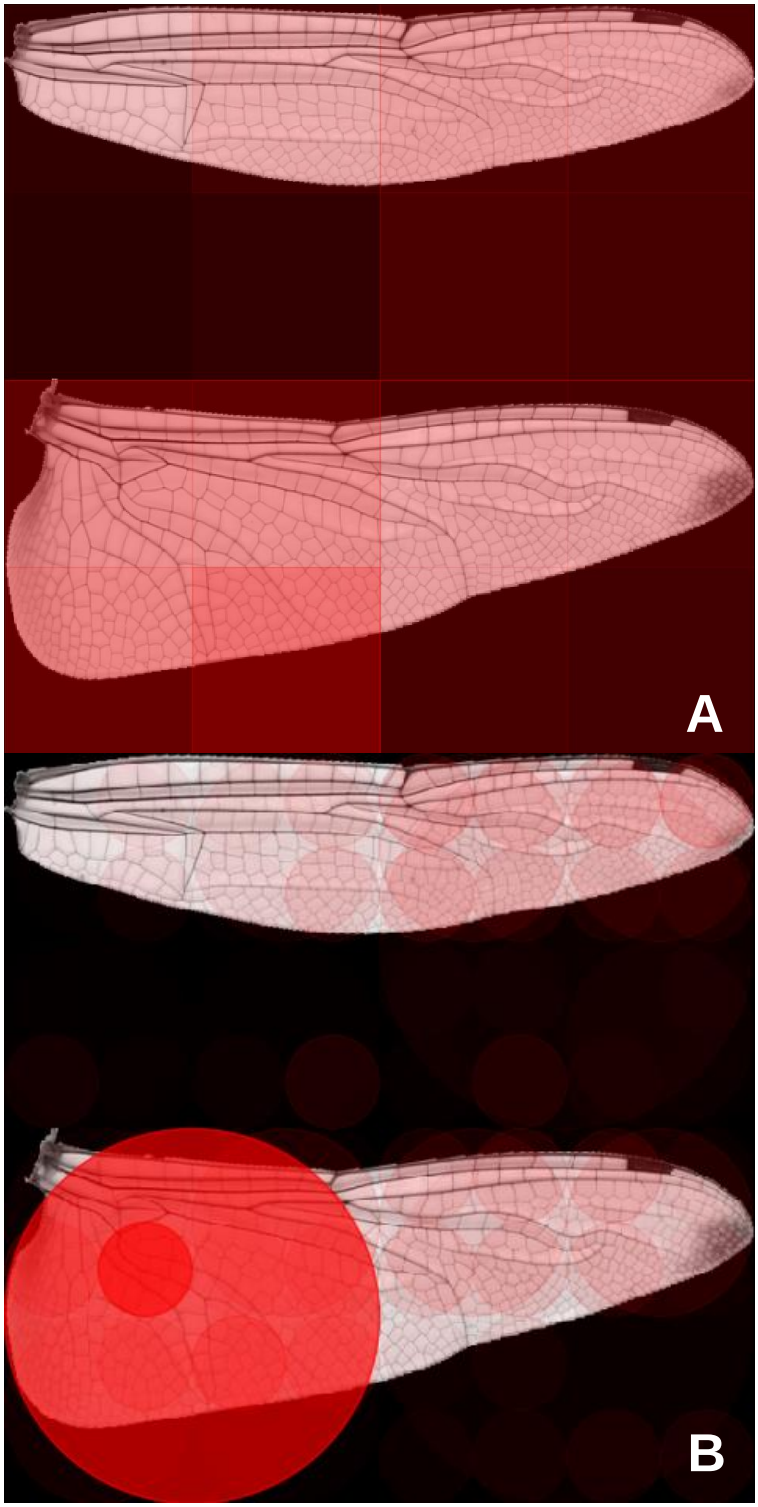

Figure 15. **Map of wing importance for species discrimination according to chromaticity (A) and GWT (B).** These squares summarize Figures 13 & 14, where all square or circles are overlaid onto a single set of wings. Here, intensely red areas correspond to regions of the wings that have higher *F*-statistics. For visual clarity, only squares and circles corresponding to scales less than one are shown.

Chapter 4. Odomatic: a system for automatically identifying Odonata from images of their wings

4.1. Abstract

Understanding Earth's species—a task assigned to the field of taxonomy—informs biodiversity research, conservation efforts, management strategies, and global policy. In recent decades, however, a 'taxonomic impediment' has arisen: there is an urgent need to know the millions of yet-undiscovered species, while funding for taxonomic sciences and the number of trained taxonomists are both in decline. In this work, I present Odomatic, a system for identifying dragonflies and damselflies (Odonata) from their wings. In the system, images of odonate wings are preprocessed into standardized images, features are extracted from them relating to color texture and shape of the wings, and a classifier model is trained to identify them to generic, species, or species-sex level. In tests, the system worked best using the random forest classification algorithm, its performance was unaffected by the taxonomic level to which classes were identified (at least up to the generic level), and it performed similarly well on small and large sets of species. Odomatic was also accurate: it identified 18 species with up to 92% accuracy and 32 species with up to 91%. I plan to incorporate this system into an existing web repository for information and images and test it on a much larger set of species.

4.2. Introduction

It is imperative that we know and understand the life on Earth in order to inform biodiversity research, conservation efforts, management strategies, and

global policy (Weeks & Gaston 1997), but anthropogenic climate change and gross habitat destruction are causing many species to become increasingly threatened. Incomprehensibly, funding for taxonomy—the science of naming and classifying organisms—and the number of trained taxonomists have declined markedly in recent decades (Godfray 2002; Gaston & O'Neill 2004; La Salle *et al.* 2009). There is seemingly a need for more taxonomy from fewer taxonomists. This conundrum, coined the 'taxonomic impediment' (Hoagland 1996), warrants augmentation of the traditional practices of this science with the aid of modern technological advancements to increase the effectiveness of taxonomic pursuits. We can start by automating one of the most time-consuming tasks, identification, allowing taxonomists to focus more on much-needed alpha taxonomy (describing new species and making taxonomic revisions).

Automatic taxonomic identification is a problem of supervised machine learning (e.g., Bishop 2006). In this type of learning, a model is *trained* or *fitted* to infer information from a set of labeled examples, allowing it to discriminate between a set of *classes* (such as genera or species), then its performance is checked against additional labeled examples during a *testing* or *validation* phase. The trained and validated model can then be applied to novel (i.e. unseen) inputs, so that it returns a class designation. There are a number of different types of models and classification algorithms for training them, which range in complexity from those with only a few parameters (e.g., nearest neighbor or nearest centroid models), to models that contain tens to thousands of parameters (or more), such as random forest, support vector machine, naïve Bayes, or

neural network models (discussed further in Methods). In all models, however, individuals are represented by feature vectors.

The present study is concerned specifically with learning models from images (although models can be built for other types of inputs, such as audio data (e.g., Russo & Jones 2002; Chesmore 2007)). Images must be converted into vectors of features before they can be used to train a model or a fitted model can be applied to them. Images are composed of pixel intensities: in a color image, these come in triplets—typically, intensities for the red, green, and blue channels—whereas grayscale images have a single intensity per pixel. These pixel intensities, themselves, can be concatenated into a single vector; however, even in small images, these vectors can be quite large (e.g., a 100×100-px color image comprises 30,000 values). Training a model using the full feature vectors of high resolution images is computationally prohibitive. Also, images tend to be highly auto-correlated, so much of the information contained in an image's full feature vector is redundant (Bovik 2000). Instead, steps are often taken to preprocess images to reduce the number of features that they contain (such as image down-sampling and cropping) and are often combined with methods (e.g., edge detection, ordination) for extracting particular features that are likely to vary between the classes of interest (Bishop 2006). These measures transform images from a relatively large set of mostly-uninformative pixel values to a relatively small set of coefficients that are more useful for classification and practical for modelling.

An image-based taxonomic identification system comprises a model trained to distinguish species using a set of images that exemplify the appearance of each species. Great care must be taken when designing the model's training scheme to prevent it from becoming too good at classifying these example images at the expense of poor classification performance when presented with novel images—a condition known as over-fitting. Example images are typically split into mutually exclusive training and testing sets—the former being used to train the model, and the latter to judge its performance. This scheme is one type of *cross-validation.* Increasing the size of these training and testing sets can also reduce model over-fitting. Additionally, there are methods that are unique to each model-fitting algorithm for reducing over-fitting. These practices produce taxonomic identification models that are better able to generalize between the examples upon which they are trained and real-world imagery on which they are later applied.

A taxonomic identification model is limited to identifying only taxa on which it has been trained. When applied to an image of a previously un-encountered taxon, the model will (incorrectly) assign the image to one of the categories that it "knows" (i.e. a false positive). This limitation may be inconsequential in application where unknown taxa are unlikely to be encountered, but can be problematic if they are common. This is particularly problematic if detection of rare or unknown species is desirable, as in the case of real-world species identification where such instances may represent new species or new locality records. To combat the incorrect classification of novel specimens, an extra class

can be introduced into the training set, into which are included images of taxa that are not represented in the other classes, like rare species or unidentified individuals (Wilder *et al.* 2012). By giving the model an extra class (hereafter, “rare-unknown” class), it is not forced to incorrectly identify these individuals. The downside of adding a rare-unknown class is that the variability within it can outweigh the between-class variability. This can cause “confusion” in the model, resulting in the possibility of familiar taxa being incorrectly classified as rare-unknown taxa (i.e. false negatives). The particular application for which a taxonomic identification system will be used governs whether the benefits of adding a rare-unknown class outweighs the possible reduction in model accuracy.

Insects are probably one of the most difficult groups of organisms to work with from a taxonomic standpoint: they are typically small in size, often exhibit only subtle morphological differences between species, and are incredibly speciose. To ease the burden of sometimes extremely difficult task, several automated and semi-automated identification systems have been presented for insects and other organisms. Examples of semi-automated systems—where some human input is needed to complete the identification process—are ABIS (Schroder *et al.* 2002; Steinhage *et al.* 2007), which uses images of wings to identify closely-related bee species that are otherwise difficult to distinguish, DAII (Yang *et al.* 2015), which identifies Neuroptera from images of the wings of pin-mounted specimens, and DAISY (O’Neill 2007), which provides general purpose identification for many organisms (e.g., insects, leaves, pollen, human faces)

using various types of images. These systems require the user to point out certain features in the image with a few mouse clicks. Fully automated systems—where the user needs only provide an input image—have been designed for identifying members of some spider genera to species using images of their genitalia (Do *et al.* 1999; SPIDA; Russell *et al.* 2007), stonefly nymphs using relatively unconstrained whole-body images (Larios *et al.* 2008), species of moths from images of live individuals (Mayo & Watson 2007), trees of the northeastern United States using images of their leaves (LeafSnap; Kumar *et al.* 2012), and coral reef fish using live images from underwater-mounted video cameras (Wilder *et al.* 2012). These systems are generally very successful (>80%) at identifying a relatively small number of species for which they have been trained; however, even a system that is only able to identify common species could be of enormous benefit to taxonomists, freeing them to tackle the rare or novel taxa.

Dragonflies and damselflies (collectively, the insect order Odonata) are an ideal taxonomic group for automatic identification. The diversity of recently-published field guides for Odonata (e.g. Dunkle 2000; Mead 2003; Nikula *et al.* 2003; Abbott 2005, 2011, 2015; Dubois & DuBois 2005; Beaton 2007; Barlow *et al.* 2009; Paulson 2009, 2011; Kerst & Gordon 2011) demonstrates the public's interest in these insects. Odonates are well known among the general public due to their aerial acrobatics, vibrant coloration, and ubiquity near water. They are obligatorily linked to freshwater systems, making them useful biological indicators of environmental health (Cordoba-Aguilar 2008), and making their accurate

classification important in this context. Additionally, there are considerably fewer (~6,000) species, worldwide, than of many other insect groups, making it relatively easy to conduct odonate biodiversity assessments, compared with more speciose insect orders (Corbet 1999; Cordoba-Aguilar 2008). Despite the availability of resources for identifying them, however, identification of many odonates remains difficult and time-consuming. There are large parts of the world for which no field guide is available (e.g., much of South America, the Pacific Islands, northern and central Africa); and additionally, there are many groups of dragonflies (e.g., *Erythrodiplax* spp., *Gomphus* spp., *Sympetrum* spp.) for which species' diagnostic features (e.g., small gentalic features) are difficult to distinguish. Identifications must often be made by consulting taxonomic keys and species descriptions, which require a special knowledge of taxonomic terms, or by comparison of a specimen with type specimens, which can be inaccessible in foreign museums. An automated identification system for dragonflies, perhaps available as a stand-alone program or website, can help researchers that work in less-studied regions or on more difficult dragonfly taxa by reducing the required number of manual identifications that must be performed.

Here, I present and evaluate a system for automatically identifying Odonata from images of their wings, called Odomatic, which combines methods for standardizing and extracting features from images (see Chapter 3) with powerful machine learning algorithms. Wings make a convenient morphological structure since they are relatively flat and thus can be quickly digitized on a flatbed scanner. Most odonate genera can be diagnosed down to the generic

level based on wing venation alone, and when combined with coloration that appears in the wings of many species, the wings may be enough to diagnose individuals to species and even species-sex level.

4.3. Methods

4.3.1. The Odomatic system

Odomatic was built based upon images of dragonfly and damselfly wings. A total of 172 odonate species (129 dragonfly and 43 damselfly species) from North and South America were digitized (summarized in Table 1; a full list of specimens is in Appendix A), primarily from the collection of J.L. Ware (Rutgers University, Newark). The number of individuals (i.e., scanned images) per species ranged from 1–98 (mean = 10.5). The fore- and hindwings of each dragonfly specimen were excised at their bases and scanned. For consistency, only right wings were used in this study, except for a few cases where only the left wings were intact; in those cases, the left wings were digitized and digitally reflected to match the right wings. The two wings and a specimen label were placed on the glass of the flatbed scanner (Epson NX420 or NX625, Epson America, Long Beach, CA) with their dorsal side facing the scanner glass, covered with a white index card or the plastic scanner lid, and scanned in 24-bit color at 1,200 or 2,400 dpi. Images were saved in .tif format with LZW compression.

The system was designed (outlined in Figure 1) with the goal of achieving the highest classification accuracy between classes. Classification at multiple taxonomic levels was tested (see section 4.3.2.2), and all tests included a rare-

unknown class. Membership of individuals in the rare-unknown class was determine based on a cut-off value for class size, s. If a class contained fewer than s individuals, its members were automatically reassigned to the rare-unknown class for training and testing. Classes were then randomized and assigned to training and testing sets (described below). Training images were down-sampled to 650-px in width, then transformed into a standardized square image, where the masked forewing spans the upper half of the image and the hindwing spans the lower half, on a black background, using the image preprocessing steps described in Chapter 3. Chromaticity, Gabor wavelet transform (GWT), and morphometric features (also described in Chapter 3) were then extracted from each standardized image, so that every set of wings was represented by a vector of 663 features (15 morphometric, 138 chromaticity and 510 GWT features). Training features were rescaled so that each had a mean of zero and standard deviation between -1 and 1. Each feature set was truncated across all individuals in the training set using principal component analysis (PCA; Bishop 2006), such that if the number of features from any of the classes in the training set exceeded the value of j, they were replaced by the first j principal components (PCs). The transformed feature sets were then concatenated and a classification model was fit to those features. The same procedure (image preprocessing, feature extraction, rescaling, and feature set truncation) was applied to the images in the testing set, using the rescaling and truncation transformations from the training set, which were saved for this purpose. Finally, the trained classification model was applied to the testing set in order to predict

class identity for each individual. The model was scored by using mean classification accuracy, the average per-class proportion of correctly-identified individuals to class size. I experimented with several aspects of this process to determine the effect on overall model performance (see below).

For convenience, the entire process described above was divided into three separate tasks. First, all images were down-sampled, preprocessed and saved as standardized squares. Second, features were extracted from all standardized squares and saved to a database. Finally, model training and testing was performed using the pre-existing features in the database. The first two tasks were the most time-consuming; however, model training and testing was very rapid. Thus this batch-based approach made it possible to train and validate thousands of models (using pre-extracted features) in a reasonable amount of time (minutes to hours). This would not have been possible if each of these tasks were performed on each individual every time a model was trained.

Odomatic was written in Python and uses the scikit-learn library (Pedregosa *et al.* 2011). My code is in the form of a Python package, *autoID*, which includes modules for image preprocessing, feature extraction, and model-building, and is available at http://www.crossveins.com.

4.3.2. Evaluating the performance of Odomatic

4.3.2.1. General parameter search

I first examined the effects of three factors concerning the training of classification models that I expected to have a great effect on species classification accuracy: size of classes in the training set, the cutoff value for

truncating features (j), and the classification algorithm used to train the model. A parameter search was conducted over 160 unique combinations of these three factors, and was replicated for each parameter combination 10 times. In each replicate, a model was trained according to the prescribed set of parameters on a randomly selected training set, then the trained model was applied to another randomly selected testing set, producing a predicted class designation for every member of the testing set. Mean accuracy was then recorded for that replicate and the process was repeated. The number of individuals in each training and testing class are discussed below. In this parameter search, individuals were labeled to species. The best-performing 6 out of 10 replicates for each parameter combination were taken for analysis, based on mean accuracy.

I varied the values for j, the cutoff value for truncating features. If the number of features from a feature set (chromaticity, GWT, or morphometric) was greater than j, the values for that feature set were replaced by its first j PCs. Note that for $j \geq 15$, the morphometric feature set (comprising 15 features) was not truncated. I tested classifiers trained with features conditioned by j-values of 5, 10, 15, 25, 50, 75, 100 and 125 (yielding 15, 30, 45, 65, 115, 165, 215, and 265 coefficients, respectively). I hypothesized that larger values of j would yield higher mean accuracies than lower values, since the former yields more features, and presumably more information for classification, than the latter.

I also varied the size of the training set in the parameter search. To do this, the dataset was first relabeled using s set to 25, so that all species represented by fewer than 25 individuals in the dataset were renamed as “rare-

unknown." The dataset contained 21 species with at least 25 individuals. Models were then fitted on training sets containing 5, 10, 15, or 20 individuals per species class (including the "rare-unknown" class), and were tested against a set comprising 5 individuals per class, to remove the effect of varying the size of the testing set. As a general rule, models trained using more individuals are expected to perform better than models trained on smaller datasets (e.g., Bishop 2006), therefore I expected to see higher-accuracy models from those trained with 20 individuals per class.

I tested six different classifications algorithms for training a classification model from the features, all of which were available in scikit-learn. The nearest centroid algorithm (NC), where class predictions are made based on the distance between a feature vector and each of the class means from the training data, was used as a simple baseline model. The Gaussian naïve Bayes algorithm (NB) works by "naïvely" assuming that all features are independent from one another, but generally performs surprisingly well and very fast (Zhang 2004; Pedregosa *et al.* 2011). These first two algorithms do not require any tuning of the model parameters (called *hyperparameters*); all parameters are calculated directly from the training data. I also tried four algorithms that do require optimization of the model hyperparameters. Prior to the general parameter search, I ran an independent search for each of the following classifier algorithms to find the best hyperparameters. For this, I used the process described above for the full parameter search, except that j was set to 40, and training class size was set to 20. Reasonable values for each hyperparameter were chosen based on the

recommendations in the documentation for scikit-learn (Pedregosa *et al.* 2011). The highest-scoring combination of hyperparameters for each classification algorithm were used in the general parameter search. The random forest (RF) classifier comes from a class of algorithms known as ensemble methods, where numerous statistical subunits are each trained on a small subset of the training data (Pedregosa *et al.* 2011). During application of an ensemble model, predicted class designation is determined by a “vote” from these subunits; the class that gets the highest vote is returned as the predicted class. In an RF classifier, these subunits are decision trees and the classification is made by the whole “forest” of these trees, hence the name. Artificial neural networks (ANNs) are another class of learning algorithms that function similarly to the way the brain processes information: inputs are processed by multiple layers of parallel artificial neurons (Lang 2008). ANNs are popular for automatic identification (e.g., O’Neill 2007; Russell *et al.* 2007; Wilder *et al.* 2012) as they are good at generalizing from a small set of training examples. Specifically, I tested a Bernoulli restricted Boltzmann machine neural network (RBM), which functioned as a second feature extractor, and was followed by a logistic regression classifier in order to properly classify individuals. Finally, I tested a support vector machine (SVM) with a radial-basis filter. SVMs are also popular in species identification (e.g., Mayo & Watson 2007; Yang *et al.* 2015) as they are fast, efficient and accurate (Pedregosa *et al.* 2011). In all, five classification algorithms were tested: NC, NB, RF, RBM, and SVM.

4.3.2.2. Taxonomic level

I measured the performance of models trained to identify species on three taxonomic levels: genus, species, and species-sex. The last level was chosen to test the effects of sexual dimorphism (where males differ in appearance from females) on model performance. Eight species were used throughout this experiment, for which there were at least 20 females and 20 males, *Celithemis eponina, Erythemis simplicicollis, E. vesiculosa, Erythrodiplax fervida, Hetaerina occisa, Macromia illinoiensis, Pachydiplax longipennis, Pantala hymenaea*, as well as a rare-unknown class. Individuals were labeled by their genus only, their full species name, or species and sex. Each taxonomic level was tested 10 times, and for each replicate, the per-class sizes were held to 15 and 5 individuals for the training and testing sets, respectively. Models were trained using the best classification algorithm and j-value from the general parameter search, above. As before, the best 6 of 10 replicates for each level were analyzed. It should be noted that the number of classes was 8 at the genus level, 9 at the species level, and 17 at the genus-species-sex level. Also, *C. eponina* and *H. occisa*, varied markedly in wing appearance between sexes, while the other species showed little to no apparent dimorphism. In this experiment, it followed that prediction accuracy would be confounded by sexual dimorphism in the first two species when identifying at the species level (i.e. those species each have two forms, which were lumped together into a single category), while confounding at the genus-species-sex level would come from the non-dimorphic species being split into two, relatively similar, classes. At the genus level, both

Erythemis species were placed into a single class. It was difficult to predict which of the three levels would perform best.

4.3.2.3. Number of classes

The number of classes on which a model was trained was varied and the effect on classification accuracy was measured. Individuals were labeled to the species level and s was set to 15 for relabeling the rare-unknown class, producing a dataset with 31 unique species (each with ≥15 individuals) plus the rare-unknown class. In each replicate of this experiment, a model was trained and tested between 2 and 31 randomly selected species, plus the rare-unknown class, on 10 training and 5 testing set individuals per class, respectively; thus the number of classes ranged from 3–32. Models were trained using the best classification algorithm and j-value. I performed 50 replicates for each number of classes, since the class content could vary widely for larger class sizes, and analyzed the best 30 of 50. I expected that models trained on fewer classes would out-perform those trained on more classes, as the probability of between-class confusion would be higher in the latter scenario.

4.3.2.4. Best-case classifier model

In order to explore the upper limits of my classification system given the current dataset, I trained models using the best parameters for the parameter search, set s to 15, 25, or 40 individuals, labeled individuals to the species level, and randomly assigned 75% of each class to the training set and the rest of individuals to the testing set. These values of s produced datasets with 32, 22, and 18 classes (including the rare-unknown class), respectively. I ran 100

replications of this experiment and analyzed the top 5 of them. In pilot experiments, I found that extreme variability in class size negatively affected classification performance. In order to limit this effect (particularly between the rare-unknown class, which is typically very large, and the smallest classes), I limited the size of all classes to twice the median of the original class sizes.

4.4. Results

4.4.1. General parameter search

One hundred and sixty unique combinations of three model parameters were searched in order to find the best combination. It took less than 1 s to train and test a classification model on a laptop computer, and less than 5 s to train 10 replications of a parameter combination. Figure 2 summarizes the results of this search. As predicted, there was a clear, increasing trend between training class size and model performance, where models trained with 5 individuals per class had a mean accuracy (± standard deviation) of 70.7 ± 15.2%, while those trained with 20 per class averaged 84.3 ± 3.8%. Given increasing values of j, model performance also increased from 75.0 ± 5.5% at j = 5 up to 82.2 ± 7.4% at j = 50, but then decreased after 50. The SVM and RF classifiers worked similarly well (82.8 ± 4.5% and 82.5 ± 5.7%, respectively), while NB performed worst (70.6 ± 17.6%) and also had the most variable performance among the classification algorithms tested. The best overall combination of parameters, which scored 90.3%, was the 20 per-class size, j = 75, and the RF classification algorithm.

4.4.2. Taxonomic level

The effects of classifying individuals to genus level, species level, and species-sex level were investigated (Figure 3). Classification accuracy was highest in models trained to identify to the species-sex level (80.4 ± 3.2%); however, there were no significant differences between the three different classification levels (ANOVA: df = 2 & 15, $F = 2.43$, $p = 0.12$).

4.4.3. Number of classes

The effect of increasing the number of species classes for which a model was trained to identify on the model's classification performance was investigated (Figure 4). Models with 3- and 4-classes performed significantly better (93.6 ± 6.2% and 92.1 ± 4.5%, respectively) than models trained with all other numbers of classes except 5 (ANOVA (df = 29 & 870, $F = 7.66$, $p <<< 0.0001$) followed by Tukey HSD ($\alpha = 0.05$)). Models trained with 26 classes performed worse (87.0 ± 1.9%). Despite the significant differences, the number of classes had a relatively small effect on mean accuracy; however, there was a marked reduction in the variability of accuracy as the number of classes increased (Figure 4).

4.4.4. Best-case classifier model

Three values for s were tested in order to determine the best possible classification accuracy for Odomatic, with the current image dataset. Averaged over the top 5 of 100 replicates, the models trained with the $s = 40$ dataset performed the best overall, averaging 91.1 ± 0.5% (Figure 5). This dataset contained both the fewest species classes (18) of the three tested here and the most individuals per species class—ranging from 40–98 individuals (mean, 58).

The top replicate for each of the s-values scored 91.3% for s = 15 (32 species classes), 90.8% for s = 25 (22), and 91.9% for s = 40. The classification ability of the latter replicate is illustrated in Figure 6 as a *confusion matrix*. Rows of this matrix are the true classes from the testing set, and columns are the classes predicted by the model. For example, among *E. simplicicollis* individuals (third row), 20 were classified correctly, 2 were classified as its congeneric, *E. vesiculosa*, 1 as *P. longipennis* (whose wings are similar in appearance), and 1 as rare-unknown.

4.5. Discussion

Here I present Odomatic, a system for identifying odonates from their wings. In the system, images of dragonfly and damselfly wings are preprocessed into standardized images, features are extracted from them, and a classifier model is then trained to identify them to generic, species, or species-sex level. The system worked best using the random forest classification algorithm, was relatively unaffected by the taxonomic level to which classes were identified (at least up to the generic level), and it performed best on small numbers of species, although classification accuracy was only slightly reduced for larger species sets up to 32 classes. This system was also accurate: Odomatic identified 18 species with up to 92% accuracy and 32 species with up to 91%. For comparison, Culverhouse *et al.* (2003), found that trained para-taxonomists were 72% accurate in identifying dinoflagellates, where experts had an accuracy of 84–95%. Odomatic was well within this expert-level range.

Remarkably, Odomatic was able to distinguish these species from wings alone. In many odonate genera, such as *Erythemis*, wings alone are not enough to identify individuals to species; body coloration, caudal appendages and genitalia must usually be inspected to make a positive identification. However, the machine learning algorithms used here were able to discern reliable (and perhaps subtle) differences between *E. simplicicollis* and *E. vesiculosa* (Figure 6; Appendix B, Plate 6E–F).

I plan to implement this system within OdonataCentral.org (OC), a web-based repository for images, records, distribution maps, and identification information for dragonflies and damselflies of the Western Hemisphere (Abbott 2006, 2010). This implementation will allow researchers and citizen scientists to upload their own images of odonate wings and receive rapid, expert-level identifications. It will also allow me to test this system on a much larger number (600+) of species.

In addition to identifying Odonata, the code underlying Odomatic—available as an open-sourced, Python package called *autoID* (available from http://www.crossveins.com)—was designed to be easily adapted to identify other organisms with minimal customization. I hope that the tool presented here, as well as its underlying code, will help to reduce the taxonomic impediment by automating the process of taxon identification.

4.6. References

Abbott, J.C. (2011). *Damselflies of Texas: A Field Guide*. University of Texas Press.

Abbott, J.C. (2005). *Dragonflies and Damselflies of Texas and the South-Central United States: Texas, Louisiana, Arkansas, Oklahoma, and New Mexico*. Princeton University Press, Princeton, New Jersey.

Abbott, J.C. (2015). *Dragonflies of Texas: A Field Guide*. University of Texas Press.

Abbott, J.C. (2006). OdonataCentral: An online resource for the distribution and identification of Odonata. *OdonataCentral: An online resource for the distribution and identification of Odonata*. URL http://www.odonatacentral.org [accessed 1 August 2015]

Abbott, J.C. (2010). OdonataCentral: the past, present and future. *Argia*, **22**, 10–14.

Barlow, A.E., Golden, D.M. & Bangma, J. (2009). *Field Guide to Dragonflies and Damselflies of New Jersey*. New Jersey Department of Environmental Protection, Division of Fish and Wildlife, Flemington, NJ.

Beaton, G. (2007). *Dragonflies and Damselflies of Georgia and the Southwest*. The University of Georgia Press, Athens, GA.

Bishop, C. (2006). *Pattern Recognition and Machine Learning*. Springer, New York, NY.

Bovik, A. (Ed.). (2000). *Handbook of Image and Video Processing*. Academic Press.

Chesmore, D. (2007). The automated identification of taxa: concepts and applications. *Automated Object Identification in Systematics: Theory, Approaches, and Applications*, pp. 83–100. CRC Press, New York, NY.

Corbet, P.S. (1999). *Dragonflies: Behavior and Ecology of Odonata*. Cornell University Press, Ithaca, NY.

Cordoba-Aguilar, A. (2008). *Dragonflies & Damselfies: Model Organisms for Ecological and Evolutionary Research*. Oxford University Press, Oxford, UK.

Culverhouse, P.F., Williams, R., Reguera, B., Herry, V. & González-Gil, S. (2003). Do experts make mistakes? A comparison of human and machine identification of dinoflagellates. *Marine Ecology Progress Series*, **247**, 17–25.

Do, M.T., Harp, J.M. & Norris, K.C. (1999). A test of a pattern recognition system for identification of spiders. *Bulletin of Entomological Research*, **89**, 217–224.

Dubois, R. & DuBois, B. (2005). *Damselflies of the North Woods*. Kollath-Stensaas Publishers.

Dunkle, S.W. (2000). *Dragonflies Through Binoculars: A Field Guide to Dragonflies of North America*. Oxford University Press, New York, NY.

Gaston, K.J. & O'Neill, M.A. (2004). Automated Species Identification: Why Not? *Philosophical Transactions: Biological Sciences*, **359**, 655–667.

Godfray, H.C.J. (2002). Challenges for taxonomy. *Nature*, **417**, 17–19.

Hoagland, K.E. (1996). The taxonomic impediment and the convention on biodiversity. *Association of Systematics Collections Newsletter*, **24.5**, 61–62.

Kerst, C. & Gordon, S. (2011). *Dragonflies and Damselflies of Oregon: A Field Guide*. Oregon State University Press, Corvallis, OR.

Kumar, N., Belhumeur, P., Biswas, A., Jacobs, D., Kress, W.J., Lopez, I. & Soares, J.B. (2012). Leafsnap: A Computer Vision System for Automatic Plant Species Identification. *Computer Vision – ECCV 2012* (eds A. Fitzgibbon, S. Lazebnik, P. Perona, Y. Sato & C. Schmid), pp. 502–516. Lecture Notes in Computer Science. Springer Berlin Heidelberg.

La Salle, J., Wheeler, Q., Jackway, P., Winterton, S., Hobern, D. & Lovell, D. (2009). Accelerating taxonomic discovery through automated character extraction. *Zootaxa*, **2217**, 43–55.

Lang, R. (2008). Neural Networks in Brief. *Automated Taxon Identification in Systematics: Theory, Approaches and Applications* (ed N. MacLeod), pp. 47–68. CRC Press, London, UK.

Larios, N., Deng, H., Zhang, W., Mortensen, E. n., Dietterich, T. g., Sarpola, M., Paasch, R., Moldenke, A., Lytle, D. a., Yuen, J., Correa, S. r. & Shapiro, L. g. (2008). Automated insect identification through concatenated histograms of local appearance features: Feature vector generation and region detection for deformable objects. *Machine Vision and Applications*, **19**, 105–123.

Mayo, M. & Watson, A.T. (2007). Automatic species identification of live moths. *Knowledge-Based Systems*, **20**, 195–202.

Mead, K. (2003). *Dragonflies of the North Woods*. Kollath-Stensaas Publishing, Duleth, MN.

Nikula, B., Loose, J.L. & Burne, M.R. (2003). *A field guide to the dragonflies and damselflies of Massachusetts*. Westborough, MA : Massachusetts Division of Fisheries & Wildlife, Natural Heritage & Endangered Species Program.

O'Neill, M.A. (2007). DAISY: A Practical Computer-Based Tool for Semi-Automated Species Identification. *Automated Object Identification in Systematics: Theory, Approaches, and Applications* (ed N. MacLeod), pp. 101–114. CRC Press, New York, NY.

Paulson, D. (2011). *Dragonflies and Damselflies of the East*. Princeton University Press, Princeton, NJ.

Paulson, D. (2009). *Dragonflies and Damselflies of the West*. Princeton University Press, Princeton, NJ.

Pedregosa, F., Varoquaux, G., Gramfort, A., Michel, V., THirion, B., Grisel, O., Blondel, M., Prettenhofer, P., Weiss, R., Dubourg, V., Vanderplas, J., Passos, A., Cournapeau, D., Brucher, M., Perrot, M. & Duchesnay, E. (2011). Scikit-learn: machine learning in Python. *Journal of Machine Learning Research*, **12**, 2825–2830.

Russell, K.N., Do, M.T., Huff, J.C. & Platnick, N.I. (2007). Introducing SPIDA-web: wavelets, neural networks and internet accessibility in an image-based automated identification system. *Automated Object Identification in Systematics: Theory, Approaches, and Applications* (ed N. MacLeod), pp. 131–152. CRC Press, New York, NY.

Russo, D. & Jones, G. (2002). Identification of twenty-two bat species (Mammalia: Chiroptera) from Italy by analysis of time-expanded recordings of echolocation calls. *Journal of Zoology*, **258**, 91–103.

Schroder, S., Wittmann, D., Drescher, W., Roth, V., Steinhage, V. & Cremers, A.B. (2002). The new key to bees: automated identification by image analysis of wings. *Pollinating Bees - The Conservation Link Between Agriculture and Nature* (eds P. Kevan & V.L. Imperatriz Fonseca), pp. 209–216. Ministry of Environment, Brasilia, Brazil.

Steinhage, V., Schroder, S., Lampe, K.-H. & Cremers, A.B. (2007). Automated extraction and analysis of morphological features for species identification. *Automated Object Identification in Systematics: Theory, Approaches, and Applications* (ed N. MacLeod), pp. 115–129. CRC Press, New York, NY.

Weeks, P.J.D. & Gaston, K.J. (1997). Image analysis, neural networks, and the taxonomic impediment to biodiversity studies. *Biodiversity & Conservation*, **6**, 263–274.

Wilder, J., Tonde, C., Sundar, G., Huang, N., Barinov, L., Baxi, J., Bibby, J., Rapport, A., Pavoni, E., Tsang, S., Garcia, E., Mateo, F., Lubansky, T.M. & Russell, G.J. (2012). An automatic identification and monitoring system for coral reef fish. *Proceedings of SPIE 8499, Applications of Digital Image Processing XXXV*, p. 84991H–84991H–15.

Yang, H.-P., Ma, C.-S., Wen, H., Zhan, Q.-B. & Wang, X.-L. (2015). A tool for developing an automatic insect identification system based on wing outlines. *Scientific Reports*, **5**, 12786.

Zhang, H. (2004). The Optimality of Naive Bayes. *Proceedings of the 7th International Florida Artificial Intelligence Research Society Conference*, pp. 562–567. AAAI Press.

4.7. Tables and Figures

Table 1. **Summary of wing image dataset.** 1799 images from 172 odonate species were used to test the feature extraction procedure presented here. Listed are the species and number of images per species. Appendix A contains a full list of specimens.

Suborder	Family	Genus	Species	♀	♂	Total
Anisoptera	Aeshnidae	*Aeshna*	*canadensis*	0	1	1
			eremita	1	9	10
			interrupta	2	2	4
			juncea	6	20	26
		Anax	*junius*	0	6	6
		Basiaeschna	*janata*	5	13	18
		Boyeria	*vinosa*	1	5	6
		Epiaeschna	*heros*	1	1	2
		Gomphaeschna	*furcillata*	1	3	4
		Staurophlebia	*reticulata*	2	1	3
		Triacanthagyna	*septima*	1	1	2
	Cordulegastridae	*Cordulegaster*	*erronea*	1	1	2
			maculata	4	11	15
	Corduliidae	*Cordulia*	*shurtleffii*	7	1	8
		Didymops	*transversa*	0	3	3
		Dorocordulia	*lepida*	1	0	1
			libera	8	6	14
		Epitheca	*cynosura*	12	58	70
			princeps	4	9	13
		Helocordulia	*uhleri*	0	3	3
		Phyllomacromia	*picta*	1	2	3
		Somatochlora	*albicincta*	1	8	9
			linearis	1	0	1
			margarita	0	1	1
			minor	0	2	2
			tenebrosa	2	0	2
	Gomphidae	*Aphylla*	*williamsonia*	0	1	1
		Arigomphus	*villosipes*	0	2	2
		Erpetogomphus	*designatus*	3	4	7
		Gomphus	*abbreviatus*	3	0	3
			exilis	0	8	8
			lineatifrons	4	10	14
			vastus	11	4	15
		Hagenius	*brevistylus*	2	1	3
		Phyllogomphoides	*pedunculus*	0	1	1
		Progomphus	*obscurus*	0	1	1
	Libellulidae	*Acisoma*	*panarpoides*	1	1	2
		Brachymesia	*furcata*	0	6	6
			gravida	2	3	5
			herbida	5	8	13
		Brachythemis	*contaminata*	1	0	1
		Celithemis	*elisa*	11	7	18
			eponina	31	42	73
			fasciata	1	0	1
			martha	0	1	1

Suborder	**Family**	**Genus**	**Species**	♀	♂	**Total**
Anisoptera (cont.)	Libellulidae (cont.)	*Crocothemis*	*servilia*	1	1	2
		Dasythemis	*esmeralda*	0	1	1
		Diastatops	*intensa*	1	11	12
			obscura	1	3	4
		Diplacodes	*trivialis*	1	5	6
		Dythemis	*velox*	1	1	2
		Elga	*longistyla*	0	1	1
		Epiaeschna	*heros*	0	1	1
		Epitheca	*cynosura*	0	2	2
		Epophthalmia	*elegans*	2	2	4
			vittata	0	1	1
			vittigera	0	1	1
		Erythemis	*attala*	3	4	7
			credula	0	1	1
			haematogastra	0	14	14
			peruviana	0	20	20
			plebeja	2	5	7
			simplicicollis	34	64	98
			vesiculosa	28	25	53
		Erythrodiplax	*amazonica*	0	1	1
			basalis	0	2	2
			berenice	5	3	8
			fervida	54	43	97
			fusca	1	0	1
			umbrata	1	18	19
		Ladona	*deplanata*	2	6	8
			exusta	0	2	2
			julia	3	4	7
		Leucorrhinia	*frigida*	1	0	1
			intacta	7	18	25
		Libellula	*axilena*	0	4	4
			cyanea	2	4	6
			herculea	0	1	1
			incesta	0	47	47
			luctuosa	6	39	45
			needhami	0	9	9
			pulchella	0	2	2
			quadrimaculata	6	0	6
			semifasciata	0	3	3
			vibrans	0	2	2
		Macrothemis	*extensa*	0	2	2
		Miathyria	*marcella*	0	4	4
			simplex	0	3	3
		Misagria	*parana*	0	2	2
		Nephepeltia	*phryne*	0	2	2
		Orthemis	*discolor*	0	1	1
			feiruginea	0	2	2
			schmidti	1	4	5

Suborder	**Family**	**Genus**	**Species**	♀	♂	**Total**
Anisoptera (cont.)	Libellulidae (cont.)	*Pachydiplax*	*longipennis*	23	28	51
		Pantala	*flavescens*	14	27	41
			hymenaea	23	25	48
		Perithemis	*lais*	0	3	3
			tenera	7	25	32
			thais	0	2	2
		Plathemis	*lydia*	13	30	43
		Tholymis	*citrina*	0	1	1
		Tramea	*carolina*	0	2	2
			lacerata	7	14	21
			rustica	0	2	2
		Uracis	*imbuta*	0	4	4
			ovipositrix	2	4	6
		Zenithoptera	*viola*	1	7	8
	Macromiidae	*Didymops*	*transversa*	0	2	2
		Macromia	*alleghaniensis*	0	1	1
			amphigena	1	1	2
			annulata	2	1	3
			aureozona	0	1	1
			bifasciata	0	1	1
			daimoji	1	1	2
			illinoiensis	20	24	44
			irata	1	0	1
			magnifica	0	4	4
			manchurica	0	1	1
			margarita	2	3	5
			melpomene	0	1	1
			monoceros	0	2	2
			moorei	0	2	2
			onerata	0	1	1
			pacifica	1	3	4
			pinratani	0	1	1
			rickeri	1	0	1
			sophia	1	0	1
			taeniolata	0	5	5
			tillyardi	1	1	2
			urania	1	0	1
			wabashensis	1	2	3
	Petaluridae	*Tachopteryx*	*thoreyi*	0	3	3
Zygoptera	Calopterygidae	*Calopteryx*	*aequabilis*	4	9	13
			maculata	14	17	31
		Hetaerina	*caja*	0	2	2
			capitalis	1	3	4
			duplex	0	3	3
			occisa	25	49	74
		Mnesarete	*metallica*	0	3	3
	Coenagrionidae	*Argia*	*apicalis*	1	0	1
	Euphaeidae	*Dysphaea*	*ethela*	0	1	1

Suborder	Family	Genus	Species	♀	♂	Total
Zygoptera (cont.)	Lestidae	*Lestes*	*dryas*	3	3	6
	Polythoridae	*Chalcopteryx*	*rutilans*	0	4	4
			scintillans	1	1	2
		Cora	*avrea*	0	1	1
			chirripa	0	4	4
			cyane	0	2	2
			inca	1	2	3
			irene	1	3	4
			jocosa	0	1	1
			marina	0	6	6
			notoxantha	0	1	1
			semiopaca	0	2	2
		Euthore	*fasciata*	0	2	2
			merdiana	0	1	1
			meridana	0	1	1
		Miocora	*peraltica*	0	3	3
			subapicalis	1	0	1
		Polythore	*aurora*	0	1	1
			beata	0	2	2
			boliviana	2	3	5
			concinna	6	18	24
			derivata	9	38	47
			gigantea	6	13	19
			manua	0	2	2
			mutata	6	14	20
			neopicta	8	45	53
			ornata	17	31	48
			picta	4	8	12
			procera	5	3	8
			terminata	3	5	8
			victoria	7	47	54
			williamsoni	0	2	2
		Stenocora	*percornuta*	1	1	2
Total		**67**	**172**	**549**	**1,250**	**1,799**

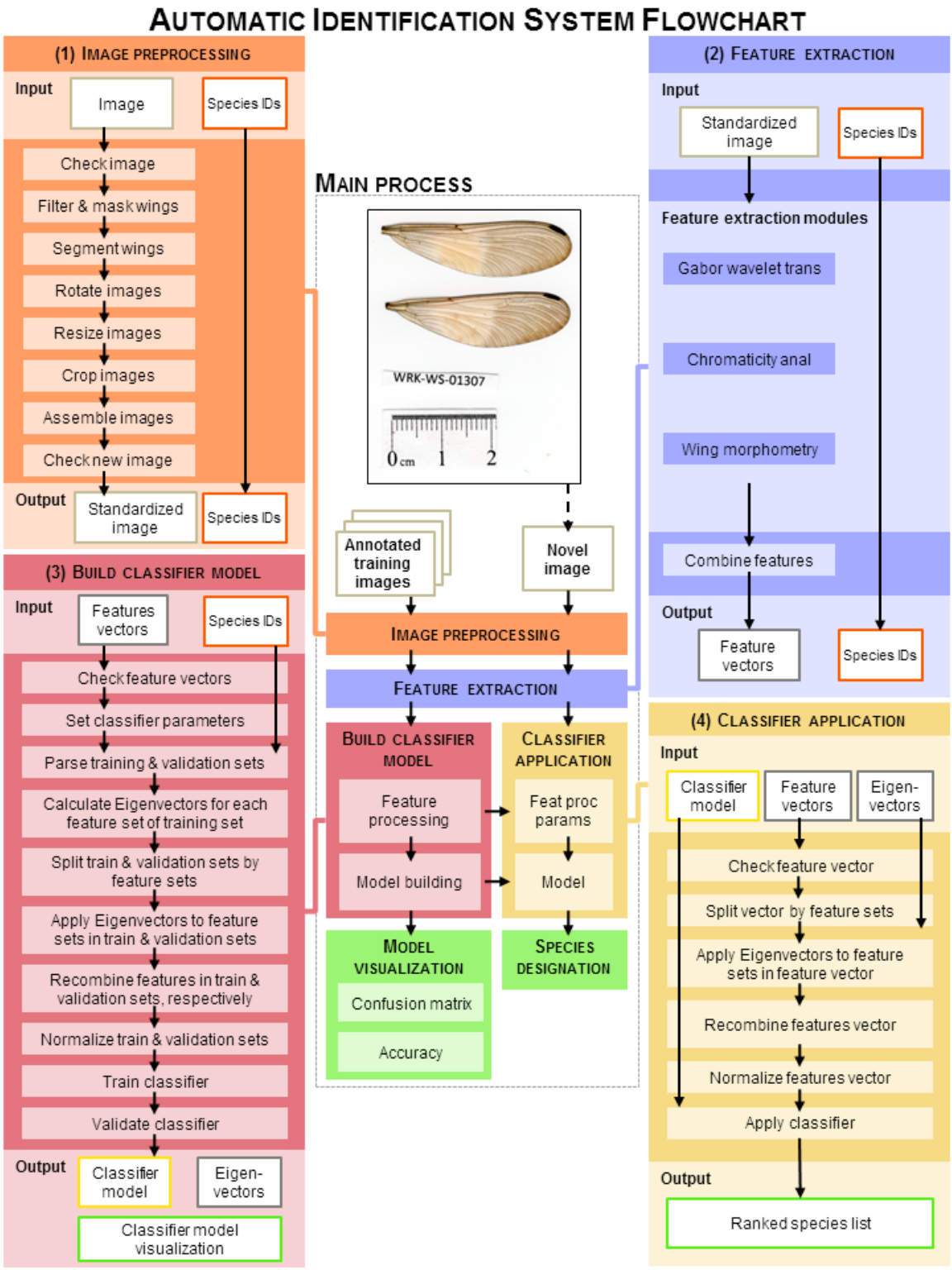

Figure 1. **Flowchart of automatic identification framework.**

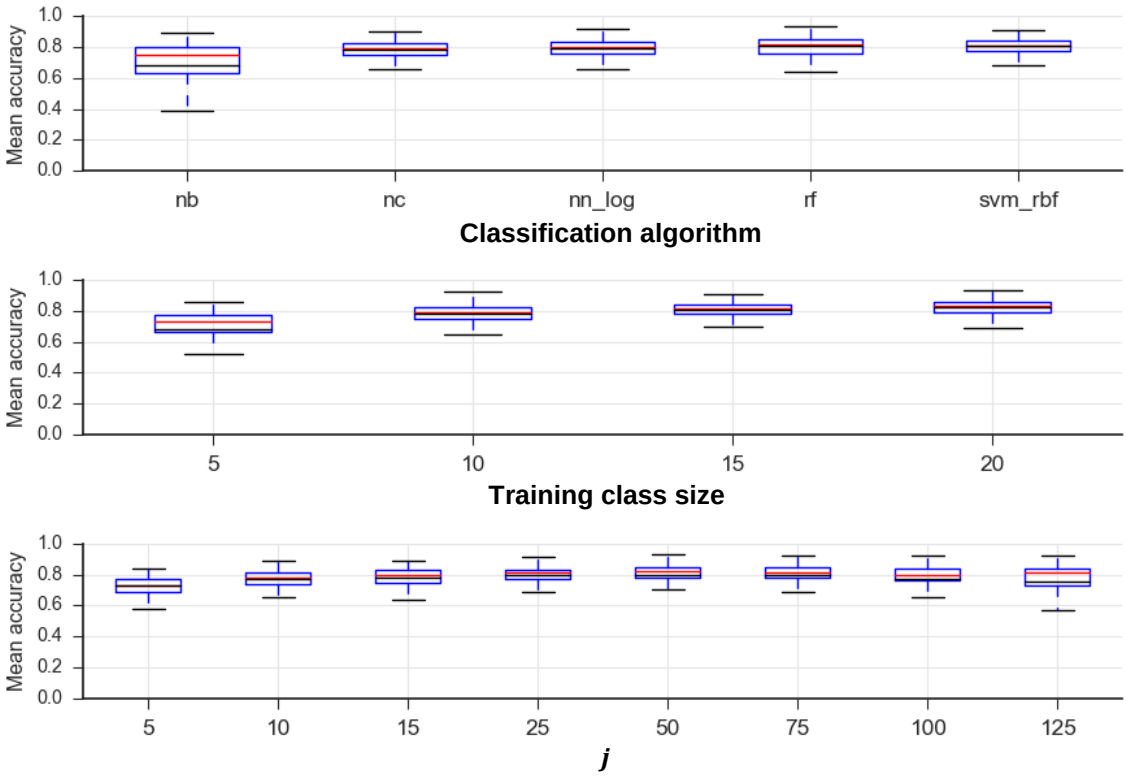

Figure 2. **Results of general parameter search.** The mean per-class classification accuracy of the best 6 of 10 replicated models trained using different combinations of three types of parameters are shown, by parameter: classification algorithm, where 'nb' is naïve Bayes, 'nc' is nearest centroid, 'nn_log' is RBM neural network with logistic classifier, 'rf' is random forest, and 'svm_rbf' is support vector machine with radial-basis filter (see Methods for details); size of the training class (testing class size was held at 5 individuals); and the feature truncation parameter, j (see text for details). Boxplots: black line, mean; red line, median; blue box, 1st & 3rd quartiles; black whiskers, 95% confidence interval. The best combination was random forest classifier with training class size 20 and j = 75.

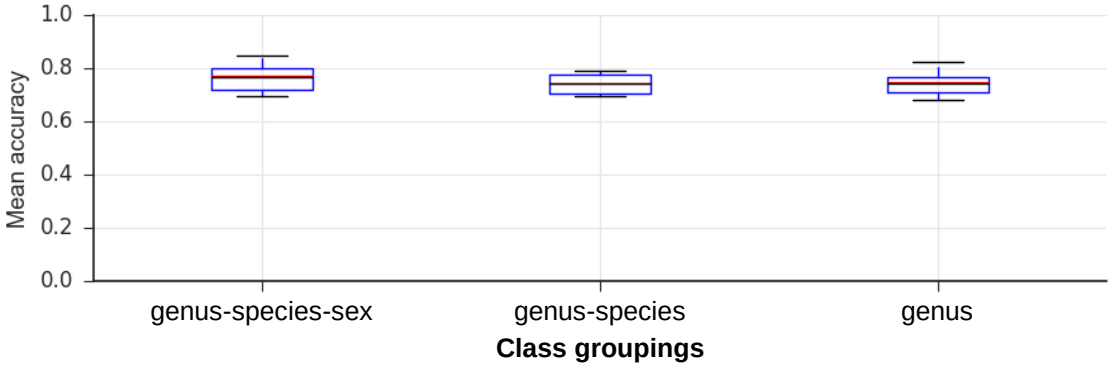

Figure 3. **Effect of number of taxonomic level on classification accuracy.** The mean per-class classification accuracy over best 6 of 10 replicated models by taxonomic level for grouping individuals (see text for details). Boxplots: black line, mean; red line, median; blue box, 1st & 3rd quartiles; black whiskers, 95% confidence interval. There were no significant difference between the three class groupings (ANOVA: df = 2 & 15, F = 2.43, p = 0.12).

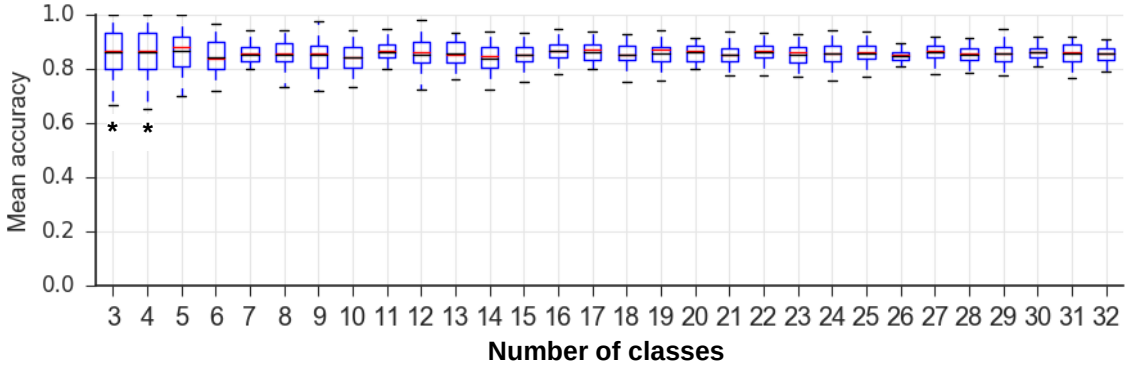

Figure 4. **Effect of number of species classes on classification accuracy.** The mean per-class classification accuracy over best 30 of 50 replicated models trained by number of classes in training and testing sets (see text for details). Boxplots: black line, mean; red line, median; blue box, 1st & 3rd quartiles; black whiskers, 95% confidence interval. *The 3- and 4-class models performed significantly better than all others except the 5-class models (ANOVA (df = 29 & 870, F = 7.66, p <<< 0.0001) followed by Tukey HSD (α = 0.05)).

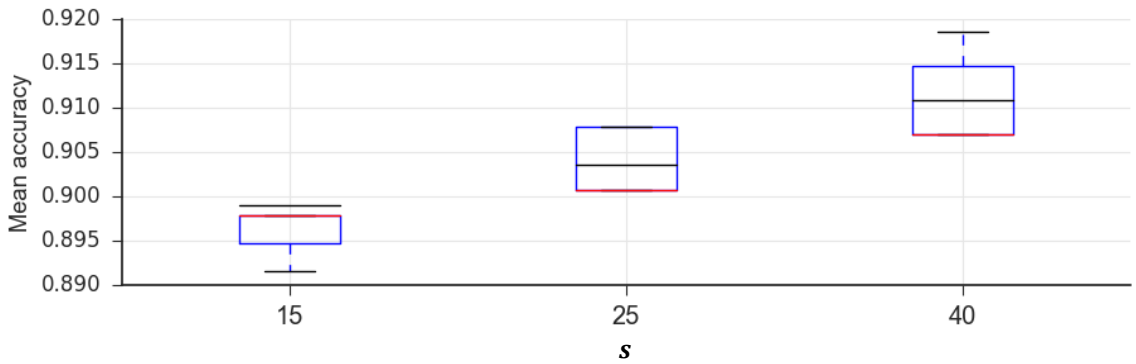

Figure 5. **Best-case classification accuracy.** The mean per-class classification accuracy over best 5 of 100 replicated models trained by the cutoff value s, where classes with few than s individuals are lumped into the rare-unknown class (see text for details). Boxplots: black line, mean; red line, median; blue box, 1st & 3rd quartiles; black whiskers, 95% confidence interval.

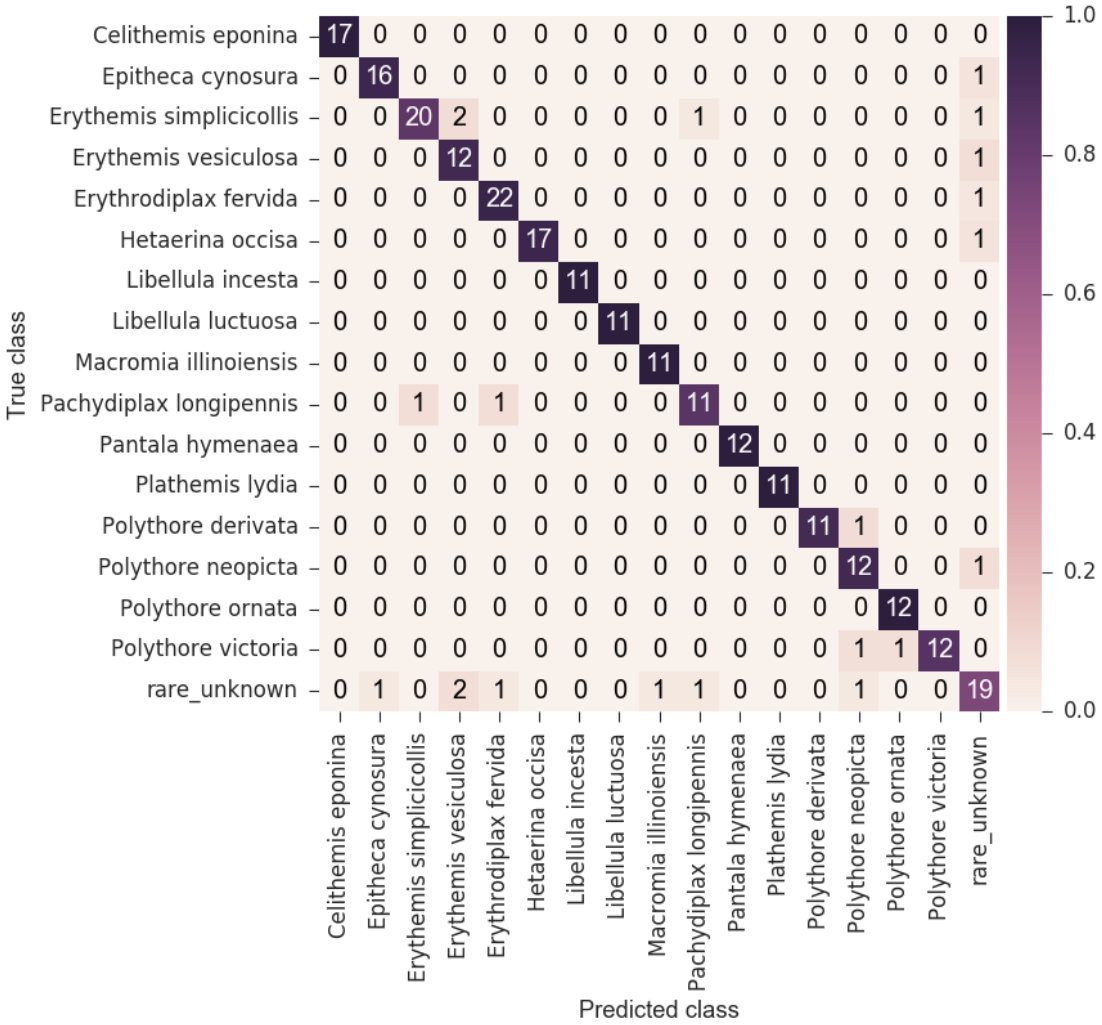

Figure 6. **Confusion matrix for best model.** This confusion matrix for the top replicate in the best-case experiment, which scored 91.9%. True class designations from the testing set are along the rows; columns are class designations predicted by the model; numbers in cells are the number of individuals in the row class to be predicted as the column class; cells are colored by the proportion of the individuals in that row. For a model that performs perfect classification, all individuals will be in the diagonal of the matrix.

Conclusions

In this dissertation work, three computational tools were introduced for describing images of biological specimens. These tools were provided to augment taxonomic research, by allowing taxonomists to be more effective and efficient, and thereby reduce the taxonomic impediment.

In Chapter 2, a time-consuming and tedious task was tackled: landmarking specimen images for comparing the shape of morphological structures across taxa. This process is typically done manually, which can actually limit the size of comparative studies due to the amount of time required for human workers to perform manual landmarking. My system for automatically landmarking was based on a pictorial structures model, which uses the appearance and configuration of manually-placed landmarks in example images to predict the locations of corresponding landmarks in novel images. The system was trained using images of odonate wings, containing 11 landmarks per wing. In its current form, was unable to compete with manual landmarking as its landmarking error was high and variable, but I suggest methods for improving the system's accuracy.

In Chapter 3, I introduced a novel set of feature coefficients and a method for extracting them from images following a novel standardization procedure. Using my methods, I was able to extract species-discriminating information from images of dragonfly and damselfly wings, which was encapsulated in a relatively small number of feature coefficients (~650). From these coefficients, I was not

only able to distinguish between species, but also elucidate areas of the specimen's wings that were most conserved or variant among species.

Finally, in Chapter 4, I presented a system that combined my feature extraction methods from Chapter 3 with machine learning to identify species of Odonata from images of their wings. The system was trained using examples of the wings of species, then tested using additional examples. I showed that the system made expert-level species identifications (able to identify 32 species with up to 91% accuracy), and that it was able to be trained to classify individuals to genus or species-sex levels, as well, with a similar degree of accuracy.

The Python scripts for these software tools, which are open-sourced and thus customizable, are available from the http://www.crossveins.com. I hope that by making these tools available to the public, that researchers will use them not only to describe and identify Odonata, but also to customize them for other groups of organisms, as well. I plan to make the odonate identification system (called Odomatic) available via the odonate information repository, OdonataCentral.org, allowing odonate researchers and other interested parties to quickly identify odonates and allowing me to expand the number of species included in this system. It is my hope that this work will not only facilitate new research on Odonata and other taxa, but perhaps more importantly, that it will encourage a new generation of scientists and citizen scientists to have an appreciation for the natural world and organismal biology.

Appendix A. Table of specimen localities

Listed here are all of the dragonfly and damselfly specimens scanned for this study, sorted by suborder, family, and species. Individuals are cataloged by a unique scan code, but may have additional codes associated with them (in the Other Codes column), which include Rutgers University-Newark Insect Collection (RU-N) and Florida State Collection of Arthropods (FSCA) catalog numbers, and specimen codes from Melissa Sanchez-Herrera (MSH, POZ, PAN, BOY, PHM, and MIT), Dominic Evangelista (IWO and KBO), and Adolfo Cordero-Rivera (ACR). GPS coordinates that lack “N”, “S”, “E”, and “W” are in decimal degrees. Collector abbreviations are as follows: WRK = William R Kuhn, JLW = Jessica L Ware, MSH = Melissa Sanchez-Herrera, DAG = Dominic A Evangelista, MW = Megan Wilson, MKK = Manpreet K Kohli, Aim High (RU-N) = earth ecology program for high school students at RU-N. All specimens were deposited at the Rutgers University-Newark Insect Collection, 431 Boyden Hall, 195 University Avenue, Newark, NJ 07102, except for the FSCA specimens, which are housed at FSCA.

Scan Code	Species Name	Sex	Collection Date	Country	State or Province	County	Collection Locality	GPS Coordinates	Collector	Other Codes
Anisoptera	**Aeshnidae**									
WRK-WS-02516	*Aeshna canadensis*	M	08/2015	Canada	YT		Yukon Territory CA15-08 09-04		MKK, WRK	
WRK-WS-02524	*Aeshna eremita*	F	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02513	*Aeshna eremita*	M	08/2015	Canada	YT		Yukon Territory CA15-08 07-08		MKK, WRK	
WRK-WS-02515	*Aeshna eremita*	M	08/2015	Canada	YT		Yukon Territory CA15-08 07-08		MKK, WRK	
WRK-WS-02519	*Aeshna eremita*	M	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02520	*Aeshna eremita*	M	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02521	*Aeshna eremita*	M	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02522	*Aeshna eremita*	M	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02523	*Aeshna eremita*	M	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02525	*Aeshna eremita*	M	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02526	*Aeshna eremita*	M	08/2015	Canada	NWT		Northwest Territory CA15-08 07-08		MKK,	
WRK-WS-02507	*Aeshna interrupta*	F	08/2015	Canada	YT		Yukon Territory CA15-08 03-01		MKK, WRK	
WRK-WS-02510	*Aeshna interrupta*	F	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK, WRK	
WRK-WS-02517	*Aeshna interrupta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 02-01		MKK, WRK	
WRK-WS-02518	*Aeshna interrupta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 03-01		MKK, WRK	
WRK-WS-02508	*Aeshna juncea*	F	08/2015	Canada	YT		Yukon Territory CA15-08 05-0B3		MKK, WRK	
WRK-WS-02533	*Aeshna juncea*	F	08/2015	Canada	YT		Yukon Territory CA15-08 14-06		MKK, WRK	
WRK-WS-02534	*Aeshna juncea*	F	08/2015	Canada	YT		Yukon Territory CA15-08 14-06		MKK, WRK	
WRK-WS-02538	*Aeshna juncea*	F	08/2015	Canada	YT		Yukon Territory CA15-08 18-02		MKK, WRK	
WRK-WS-02545	*Aeshna juncea*	F	08/2015	Canada	YT		Yukon Territory CA15-08 13-05B		MKK, WRK	
WRK-WS-02546	*Aeshna juncea*	F	08/2015	Canada	YT		Yukon Territory CA15-08 18-01		MKK, WRK	
WRK-WS-02511	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 13-05B		MKK, WRK	
WRK-WS-02512	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 13-05		MKK, WRK	
WRK-WS-02514	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 13-05B		MKK, WRK	
WRK-WS-02527	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-01C		MKK, WRK	
WRK-WS-02528	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 04-03A		MKK, WRK	
WRK-WS-02529	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 10-05B		MKK, WRK	
WRK-WS-02530	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 07-09B		MKK, WRK	
WRK-WS-02532	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 14-06		MKK, WRK	
WRK-WS-02535	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 14-06		MKK, WRK	
WRK-WS-02536	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 14-06		MKK, WRK	
WRK-WS-02537	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 18-02		MKK, WRK	
WRK-WS-02539	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 14-10		MKK, WRK	
WRK-WS-02540	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 07-08		MKK, WRK	
WRK-WS-02541	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 08-02B		MKK, WRK	
WRK-WS-02542	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK, WRK	
WRK-WS-02543	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK, WRK	
WRK-WS-02544	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK, WRK	
WRK-WS-02547	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 18-01		MKK, WRK	
WRK-WS-02548	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 14-06		MKK, WRK	
WRK-WS-02549	*Aeshna juncea*	M	08/2015	Canada	YT		Yukon Territory CA15-08 14-06		MKK, WRK	
WRK-WS-00782	*Anax junius*	M	5/17/2013	USA	NJ	Sussex	Stokes State Forest		Anna Deichmann	
WRK-WS-00783	*Anax junius*	M	9/15/2012	USA	NJ	Sussex	Stokes State Forest		WRK	
WRK-WS-00784	*Anax junius*	M	7/14/2012	USA	NJ	Passaic/Sussex	Lake Wawayanda, Wawayanda S.P.			
WRK-WS-00785	*Anax junius*	M	7/14/2012	USA	NJ	Passaic/Sussex	Lake Wawayanda, Wawayanda S.P.			RU-N:WL:OdoD: 2014 00393
WRK-WS-00786	*Anax junius*	M	7/14/2012	USA	NJ	Passaic/Sussex	Lake Wawayanda, Wawayanda S.P.			RU-N:WL:OdoD: 2014 00394
WRK-WS-02312	*Anax junius*	M	6/6/2014							
WRK-WS-00035	*Basiaeschna janata*	F	5/27/2012	USA	NJ	Sussex	NJ, near Delaware Water Gap	41°20'0.94"N, 74°45'16.96"W	George Nixon	
WRK-WS-01389	*Basiaeschna janata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01390	*Basiaeschna janata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-02020	*Basiaeschna janata*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02021	*Basiaeschna janata*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	

WRK-WS-00031	*Basiaeschna janata*	M	5/27/2012	USA	NJ	Sussex	NJ, Stokes State Forest, Stream Mill Bridge	41°14'20.23"N, 74°44'8.67"W	DAG, N Dharithreesan, WRK	
WRK-WS-00033	*Basiaeschna janata*	M	5/27/2012	USA	NJ	Sussex	NJ, Stokes State Forest, Stream Mill Bridge	41°14'20.23"N, 74°44'8.67"W	DAG, N Dharithreesan, WRK	
WRK-WS-00787	*Basiaeschna janata*	M	5/17/2013	USA	NJ	Sussex	Stokes State Forest			
WRK-WS-00788	*Basiaeschna janata*	M	5/27/2013	USA	NY	Orange	Black Rock Forest	41.4104, -74.0052		
WRK-WS-00789	*Basiaeschna janata*	M	5/27/2013	USA	NY	Orange	Black Rock Forest			
WRK-WS-01391	*Basiaeschna janata*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01392	*Basiaeschna janata*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01393	*Basiaeschna janata*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01394	*Basiaeschna janata*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01395	*Basiaeschna janata*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-02017	*Basiaeschna janata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02018	*Basiaeschna janata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02019	*Basiaeschna janata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-00790	*Boyeria vinosa*	F	9/15/2012	USA	NJ	Sussex	Beaver Pond Stokes SF		WRK	
WRK-WS-00080	*Boyeria vinosa*	M	7/5/2012	USA	RI	Washington	RI, Arcadia Manag. Area 0183	41.58238°N,71.72790°W	WRK, A Collins, A Kuhn, B Kuhn	
WRK-WS-00081	*Boyeria vinosa*	M	7/5/2012	USA	RI	Washington	RI, Arcadia Manag. Area 0184	41.58238°N,71.72790°W	WRK, A Collins, A Kuhn, B Kuhn	
WRK-WS-00791	*Boyeria vinosa*	M	9/15/2012	USA	NJ	Sussex	Beaver Pond Stokes SF		WRK	RU-N:WL:OdoD: 2013 00320
WRK-WS-00792	*Boyeria vinosa*	M	9/15/2012	USA	NJ	Sussex	Beaver Pond Stokes SF		WRK	RU-N:WL:OdoD: 2013 00319
WRK-WS-00793	*Boyeria vinosa*	M	9/15/2012	USA	NJ	Sussex	Beaver Pond Stokes SF		WRK	RU-N:WL:OdoD: 2013 00317
WRK-WS-00794	*Epiaeschna heros*	F	7/11/2013	USA	NJ	Hudson	Liberty State Park, Jersey City		Ummy Tanko	RU-N:WL:OdoD: 2013 00113
WRK-WS-00067	*Epiaeschna heros*	M	7/19/2012	USA	NJ	Essex	NJ, Newark, Rutgers campus near Boyden hall, 0190		WRK	
WRK-WS-00795	*Gomphaeschna furcillata*	F	5/27/2013	USA	NY	Orange	Black Rock Forest	41.4104, -74.0052		RU-N:WL:OdoD: 2013 00378
WRK-WS-00008	*Gomphaeschna furcillata*	M	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-00009	*Gomphaeschna furcillata*	M	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-02173	*Gomphaeschna furcillata*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	41.0635N, 74.5707 W	WRK, R Pranter	
WRK-WS-00797	*Staurophlebia reticulata*	F	8/22/2012	Guyana	Demerara-Mahaica		Kamuni Creek	6.51382, -58.30235		RU-N:WL:OdoD: 2014 00735
WRK-WS-00798	*Staurophlebia reticulata*	F	5/15/2013	Guyana	Rupununi		Ruprean River, Karanambe		MW, ON, DAG	RU-N:WL:OdoD: 2014 00196
WRK-WS-01708	*Staurophlebia reticulata*	M		Guyana	Kurupukari Crossing				DAG	IWO-000
WRK-WS-00800	*Triacanthagyna septima*	F	8/22/2012	Guyana	Demerara-Mahaica		Demerara River	6.50904, -58.27249		RU-N:WL:OdoD: 2014 00736
WRK-WS-00799	*Triacanthagyna septima*	M	8/16/2011	Guyana	Demerara-Mahaica		Georgetown; Tropical View International Hotel		N Sroczynski	RU-N:WL:OdoD: 2013 00353
Anisoptera	**Cordulegastridae**									
WRK-WS-00069	*Cordulegaster erronea*	F	7/17/2012	USA	NJ	Hunterdon	NJ, Ken Lockwood Gorge, 0188	40.6945°N,74.8743°W	Aim High Students (RU-N)	
WRK-WS-02172	*Cordulegaster erronea*	M	6/17/2015	USA	NJ	morris	Pond across Weldon RD from Jefferson Twp HS	41.0186 N 74.5523W	WRK, R Pranter	
WRK-WS-02022	*Cordulegaster maculata*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02023	*Cordulegaster maculata*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02024	*Cordulegaster maculata*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02033	*Cordulegaster maculata*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-00032	*Cordulegaster maculata*	M	5/27/2012	USA	NJ	Sussex	NJ, Stokes State Forest, Stream Mill Bridge	41°14'20.23"N, 74°44'8.67"W	DAG, N Dharithreesan, WRK	
WRK-WS-00036	*Cordulegaster maculata*	M	5/27/2012	USA	NJ	Sussex	NJ, Stokes State Forest, Stream Mill Bridge	41°14'20.23"N, 74°44'8.67"W	DAG	
WRK-WS-00078	*Cordulegaster maculata*	M	7/5/2012	USA	RI	Washington	RI, Arcadia Manag. Area 0181	41.58238°N,71.72790°W	WRK, A Collins, A Kuhn, B Kuhn	
WRK-WS-00079	*Cordulegaster maculata*	M	7/5/2012	USA	RI	Washington	RI, Arcadia Manag. Area 0182	41.58238°N,71.72790°W	WRK, A Collins, A Kuhn, B Kuhn	
WRK-WS-02034	*Cordulegaster maculata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02035	*Cordulegaster maculata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02036	*Cordulegaster maculata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	

WRK-WS-02037	*Cordulegaster maculata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02038	*Cordulegaster maculata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02039	*Cordulegaster maculata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02040	*Cordulegaster maculata*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
Anisoptera	**Corduliidae**									
WRK-WS-01344	*Cordulia shurtleffii*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01345	*Cordulia shurtleffii*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01346	*Cordulia shurtleffii*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01347	*Cordulia shurtleffii*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01348	*Cordulia shurtleffii*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01378	*Cordulia shurtleffii*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01777	*Cordulia shurtleffii*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01377	*Cordulia shurtleffii*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-00232	*Didymops transversa*	M	4/20/2005	USA	GA	Greene	Fishing Creek and Callaway Rd., evel 480', 11:15am-12:30pm, 70s clear, common all along edge of stream patrilling from bank to 5' out	33° 41.1', -83° 14.2'	FC Sibley?	
WRK-WS-00233	*Didymops transversa*	M	4/19/2005	USA	GA	Oconee	Athens Academy, 6 mi SW of Athens, evel 580', 4:30-5:15pm, 70s, clear, one one seen patrolling edge of small man-made lake	33° 54.0', -83° 23.9'	FC Sibley?	
WRK-WS-01388	*Didymops transversa*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-02326	*Dorocordulia lepida*	F	6/17/2015	USA	NJ	Morris	Sparta Twp off Edison Rd along powerline right-of-way	41.0635N, 74.5707 W	WRK, R Pranter	
WRK-WS-01350	*Dorocordulia libera*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-02301	*Dorocordulia libera*	F	06/2015							
WRK-WS-02302	*Dorocordulia libera*	F	06/2015							
WRK-WS-02303	*Dorocordulia libera*	F	06/2015							
WRK-WS-02308	*Dorocordulia libera*	F	06/2015							
WRK-WS-02309	*Dorocordulia libera*	F	06/2015							
WRK-WS-02310	*Dorocordulia libera*	F	06/2015							
WRK-WS-02311	*Dorocordulia libera*	F	06/2015							
WRK-WS-00077	*Dorocordulia libera*	M	7/2/2012	USA	NJ	Sussex	NJ, Sparta Mountain WMA 0179	41.06479°N,74.57115°W	Jess, WRK	
WRK-WS-01349	*Dorocordulia libera*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-02304	*Dorocordulia libera*	M	06/2015							
WRK-WS-02305	*Dorocordulia libera*	M	06/2015							
WRK-WS-02306	*Dorocordulia libera*	M	06/2015							
WRK-WS-02307	*Dorocordulia libera*	M	06/2015							
WRK-WS-00012	*Epitheca cynosura*	F	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-00013	*Epitheca cynosura*	F	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-00014	*Epitheca cynosura*	F	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-00015	*Epitheca cynosura*	F	5/1/2012	USA	NJ		NJ		Ware Lab	
WRK-WS-01825	*Epitheca cynosura*	F	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01826	*Epitheca cynosura*	F	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01827	*Epitheca cynosura*	F	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01829	*Epitheca cynosura*	F	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01835	*Epitheca cynosura*	F	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01841	*Epitheca cynosura*	F	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01853	*Epitheca cynosura*	F	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	

WRK-WS-02032	*Epitheca cynosura*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-00016	*Epitheca cynosura*	M	5/1/2012	USA	NJ		NJ		Ware Lab
WRK-WS-00070	*Epitheca cynosura*	M	7/12/2012	USA	NJ	Cross	NJ, Garrett Mountain Res., Barbour Pond, 0185	40.8991°N,74.1831°W	Aim High Students (RU-N)
WRK-WS-01802	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01803	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01804	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01805	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01806	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01807	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01808	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01809	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01810	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01811	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01812	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01813	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01814	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01815	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01816	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01817	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01818	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01819	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01820	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01821	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01822	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01823	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01824	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW
WRK-WS-01828	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins
WRK-WS-01830	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins
WRK-WS-01831	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins
WRK-WS-01832	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins
WRK-WS-01833	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins

WRK-WS-01834	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01836	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01837	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01838	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01839	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01840	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01842	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01843	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01844	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01845	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01846	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01847	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01848	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01849	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01850	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01851	*Epitheca cynosura*	M	5/23/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01852	*Epitheca cynosura*	M	5/24/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	WRK, A Collins	
WRK-WS-01854	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01855	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01856	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01857	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02025	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02026	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02027	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02028	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02029	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02030	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02031	*Epitheca cynosura*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-00038	*Epitheca princeps*	F	5/17/2012	USA	NJ	Union	NJ, Watchung Reservation, Lake Surprise		MKK, WRK	
WRK-WS-01758	*Epitheca princeps*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-02313	*Epitheca princeps*	F	6/6/2014							
WRK-WS-02315	*Epitheca princeps*	F	6/6/2014							

WRK-WS-00066	*Epitheca princeps*	M	06/12-24/12	USA	TX	Walker	TX, Dodge, Lake McMillan, 125 Dogwood Ln., 0160		WRK	
WRK-WS-00071	*Epitheca princeps*	M	7/12/2012	USA	NJ	Cross	NJ, Garrett Mountain Res., Barbour Pond, 0185	40.8991°N,74.1831°W	Aim High Students (RU-N)	
WRK-WS-00806	*Epitheca princeps*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00117
WRK-WS-00807	*Epitheca princeps*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00121
WRK-WS-00808	*Epitheca princeps*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00119
WRK-WS-00809	*Epitheca princeps*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00118
WRK-WS-00810	*Epitheca princeps*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00120
WRK-WS-01757	*Epitheca princeps*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-02314	*Epitheca princeps*	M	6/6/2014							A15
WRK-WS-00037	*Helocordulia uhleri*	M	5/27/2012	USA	NJ	Sussex	NJ, Stokes State Forest, Stream Mill Bridge	41°14'20.23"N, 74°44'8.67"W	WRK	
WRK-WS-00811	*Helocordulia uhleri*	M	5/17/2013	USA	NJ	Sussex	Stokes State Forest			RU-N:WL:OdoD: 2013 00358
WRK-WS-00812	*Helocordulia uhleri*	M	5/17/2013	USA	NJ	Sussex	Stokes State Forest			RU-N:WL:OdoD: 2013 00359
WRK-WS-00093	*Lauromacromia sp1*	F	1/4/2012	Guyana			Guyana, tributary of Demarera River near Santa Mission		Ware Lab	
WRK-WS-00229	*Phyllomacromia picta*	F	3/2/1985	Malawi			Mt. Dedza, evel 5500'		RJ Murphy	
WRK-WS-00227	*Phyllomacromia picta*	M	6/2/1965	Rhodesia			Chirundu Bridge, Zambezi River		DR Paulson?	
WRK-WS-00228	*Phyllomacromia picta*	M	5/2/2002	Uganda	Mpigi District		Entebbe Botanical Garden, evel 1100 m, 10:30am-2pm, clear, 80, common foraging at 4-5' over the grassy areas	00° 03.7', 32° 28.8'	FC Sibley?	
WRK-WS-02563	*Somatochlora albicincta*	F	08/2015	Canada	YT		Yukon Territory CA15-08 05-01C		MKK, WRK	
WRK-WS-02555	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 09-05B		MKK,	
WRK-WS-02556	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 09-05B		MKK,	
WRK-WS-02557	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 09-05B		MKK,	
WRK-WS-02558	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 09-05B		MKK,	
WRK-WS-02559	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK,	
WRK-WS-02560	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK,	
WRK-WS-02561	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK,	
WRK-WS-02562	*Somatochlora albicincta*	M	08/2015	Canada	YT		Yukon Territory CA15-08 05-03B		MKK,	
WRK-WS-02316	*Somatochlora linearis*	F	6/6/2014							
WRK-WS-00064	*Somatochlora margarita*	M	6/18-23/12	USA	TX	Walker	TX, Sam Houston NF, creek near NF-216, 0168	30°33.356'N,95°39.104'W	WRK	
WRK-WS-00074	*Somatochlora minor*	M	7/7/2012	USA	NH	Alton/Belknap	NH, Mt. Major 0182		A Collins, WRK	
WRK-WS-00075	*Somatochlora minor*	M	7/7/2012	USA	NH	Alton/Belknap	NH, Mt. Major 0182		A Collins, WRK	
WRK-WS-00068	*Somatochlora tenebrosa*	F	7/22/2012	USA	NJ	Passaic	NJ, Ramapo Lake & park, near "castle", 0192	41.0445°N,74.2630°W	DAG	
WRK-WS-00076	*Somatochlora tenebrosa*	F	7/7/2012	USA	NH	Alton/Belknap	NH, Mt. Major 0182		A Collins, WRK	
Anisoptera	**Gomphidae**									
WRK-WS-00042	*Aphylla williamsonia*	M	6/12/2012	USA	TX	Walker	TX, Sam Houston NF, grassing clearing, 0162	30.73500N,95.42243W	WRK	
WRK-WS-02219	*Arigomphus villosipes*	M	6/17/2015	USA	NJ	Morris	Pond across Weldon RD from Jefferson Twp HS	41.0186 N 74.5523W	WRK, R Pranter	
WRK-WS-02220	*Arigomphus villosipes*	M	6/17/2015	USA	NJ	Morris	Pond across Weldon RD from Jefferson Twp HS	41.0186 N 74.5523W	WRK, R Pranter	
WRK-WS-00815	*Dromogomphus spinosus*	F	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00278
WRK-WS-02218	*Dromogomphus spinosus*	F	6/17/2015	USA	NJ	Morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-00816	*Dromogomphus spoliatus*	F	6/12-14/12	USA	TX	Dodge	McMillan Lake	30.734, -95.412		RU-N:WL:OdoD: 2013 00325
WRK-WS-00818	*Dromogomphus spoliatus*	F	8/15/2013							
WRK-WS-00819	*Dromogomphus spoliatus*	F		USA	NJ	Warren	Allamuchy	40.9213, -74.7823		RU-N:WL:OdoD: 2013 00282
WRK-WS-00817	*Dromogomphus spoliatus*	M	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		
WRK-WS-00821	*Erpetogomphus designatus*	F	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00271
WRK-WS-00824	*Erpetogomphus designatus*	F	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00256
WRK-WS-00825	*Erpetogomphus designatus*	F	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00272
WRK-WS-00072	*Erpetogomphus designatus*	M	6/14/2012	USA	TX	Travis	TX, Austin, St. Edwards Park, 0166	30.40685°N,97.7921°W	WRK	
WRK-WS-00820	*Erpetogomphus designatus*	M	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00254
WRK-WS-00822	*Erpetogomphus designatus*	M	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00255
WRK-WS-00823	*Erpetogomphus designatus*	M	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00273
WRK-WS-00010	*Gomphus abbreviatus*	F	5/17/2012	USA	NJ	Morris	NJ, Watchung Reservation, Lake Surprise		Manpreet, WRK	
WRK-WS-00011	*Gomphus abbreviatus*	F	5/17/2012	USA	NJ	Morris	NJ, Watchung Reservation, Lake Surprise		Manpreet, WRK	
WRK-WS-00030	*Gomphus abbreviatus*	F	5/17/2012	USA	NJ	Union	NJ, Watchung Reservation, Lake Surprise		Manpreet, WRK	
WRK-WS-00034	*Gomphus exilis*	M	5/27/2012	USA	NJ	Sussex	NJ, Stokes State Forest, Stream Mill Bridge	41°14'20.23"N, 74°44'8.67"W	WRK	
WRK-WS-00827	*Gomphus exilis*	M								RU-N:WL:OdoD: 2013 00123
WRK-WS-01351	*Gomphus exilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	

WRK-WS-01352	*Gomphus exilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01353	*Gomphus exilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-02215	*Gomphus exilis*	M	6/17/2015	USA	NJ	Morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-02216	*Gomphus exilis*	M	6/17/2015	USA	NJ	Morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-02217	*Gomphus exilis*	M	6/17/2015	USA	NJ	Morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-01778	*Gomphus lineatifrons*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01781	*Gomphus lineatifrons*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01785	*Gomphus lineatifrons*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01786	*Gomphus lineatifrons*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01772	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D3
WRK-WS-01773	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01774	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01775	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01776	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01779	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01780	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01782	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01783	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01784	*Gomphus lineatifrons*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-02214	*Gomphus spicatus*	M	6/12/2015	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA/Along trail/road	40.6945N, 74.8743W	WKuhn, D Banerjee	
WRK-WS-00828	*Gomphus vastus*	F								RU-N:WL:OdoD: 2013 00125
WRK-WS-01760	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01761	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01762	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01763	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01764	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01765	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01767	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01769	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01770	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01771	*Gomphus vastus*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-00829	*Gomphus vastus*	M								RU-N:WL:OdoD: 2013 00124
WRK-WS-01759	*Gomphus vastus*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01766	*Gomphus vastus*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01768	*Gomphus vastus*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-00830	*Hagenius brevistylus*	F	8/15/2013					40.88826, -74.797419		RU-N:WL:OdoD: 2013 00347
WRK-WS-00832	*Hagenius brevistylus*	F	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00276
WRK-WS-00831	*Hagenius brevistylus*	M	8/15/2013	USA	NJ		Jefferson Lake	40.921622, -74.73925		RU-N:WL:OdoD: 2013 00277
WRK-WS-01690	*Phyllogomphoides pedunculus*	M							MSH	MIT-142
WRK-WS-00835	*Progomphus obscurus*	M								RU-N:WL:OdoD: 2013 00126
Anisoptera	**Libellulidae**									
WRK-WS-00919	*Acisoma panarpoides*	F		India	Demerara-Mahaica		Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00881
WRK-WS-00918	*Acisoma panarpoides*	M		India	Demerara-Mahaica		Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00881
WRK-WS-00089	*Brachymesia furcata*	M	8/5/2011	Guyana	Demerara-Mahaica		Guyana, CEIBA, garbage canal ("Trashmins")		Ware Lab	
WRK-WS-00599	*Brachymesia furcata*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge		WRK	
WRK-WS-00923	*Brachymesia furcata*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA; Splashmins Boat	6°29' 57.75" N; 58° 13' 7.28" W	JLW Team	RU-N:WL:OdoD: 2014 00135
WRK-WS-00924	*Brachymesia furcata*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29' 57.75" N; 58° 13' 7.28" W	JLW Team	RU-N:WL:OdoD: 2013 00137
WRK-WS-00925	*Brachymesia furcata*	M	8/4/2011	Guyana	Demerara-Mahaica		CEIBA; Splashmins Boat	6°29' 57.75" N; 58° 13' 7.28" W	JLW Team	RU-N:WL:OdoD: 2013 00138
WRK-WS-00926	*Brachymesia furcata*	M	8/4/2011	Guyana	Demerara-Mahaica		CEIBA; Splashmins Boat	6°29' 57.75" N; 58° 13' 7.28" W	JLW Team	RU-N:WL:OdoD: 2013 00136
WRK-WS-00928	*Brachymesia gravida*	F	7/1/2012							RU-N:WL:OdoD: 2013 00275
WRK-WS-00929	*Brachymesia gravida*	F	8/2/2013							RU-N:WL:OdoD: 2013 00274
WRK-WS-00600	*Brachymesia gravida*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00601	*Brachymesia gravida*	M	8/6/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00927	*Brachymesia gravida*	M	6/12-24/2012	USA	TX		McMillan Lake			RU-N:WL:OdoD: 2013 00131

WRK-WS-00938	*Brachymesia herbida*	F	8/1/2013						WRK	RU-N:WL:OdoD: 2014 00047
WRK-WS-00939	*Brachymesia herbida*	F	8/1/2013						WRK	RU-N:WL:OdoD: 2014 00046
WRK-WS-00940	*Brachymesia herbida*	F	8/1/2013						WRK	RU-N:WL:OdoD: 2014 00043
WRK-WS-00941	*Brachymesia herbida*	F	8/1/2013						WRK	RU-N:WL:OdoD: 2014 00050
WRK-WS-00942	*Brachymesia herbida*	F	1/8/2012	Guyana	Demerara-Mahaica		Splashmin's Camp, CEIBA Biological Station		JLW, WRK, P Frandsen	RU-N:WL:OdoD: 2014 00360
WRK-WS-00930	*Brachymesia herbida*	M	8/1/2013						WRK	RU-N:WL:OdoD: 2014 00045
WRK-WS-00931	*Brachymesia herbida*	M		Guyana	Demerara-Mahaica		CEIBA Biological Station	6'29° 57.75° N; 58' 13" 7.28° W. elev 19m	JLW, MKK, I Biazzo, L Ballare, DAG, N Sroczynski	RU-N:WL:OdoD: 2013 00644
WRK-WS-00932	*Brachymesia herbida*	M	8/6/2012	Guyana	Demerara-Mahaica		Boat to Santa Mission	6° 31' 2.48" N; 58° 18' 17' 195" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2013 00134
WRK-WS-00933	*Brachymesia herbida*	M	8/14/2011						WRK	RU-N:WL:OdoD: 2014 00643
WRK-WS-00934	*Brachymesia herbida*	M	1/1/2012	Guyana	Demerara-Mahaica					RU-N:WL:OdoD: 2014 00621
WRK-WS-00935	*Brachymesia herbida*	M	8/1/2013						WRK	RU-N:WL:OdoD: 2014 00049
WRK-WS-00936	*Brachymesia herbida*	M	8/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MSH	RU-N:WL:OdoD: 2013 00139
WRK-WS-00937	*Brachymesia herbida*	M	8/1/2013						WRK	RU-N:WL:OdoD: 2014 00116
WRK-WS-00943	*Brachythemis contaminata*	F		India			Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00900
WRK-WS-00964	*Celithemis elisa*	F	7/19/2012	USA	NJ		Lake Wawayanda, Wawayanda S.P.			RU-N:WL:OdoD: 2014 00383
WRK-WS-00972	*Celithemis elisa*	F								RU-N:WL:OdoD: 2013 00268
WRK-WS-00976	*Celithemis elisa*	F	8/4/2013				Forest Clearing			RU-N:WL:OdoD: 2013 00266
WRK-WS-00977	*Celithemis elisa*	F	8/2/2013							RU-N:WL:OdoD: 2013 00261
WRK-WS-00978	*Celithemis elisa*	F	8/4/2013				Forest Clearing			RU-N:WL:OdoD: 2013 00264
WRK-WS-00979	*Celithemis elisa*	F	8/4/2013				Forest Clearing			RU-N:WL:OdoD: 2013 00263
WRK-WS-00980	*Celithemis elisa*	F	8/4/2013				Forest Clearing			RU-N:WL:OdoD: 2013 00267
WRK-WS-00981	*Celithemis elisa*	F	8/4/2013				Forest Clearing			RU-N:WL:OdoD: 2013 00265
WRK-WS-02179	*Celithemis elisa*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	41.0635N, 74.5707 W	WRK, R Pranter	
WRK-WS-02318	*Celithemis elisa*	F	06/2014							A12
WRK-WS-02321	*Celithemis elisa*	F	6/2014							
WRK-WS-00049	*Celithemis elisa*	M	6/12-24/12	USA	TX	Walker	TX, Dodge, Lake McMillan, 125 Dogwood Ln., 0160		WRK	
WRK-WS-00605	*Celithemis elisa*	M	8/9/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00973	*Celithemis elisa*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2012 00173
WRK-WS-00974	*Celithemis elisa*	M	7/19/2011	USA	NJ		Liberty State Park, Jersey City		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00173
WRK-WS-00975	*Celithemis elisa*	M			NY		Central Park		MSH	RU-N:WL:OdoD: 2014 00833
WRK-WS-02319	*Celithemis elisa*	M	06/2011							
WRK-WS-02320	*Celithemis elisa*	M	06/2011							
WRK-WS-00163	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00164	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00165	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00166	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00167	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00168	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00169	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00170	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00171	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00172	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00173	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00174	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00175	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00176	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00177	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00178	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00180	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00573	*Celithemis eponina*	F	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00945	*Celithemis eponina*	F								RU-N:WL:OdoD: 2014 01036
WRK-WS-00959	*Celithemis eponina*	F	7/23/2013	USA	NJ		Branch Brook Park		MSH	RU-N:WL:OdoD: 2013 00141
WRK-WS-00960	*Celithemis eponina*	F	7/23/2013	USA	NJ		Branch Brook Park		MSH	RU-N:WL:OdoD: 2013 00157
WRK-WS-00961	*Celithemis eponina*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00144
WRK-WS-00962	*Celithemis eponina*	F					St. Edwards Park			RU-N:WL:OdoD: 2013 00155

WRK-WS-00963	*Celithemis eponina*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00153
WRK-WS-00965	*Celithemis eponina*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00147
WRK-WS-00966	*Celithemis eponina*	F	8/2/2013							RU-N:WL:OdoD: 2013 00262
WRK-WS-00967	*Celithemis eponina*	F	7/14/2012	USA	NJ		Lake Wawayanda, Wawayanda S.P.			RU-N:WL:OdoD: 2014 00384
WRK-WS-00968	*Celithemis eponina*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00154
WRK-WS-00969	*Celithemis eponina*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2014 01035
WRK-WS-00970	*Celithemis eponina*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00145
WRK-WS-00971	*Celithemis eponina*	F	7/15/2011	USA	DE		Brandywine			RU-N:WL:OdoD: 2013 00142
WRK-WS-00179	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00181	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00182	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00183	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00184	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00185	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00186	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00187	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00188	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00189	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00190	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00191	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00192	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00193	*Celithemis eponina*	M	7/18/2012	USA	NJ				Aim High Students (RU-N)	
WRK-WS-00194	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00572	*Celithemis eponina*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00574	*Celithemis eponina*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00575	*Celithemis eponina*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00576	*Celithemis eponina*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00606	*Celithemis eponina*	M	8/6/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00607	*Celithemis eponina*	M	8/4/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00608	*Celithemis eponina*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00609	*Celithemis eponina*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00610	*Celithemis eponina*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00611	*Celithemis eponina*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00612	*Celithemis eponina*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00613	*Celithemis eponina*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00614	*Celithemis eponina*	M	8/2/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00944	*Celithemis eponina*	M								RU-N:WL:OdoD: 2013 00158
WRK-WS-00946	*Celithemis eponina*	M	12/7/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00146
WRK-WS-00947	*Celithemis eponina*	M	18-7-2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2014 01340
WRK-WS-00948	*Celithemis eponina*	M	18-7-2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00142
WRK-WS-00949	*Celithemis eponina*	M	18-7-2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2014 01037
WRK-WS-00950	*Celithemis eponina*	M	18-7-2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2014 01038
WRK-WS-00951	*Celithemis eponina*	M	7/9/2013	USA	NJ	Hudson	Laurel Hill Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00162
WRK-WS-00952	*Celithemis eponina*	M	7/16-17/2012	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA	40.6945° N, 74.8743° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00143
WRK-WS-00953	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00161
WRK-WS-00954	*Celithemis eponina*	M								RU-N:WL:OdoD: 2013 00159
WRK-WS-00955	*Celithemis eponina*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00152
WRK-WS-00956	*Celithemis eponina*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00151
WRK-WS-00957	*Celithemis eponina*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00150
WRK-WS-00958	*Celithemis eponina*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00149
WRK-WS-00982	*Celithemis fasciata*	F	8/2/2013							RU-N:WL:OdoD: 2013 00260
WRK-WS-00983	*Celithemis martha*	M	9/9/2011	USA	NJ		Forked River			RU-N:WL:OdoD: 2013 00361
WRK-WS-01014	*Crocothemis servilia*	F		India			Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00893
WRK-WS-01013	*Crocothemis servilia*	M		India			Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00894
WRK-WS-00985	*Dasythemis esmeralda*	M	8/6/2011	Guyana	Demerara-Mahaica		Boat to Santa Mission			RU-N:WL:OdoD: 2014 00602
WRK-WS-00995	*Diastatops intensa*	F	6/19/2013	Guyana	Rupununi		Karanambo Camp		DAG, MW, O Ambrose	RU-N:WL:OdoD: 2014 00065
WRK-WS-00087	*Diastatops intensa*	M	8/2/2011	Guyana	Demerara-Mahaica		Guyana, CEIBA, Splashmins		Ware Lab	

WRK-WS-00328	*Diastatops intensa*	M	8/7/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	57.75,-7.28	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00329	*Diastatops intensa*	M	8/7/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	57.75,-7.28	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00330	*Diastatops intensa*	M	8/21/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	57.75,-7.28	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00331	*Diastatops intensa*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	57.75,-7.28	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00332	*Diastatops intensa*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins Canal	57.75,-7.28	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00333	*Diastatops intensa*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins Canal	57.75,-7.28	I Biazzo	
WRK-WS-00334	*Diastatops intensa*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins Canal	57.75,-7.28	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00335	*Diastatops intensa*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	57.75,-7.28	MKK	
WRK-WS-00336	*Diastatops intensa*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	57.75,-7.28	I Biazzo	
WRK-WS-00339	*Diastatops intensa*	M	8/6/2011	Guyana	Demerara-Mahaica		Boat to Santa Mission	6°29'57.75"N,58°13'7.28"W	N Sroczynski	
WRK-WS-00997	*Diastatops obscura*	F	8/6/2011	Guyana	Demerara-Mahaica		Medewini, Bounty Farm		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 00177
WRK-WS-00996	*Diastatops obscura*	M	8/11/2011	Guyana	Demerara-Mahaica		Medewini, Bounty Farm		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 00175
WRK-WS-00998	*Diastatops obscura*	M	8/11/2011	Guyana	Demerara-Mahaica		Medewini, Bounty Farm		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 00178
WRK-WS-00999	*Diastatops obscura*	M	8/11/2011	Guyana	Demerara-Mahaica		Medewini, Bounty Farm		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 00179
WRK-WS-01016	*Diplacodes trivialis*	F		India			Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00903
WRK-WS-01015	*Diplacodes trivialis*	M		India			Angul, Odisha		MKK, A	RU-N:WL:OdoD: 2014 00906
WRK-WS-01017	*Diplacodes trivialis*	M		India			Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00905
WRK-WS-01018	*Diplacodes trivialis*	M		India			Madanapalle, Chittoor, Andhra Pradesh		MKK, A	RU-N:WL:OdoD: 2014 00904
WRK-WS-01019	*Diplacodes trivialis*	M		India			Angul, Odisha		MKK, A	RU-N:WL:OdoD: 2014 00902
WRK-WS-01020	*Diplacodes trivialis*	M		India			Sita Mata Wildlife Sanctuary; Pratapgarh, Rajasthan		MKK, A	RU-N:WL:OdoD: 2014 00901
WRK-WS-01024	*Dythemis velox*	F	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00279
WRK-WS-01025	*Dythemis velox*	M								RU-N:WL:OdoD: 2013 00199
WRK-WS-01680	*Elga longistyla*	M							MSH	MIT-33
WRK-WS-02322	*Epiaeschna heros*	M	6/2011							
WRK-WS-02221	*Epitheca cynosura*	M	6/17/2015	USA	NJ	Morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-02222	*Epitheca cynosura*	M	6/17/2015	USA	NJ	Morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-00654	*Epophthalmia elegans*	F	6/1/1924	China			Kiangsu Providence		N A Wood	
WRK-WS-00655	*Epophthalmia elegans*	F	8/26/1996	Japan			Shizuoka Pref.; Kawane cho, Nomori Pond		S Ugai	
WRK-WS-00651	*Epophthalmia elegans*	M	8/17/1996	Japan			Shizuoka; Enshuhama Hamamatsu City		S Ugai	
WRK-WS-00652	*Epophthalmia elegans*	M		China			Kiangsu Providence; near Shangha (SW district Shanghai Zikawei			
WRK-WS-00656	*Epophthalmia vittata*	M	11/15/1932	India			S. Malabas? Waligar Forest		F C Fraser	
WRK-WS-00657	*Epophthalmia vittigera*	M	7/6/1980	Malaysia			Borneo: Sabah: Menanggul R. nr Sukau	05° 29.8'N 118°14.3'E	T Donnelly	
WRK-WS-01055	*Erythemis attala*	F	6/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00080
WRK-WS-01072	*Erythemis attala*	F	1/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins Garbage Canal	6°29" N; 58° 13" W	DAG, I Biazzo, J Evangelista	RU-N:WL:OdoD: 2014 00382
WRK-WS-01073	*Erythemis attala*	F	6/4/2013	Guyana	Demerara-Mahaica		CEIBA Biological Station		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	RU-N:WL:OdoD: 2014 00054
WRK-WS-01054	*Erythemis attala*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667	I Biazzo	RU-N:WL:OdoD: 2013 00006
WRK-WS-01056	*Erythemis attala*	M	1/3/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, Pineapple Farm, (Tributary of the Demerara River)	6° 33" N; 58° 18" W	JLW, WRK, P Frandsen	RU-N:WL:OdoD: 2014 01072
WRK-WS-01060	*Erythemis attala*	M	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Farm with Kids	6°29' 57.75" N; 58° 13' 7.28" W	JLW Team	RU-N:WL:OdoD: 2014 01068
WRK-WS-01061	*Erythemis attala*	M	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins Garbage Canal	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01067
WRK-WS-00348	*Erythemis credula*	M	8/4/2011	Guyana	Demerara-Mahaica		CEIBA, Farm at Splashmins	6°29'57"N,58°13'7.23"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00636	*Erythemis haematogastra*	M	1/5/2012	Guyana	Demerara-Mahaica		Splashmins Camp, CEIBA		JLW, WRK, P Frandsen	

WRK-WS-01044	*Erythemis haematogastra*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01065
WRK-WS-01045	*Erythemis haematogastra*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins Canal	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01064
WRK-WS-01046	*Erythemis haematogastra*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01063
WRK-WS-01047	*Erythemis haematogastra*	M	8/1/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01062
WRK-WS-01048	*Erythemis haematogastra*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01061
WRK-WS-01049	*Erythemis haematogastra*	M	7/31/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, AF	6°29' 57.75" N; 58° 13' 7.28" W	EB	RU-N:WL:OdoD: 2014 01060
WRK-WS-01050	*Erythemis haematogastra*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01059
WRK-WS-01051	*Erythemis haematogastra*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	6°29' 57.75" N; 58° 13' 7.28" W	JLW Team	RU-N:WL:OdoD: 2014 01058
WRK-WS-01052	*Erythemis haematogastra*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01057
WRK-WS-01053	*Erythemis haematogastra*	M	8/1/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	6°29' 57.75" N; 58° 13' 7.28" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01056
WRK-WS-01074	*Erythemis haematogastra*	M	8/18/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station		OP, F	RU-N:WL:OdoD: 2014 00796
WRK-WS-01075	*Erythemis haematogastra*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Boardwalk	6°29' 57" N; 58° 13' 7" W	JLW, OE, MS, N Sroczynski, I Biazzo, WRK, ER	RU-N:WL:OdoD: 2014 00628
WRK-WS-01076	*Erythemis haematogastra*	M	8/22/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station		DAG	RU-N:WL:OdoD: 2014 00678
WRK-WS-00088	*Erythemis peruviana*	M	8/5/2011	Guyana	Demerara-Mahaica		Guyana, CEIBA, Splashmins		Ware Lab	
WRK-WS-00452	*Erythemis peruviana*	M	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°13'7.28"W	JLW Team	
WRK-WS-00453	*Erythemis peruviana*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00454	*Erythemis peruviana*	M	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Garbage Canal near Splashmins	6°29'57.75"N,58°13'7.23"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00455	*Erythemis peruviana*	M	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°13'7.23"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00456	*Erythemis peruviana*	M	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°13'7.23"W	JLW Team	
WRK-WS-00457	*Erythemis peruviana*	M	8/5/2011	Guyana	Demerara-Mahaica		Bounty Farm		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00458	*Erythemis peruviana*	M	8/13/2011	Guyana	Demerara-Mahaica		Emerald Tower		JLW, N Sroczynski, I Biazzo	
WRK-WS-00459	*Erythemis peruviana*	M	8/13/2011	Guyana	Demerara-Mahaica		Emerald Tower		JLW, N Sroczynski, I Biazzo	
WRK-WS-00460	*Erythemis peruviana*	M	8/13/2011	Guyana	Demerara-Mahaica		Emerald Tower		JLW, N Sroczynski, I Biazzo	
WRK-WS-00461	*Erythemis peruviana*	M	8/9/2011	Guyana	Demerara-Mahaica		Mahaica Tributary Site 3		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-01077	*Erythemis peruviana*	M	5/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667	JLW, WRK, P Frandsen	RU-N:WL:OdoD: 2013 00209
WRK-WS-01078	*Erythemis peruviana*	M	1/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins			RU-N:WL:OdoD: 2013 00210
WRK-WS-01079	*Erythemis peruviana*	M	6/18/2013	Guyana	Rupununi		Karanambo, From fern pond		O Ambrose, MW, DAG	RU-N:WL:OdoD: 2014 00056
WRK-WS-01080	*Erythemis peruviana*	M	6/18/2013	Guyana	Rupununi		Karanambo, From fern pond		O Ambrose, MW, DAG	RU-N:WL:OdoD: 2014 00057
WRK-WS-01081	*Erythemis peruviana*	M	8/19/2014		Demerara-Mahaica		S.L. Highway			RU-N:WL:OdoD: 2014 00795
WRK-WS-01082	*Erythemis peruviana*	M	8/5/2011	Guyana	Demerara-Mahaica		Bounty Farm		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2013 00185
WRK-WS-01083	*Erythemis peruviana*	M	1/2/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins			RU-N:WL:OdoD: 2013 00208
WRK-WS-01084	*Erythemis peruviana*	M	8/20/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins			RU-N:WL:OdoD: 2014 00675
WRK-WS-01085	*Erythemis peruviana*	M	6/7/2013	Guyana	Rupununi		KBO		MW, DAG, OE	RU-N:WL:OdoD: 2014 00058
WRK-WS-01086	*Erythemis plebeja*	F	6/5/2013	Guyana	Demerara-Mahaica		CEIBA Biological Station			RU-N:WL:OdoD: 2014 00052
WRK-WS-01088	*Erythemis plebeja*	F	12/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins Garbage Canal	6°29" N; 58° 13" W	JLW,WRK,P Frandsen	RU-N:WL:OdoD: 2014 00374
WRK-WS-01041	*Erythemis plebeja*	M	8/23/2012	Guyana	Demerara-Mahaica		Canal near Parika			RU-N:WL:OdoD: 2014 00860
WRK-WS-01062	*Erythemis plebeja*	M	8/9/2011	Guyana	Demerara-Mahaica		Mahiaca Tributary- Site 1	6°23' 19.55" N; 57° 35' 32.45" W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	RU-N:WL:OdoD: 2014 01066
WRK-WS-01087	*Erythemis plebeja*	M		Guyana	Demerara-Mahaica		CEIBA Biological Station			RU-N:WL:OdoD: 2014 00051
WRK-WS-01089	*Erythemis plebeja*	M	1/5/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, Splashmins	6°29" N; 58° 13" W	DAG,I Biazzo, J Evangelista	RU-N:WL:OdoD: 2014 00373
WRK-WS-01090	*Erythemis plebeja*	M	6/23/2013	Guyana	Rupununi		Karanambo, in flooded marsh		O Ambrose, DAG, MW	RU-N:WL:OdoD: 2014 00053
WRK-WS-00026	*Erythemis simplicicollis*	F	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	

WRK-WS-00045	*Erythemis simplicicollis*	F	6/12-17/12	USA	TX	Walker	Huntsville SP, Prairie Branch Loop & Chinquapin Trail at N end of Lake Raven, 0163	30.6208N, 95.5347W	WRK	
WRK-WS-00046	*Erythemis simplicicollis*	F	6/12-17/12	USA	TX	Walker	Huntsville SP, Prairie Branch Loop & Chinquapin Trail at N end of Lake Raven, 0163	30.6208N, 95.5347W	WRK	
WRK-WS-00047	*Erythemis simplicicollis*	F	6/12-17/12	USA	TX	Walker	Huntsville SP, Prairie Branch Loop & Chinquapin Trail at N end of Lake Raven, 0163	30.6208N, 95.5347W	WRK	
WRK-WS-00048	*Erythemis simplicicollis*	F	6/12-17/12	USA	TX	Walker	Huntsville SP, Prairie Branch Loop & Chinquapin Trail at N end of Lake Raven, 0163	30.6208N, 95.5347W	WRK	
WRK-WS-00132	*Erythemis simplicicollis*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00134	*Erythemis simplicicollis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00135	*Erythemis simplicicollis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00136	*Erythemis simplicicollis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00137	*Erythemis simplicicollis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00551	*Erythemis simplicicollis*	F	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-01092	*Erythemis simplicicollis*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00241
WRK-WS-01093	*Erythemis simplicicollis*	F	8/9/2013	USA	NY		Cranberry Lake Preserve			RU-N:WL:OdoD: 2013 00216
WRK-WS-01094	*Erythemis simplicicollis*	F	7/11/2012	USA	NJ	Union	Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00234
WRK-WS-01095	*Erythemis simplicicollis*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00223
WRK-WS-01096	*Erythemis simplicicollis*	F	7/11/2012	USA	NJ	Union	Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00235
WRK-WS-01103	*Erythemis simplicicollis*	F	8/9/2012	USA	NY		Cranberry Lake Preserve			RU-N:WL:OdoD: 2013 00214
WRK-WS-01104	*Erythemis simplicicollis*	F	7/3/1905	USA	MD		Idywild Park, Annapolis		MSH	RU-N:WL:OdoD: 2014 00950
WRK-WS-01109	*Erythemis simplicicollis*	F	7/11/2012	USA	NJ	Union	Watchung Res., Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00197
WRK-WS-01110	*Erythemis simplicicollis*	F	7/19/2012	USA	NJ		Branch Brook Park	40.7567° N, 74.1827° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00198
WRK-WS-01116	*Erythemis simplicicollis*	F	8/9/2012	USA	NY		Cranberry Lake Preserve			RU-N:WL:OdoD: 2013 00213
WRK-WS-01128	*Erythemis simplicicollis*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00240
WRK-WS-01129	*Erythemis simplicicollis*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00242
WRK-WS-01130	*Erythemis simplicicollis*	F	7/26/2013	USA	NJ	Union	Watchung Res., Lake Surprise		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00236
WRK-WS-01142	*Erythemis simplicicollis*	F	8/6/2013							RU-N:WL:OdoD: 2013 00289
WRK-WS-01143	*Erythemis simplicicollis*	F	6/26/2013	USA	NJ	Essex	South Mountain Reservation			RU-N:WL:OdoD: 2013 00289
WRK-WS-01144	*Erythemis simplicicollis*	F	6/26/2013	USA	NJ	Essex	South Mountain Reservation			RU-N:WL:OdoD: 2013 00288
WRK-WS-01147	*Erythemis simplicicollis*	F	8/2/2013							RU-N:WL:OdoD: 2013 00329
WRK-WS-01148	*Erythemis simplicicollis*	F	8/6/2013				Game Preserve			RU-N:WL:OdoD: 2013 00330
WRK-WS-01149	*Erythemis simplicicollis*	F	9/26/2011	USA	NJ	Essex	Branch Brook Park			RU-N:WL:OdoD: 2013 00309
WRK-WS-01863	*Erythemis simplicicollis*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01865	*Erythemis simplicicollis*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01866	*Erythemis simplicicollis*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02178	*Erythemis simplicicollis*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	41.0635N, 74.5707 W	WRK, R Pranter	
WRK-WS-00044	*Erythemis simplicicollis*	M	6/12-17/12	USA	TX	Walker	Huntsville SP, Prairie Branch Loop & Chinquapin Trail at N end of Lake Raven, 0163	30.6208N, 95.5347W	WRK	
WRK-WS-00129	*Erythemis simplicicollis*	M	4/12-17/12	USA	TX	Walker	Huntsville State Park, trail on N end of Lake Raven, 0163	30.6208,-95.5347	WRK	
WRK-WS-00130	*Erythemis simplicicollis*	M	7/18/2011	USA	NJ	Hudson	Liberty State Park		Aim High Students (RU-N)	
WRK-WS-00131	*Erythemis simplicicollis*	M	7/18/2011	USA	NJ	Hudson	Liberty State Park		Aim High Students (RU-N)	
WRK-WS-00133	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00138	*Erythemis simplicicollis*	M	7/11/2012	USA	NJ	Union	Watchung Reservation, Lake Surprise	40.6937,-74.3701	Aim High Students (RU-N)	
WRK-WS-00139	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00140	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00141	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00142	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00143	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00144	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00145	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00146	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00147	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00148	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	

WRK-WS-00149	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00150	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00151	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00152	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00549	*Erythemis simplicicollis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00550	*Erythemis simplicicollis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00552	*Erythemis simplicicollis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00553	*Erythemis simplicicollis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00554	*Erythemis simplicicollis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00555	*Erythemis simplicicollis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00556	*Erythemis simplicicollis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-01091	*Erythemis simplicicollis*	M								RU-N:WL:OdoD: 2013 00211
WRK-WS-01098	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00219
WRK-WS-01099	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00187
WRK-WS-01100	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00190
WRK-WS-01102	*Erythemis simplicicollis*	M		USA	TX		Martin Dies Jr, State Park			RU-N:WL:OdoD: 2013 00212
WRK-WS-01105	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00186
WRK-WS-01106	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00186
WRK-WS-01107	*Erythemis simplicicollis*	M	7/11/2012	USA	NJ	Union	Watchung Res., Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00195
WRK-WS-01108	*Erythemis simplicicollis*	M	7/11/2012	USA	NJ	Union	Watchung Res., Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00196
WRK-WS-01111	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00217
WRK-WS-01112	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00218
WRK-WS-01113	*Erythemis simplicicollis*	M	7/16/2011	USA	NJ	Hudson	Liberty State Park, Nature Center	40.6982° N, 74.0538° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00220
WRK-WS-01114	*Erythemis simplicicollis*	M	7/16/2011	USA	NJ	Hudson	Liberty State Park, Nature Center	40.6982° N, 74.0538° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00221
WRK-WS-01115	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00222
WRK-WS-01117	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00191
WRK-WS-01118	*Erythemis simplicicollis*	M	7/11/2012	USA	NJ	Union	Watchung Res., Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00192
WRK-WS-01119	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00225
WRK-WS-01120	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00226
WRK-WS-01121	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00227
WRK-WS-01122	*Erythemis simplicicollis*	M	7/16/2011	USA	NJ	Hudson	Liberty State Park, Nature Center	40.6982° N, 74.0538° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00228
WRK-WS-01125	*Erythemis simplicicollis*	M	7/11/2012	USA	NJ	Union	Watchung Res., Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00231
WRK-WS-01126	*Erythemis simplicicollis*	M	7/11/2012	USA	NJ	Union	Watchung Res., Lake Surprise	40.6937° N, 74.3701° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00233
WRK-WS-01127	*Erythemis simplicicollis*	M	7/11/2012	USA	NJ	Union	Watchung Res., Lake Surprise	40.6937° N, 74.3701° W	MSH	RU-N:WL:OdoD: 2013 00239
WRK-WS-01131	*Erythemis simplicicollis*	M	7/26/2013	USA	NJ	Union	Watchung Res., Lake Surprise		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00238
WRK-WS-01132	*Erythemis simplicicollis*	M	7/26/2013	USA	NJ	Union	Watchung Res., Lake Surprise		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00237
WRK-WS-01133	*Erythemis simplicicollis*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991° N, 74.1831°	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00243
WRK-WS-01134	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00244
WRK-WS-01135	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00245
WRK-WS-01136	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00246
WRK-WS-01137	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00247
WRK-WS-01138	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00248
WRK-WS-01139	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00249
WRK-WS-01140	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00250
WRK-WS-01141	*Erythemis simplicicollis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105° N, 74.4972° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00251
WRK-WS-01145	*Erythemis simplicicollis*	M	8/2/2013							RU-N:WL:OdoD: 2013 00327
WRK-WS-01146	*Erythemis simplicicollis*	M	8/2/2013							RU-N:WL:OdoD: 2013 00328
WRK-WS-01864	*Erythemis simplicicollis*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-00091	*Erythemis vesiculosa*	F	8/1/2011	Guyana	Demerara-Mahaica		Guyana, CEIBA		Ware Lab	
WRK-WS-00341	*Erythemis vesiculosa*	F	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Garbage Canal near Splashmins	6°29'57.75"N,58°13'7.23"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00356	*Erythemis vesiculosa*	F	8/4/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Elev: 19m	6°29'57.75"N,58°13'7.28"W	MSH	
WRK-WS-00357	*Erythemis vesiculosa*	F	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Elev: 19m	6°29'57.75"N,58°13'7.28"W	JLW, MSH, DAG	
WRK-WS-00358	*Erythemis vesiculosa*	F	8/7/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Elev: 19m	6°29'57.75"N,58°13'7.28"W	JLW, MSH, DAG	
WRK-WS-00359	*Erythemis vesiculosa*	F	7/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Elev: 19m	6°29'57.75"N,58°13'7.28"W	JLW, MSH, DAG	
WRK-WS-00360	*Erythemis vesiculosa*	F	7/26/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Elev: 19m	6°29'57.75"N,58°13'7.28"W		

WRK-WS-00361	*Erythemis vesiculosa*	F	8/10/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Pineapple Farm	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00362	*Erythemis vesiculosa*	F	8/10/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Pineapple Farm	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00363	*Erythemis vesiculosa*	F	8/5/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00364	*Erythemis vesiculosa*	F	8/4/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Garbage Canal near Splashmins	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00365	*Erythemis vesiculosa*	F	8/10/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00366	*Erythemis vesiculosa*	F	8/13/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Emerald Tower	6°29'57.75"N,58°13'7.28"W	JLW, MSH, DAG	
WRK-WS-00367	*Erythemis vesiculosa*	F	8/17/2012	Guyana	Demerara-Mahaica	CEIBA	6°29'57.75"N,58°13'7.28"W		
WRK-WS-00368	*Erythemis vesiculosa*	F	8/19/2012	Guyana	Demerara-Mahaica	CEIBA	6°29'57.75"N,58°13'7.28"W		
WRK-WS-00369	*Erythemis vesiculosa*	F	8/17/2012	Guyana	Demerara-Mahaica	CEIBA	6°29'57.75"N,58°13'7.28"W		
WRK-WS-00370	*Erythemis vesiculosa*	F	8/18/2012	Guyana	Demerara-Mahaica	CEIBA, Secret Garden	6°29'57.75"N,58°13'7.28"W		
WRK-WS-01150	*Erythemis vesiculosa*	F		Guyana		Site 2: Maikah			RU-N:WL:OdoD: 2013 00603
WRK-WS-01151	*Erythemis vesiculosa*	F	6/6/2013	Guyana		Open Road, KBO		MW, DAG	RU-N:WL:OdoD: 2014 00009
WRK-WS-01152	*Erythemis vesiculosa*	F	8/23/2012	Guyana		Rice field, 0206A			RU-N:WL:OdoD: 2014 00854
WRK-WS-01153	*Erythemis vesiculosa*	F	8/23/2012	Guyana		Canal near Parika, 0206 B			RU-N:WL:OdoD: 2014 01201
WRK-WS-01154	*Erythemis vesiculosa*	F	6/4/2013	Guyana		CEIBA			RU-N:WL:OdoD: 2014 00073
WRK-WS-01159	*Erythemis vesiculosa*	F	6/7/2013	Guyana		KBO, LF Wilson Trail		MW, DAG	RU-N:WL:OdoD: 2014 00074
WRK-WS-01163	*Erythemis vesiculosa*	F	6/5/2013	Guyana		CEIBA			RU-N:WL:OdoD: 2014 00062
WRK-WS-01165	*Erythemis vesiculosa*	F	6/4/2013	Guyana		CEIBA			RU-N:WL:OdoD: 2014 00059
WRK-WS-01166	*Erythemis vesiculosa*	F		Guyana		CEIBA			RU-N:WL:OdoD: 2014 00064
WRK-WS-01168	*Erythemis vesiculosa*	F	8/21/2012	Guyana		CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	RU-N:WL:OdoD: 2014 00677
WRK-WS-01169	*Erythemis vesiculosa*	F	8/22/2012	Guyana		Kamuni River			RU-N:WL:OdoD: 2014 00676
WRK-WS-00342	*Erythemis vesiculosa*	M	8/13/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Emeral Tower	6°29'57.75"N,58°18'7.28"W	JLW,N Sroczynski,I Biazzo	
WRK-WS-00343	*Erythemis vesiculosa*	M	8/4/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station,Splashmins	6°29'57.75"N,58°18'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00344	*Erythemis vesiculosa*	M	8/10/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, CEIBA Road	6°29'57.75"N,58°18'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00345	*Erythemis vesiculosa*	M	8/11/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station; Field Near Bear Tree	6°29'57.75"N,58°18'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00346	*Erythemis vesiculosa*	M	8/11/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station; AF	6°29'57.75"N,58°18'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00347	*Erythemis vesiculosa*	M	8/6/2011	Guyana	Demerara-Mahaica	Boat to Santa Mission	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00349	*Erythemis vesiculosa*	M	8/10/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Garbage Canal near Splashmins	6°29'57.75"N,58°13'7.23"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00350	*Erythemis vesiculosa*	M	8/9/2011	Guyana	Demerara-Mahaica	Mahaica Tributary		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00351	*Erythemis vesiculosa*	M	8/9/2011	Guyana	Demerara-Mahaica	Mahaica Tributary Site 3		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00352	*Erythemis vesiculosa*	M	8/9/2011	Guyana	Demerara-Mahaica	Mahaica Tributary Site 1		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00353	*Erythemis vesiculosa*	M	8/11/2011	Guyana	Demerara-Mahaica	Bounty Farm		JLW Team	
WRK-WS-00354	*Erythemis vesiculosa*	M	8/9/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Garbage Canal near Splashmins	6°29'57.75"N,58°13'7.23"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00355	*Erythemis vesiculosa*	M	7/28/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station, Elev: 19m	6°29'57.75"N,58°13'7.28"W	JLW, MSH, DAG	
WRK-WS-00371	*Erythemis vesiculosa*	M	8/16/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station,Splashmins	6°29'57.75"N,58°13'7.28"W		
WRK-WS-00372	*Erythemis vesiculosa*	M	8/16/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station,Splashmins	6°29'57.75"N,58°13'7.28"W		
WRK-WS-00373	*Erythemis vesiculosa*	M	8/18/2012	Guyana	Demerara-Mahaica	CEIBA	6°29'57.75"N,58°13'7.28"W		
WRK-WS-01155	*Erythemis vesiculosa*	M	6/5/2013	Guyana		CEIBA			RU-N:WL:OdoD: 2014 00075
WRK-WS-01156	*Erythemis vesiculosa*	M	6/6/2013	Guyana		Open Road, KBO		MW, DAG	RU-N:WL:OdoD: 2014 00068
WRK-WS-01157	*Erythemis vesiculosa*	M	6/10/2013	Guyana		Open Road, KBO		MW, DAG	RU-N:WL:OdoD: 2014 00070
WRK-WS-01158	*Erythemis vesiculosa*	M	6/4/2013	Guyana		CEIBA		MW, DAG	RU-N:WL:OdoD: 2014 00071
WRK-WS-01160	*Erythemis vesiculosa*	M	6/5/2013	Guyana		CEIBA			RU-N:WL:OdoD: 2014 00076
WRK-WS-01161	*Erythemis vesiculosa*	M		Guyana		CEIBA			RU-N:WL:OdoD: 2014 00077

WRK-WS-01162	*Erythemis vesiculosa*	M	6/4/2013	Guyana			CEIBA			RU-N:WL:OdoD: 2014 00060
WRK-WS-01164	*Erythemis vesiculosa*	M	6/5/2013	Guyana			CEIBA			RU-N:WL:OdoD: 2014 00061
WRK-WS-01167	*Erythemis vesiculosa*	M	6/5/2013	Guyana			CEIBA			RU-N:WL:OdoD: 2014 00067
WRK-WS-00584	*Erythrodiplax amazonica*	M	8/19/2012	Guyana	Demerara-Mahaica		Emerald Tower			
WRK-WS-00581	*Erythrodiplax basalis*	M	8/19/2012	Guyana	Demerara-Mahaica		Emerald Tower			
WRK-WS-00582	*Erythrodiplax basalis*	M	8/14/2012	Guyana	Demerara-Mahaica		splashmins, 0916		WRK	
WRK-WS-00056	*Erythrodiplax berenice*	F	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00057	*Erythrodiplax berenice*	F	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00058	*Erythrodiplax berenice*	F	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00059	*Erythrodiplax berenice*	F	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00062	*Erythrodiplax berenice*	F	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00055	*Erythrodiplax berenice*	M	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00060	*Erythrodiplax berenice*	M	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00061	*Erythrodiplax berenice*	M	6/3/2012	USA	NJ	Ocean	NJ, Island Beach SP		A Collins, WRK	
WRK-WS-00374	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00375	*Erythrodiplax fervida*	F	7/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00376	*Erythrodiplax fervida*	F	7/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00377	*Erythrodiplax fervida*	F	7/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00380	*Erythrodiplax fervida*	F	7/26/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00381	*Erythrodiplax fervida*	F	7/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00382	*Erythrodiplax fervida*	F	7/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00386	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00387	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00388	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00389	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00390	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00391	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00393	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00394	*Erythrodiplax fervida*	F	7/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00395	*Erythrodiplax fervida*	F	8/8/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00397	*Erythrodiplax fervida*	F	8/8/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00400	*Erythrodiplax fervida*	F	8/1/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station splashmins field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00401	*Erythrodiplax fervida*	F	8/1/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station splashmins field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00402	*Erythrodiplax fervida*	F	8/1/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station splashmins field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00406	*Erythrodiplax fervida*	F	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Andrew's Farm	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00407	*Erythrodiplax fervida*	F	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Andrew's Farm	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00408	*Erythrodiplax fervida*	F	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Andrew's Farm	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00409	*Erythrodiplax fervida*	F	8/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Farm With Kids	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00410	*Erythrodiplax fervida*	F	8/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Farm With Kids	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00411	*Erythrodiplax fervida*	F	8/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Farm With Kids	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00412	*Erythrodiplax fervida*	F	8/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Farm With Kids	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00413	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Pineapple Farm	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00414	*Erythrodiplax fervida*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Pineapple Farm	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00512	*Erythrodiplax fervida*	F	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway		DAG, WRK	
WRK-WS-00514	*Erythrodiplax fervida*	F	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway		DAG, WRK	
WRK-WS-00515	*Erythrodiplax fervida*	F	8/18/2012	Guyana	Demerara-Mahaica		CEIBA (Blacklight Trap)		DAG, WRK	
WRK-WS-00516	*Erythrodiplax fervida*	F	8/16/2012	Guyana	Demerara-Mahaica		CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00518	*Erythrodiplax fervida*	F	8/18/2012	Guyana	Demerara-Mahaica		CEIBA - DPF		DAG, WRK	
WRK-WS-00519	*Erythrodiplax fervida*	F	8/19/2012	Guyana	Demerara-Mahaica		CEIBA old pineapple field		DAG, WRK	
WRK-WS-00520	*Erythrodiplax fervida*	F	8/16/2012	Guyana	Demerara-Mahaica		CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00521	*Erythrodiplax fervida*	F	8/16/2012	Guyana	Demerara-Mahaica		CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00522	*Erythrodiplax fervida*	F	8/14/2012	Guyana	Demerara-Mahaica		CEIBA		DAG, WRK	
WRK-WS-00523	*Erythrodiplax fervida*	F	8/16/2012	Guyana	Demerara-Mahaica		CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	

WRK-WS-00524	*Erythrodiplax fervida*	F	8/16/2012	Guyana	Demerara-Mahaica	CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00525	*Erythrodiplax fervida*	F	8/16/2012	Guyana	Demerara-Mahaica	CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00526	*Erythrodiplax fervida*	F	8/16/2012	Guyana	Demerara-Mahaica	CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00527	*Erythrodiplax fervida*	F	8/14/2012	Guyana	Demerara-Mahaica	CEIBA		DAG, WRK	
WRK-WS-00528	*Erythrodiplax fervida*	F	8/19/2012	Guyana	Demerara-Mahaica	Sosdyke-Lynden Highway		DAG, WRK	
WRK-WS-00855	*Erythrodiplax fervida*	F	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00028
WRK-WS-00856	*Erythrodiplax fervida*	F	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00030
WRK-WS-00857	*Erythrodiplax fervida*	F	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00027
WRK-WS-00858	*Erythrodiplax fervida*	F	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00016
WRK-WS-00862	*Erythrodiplax fervida*	F	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00079
WRK-WS-00869	*Erythrodiplax fervida*	F	9/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		
WRK-WS-00872	*Erythrodiplax fervida*	F	9/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667	I Biazzo	
WRK-WS-00873	*Erythrodiplax fervida*	F	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667	Shareeza	
WRK-WS-00875	*Erythrodiplax fervida*	F	9/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667	I Biazzo	
WRK-WS-00880	*Erythrodiplax fervida*	F	1/2/2012	Guyana	Demerara-Mahaica	Splashmins			RU-N:WL:OdoD: 2014 00999
WRK-WS-00378	*Erythrodiplax fervida*	M	7/26/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00379	*Erythrodiplax fervida*	M	7/26/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00383	*Erythrodiplax fervida*	M	7/30/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00384	*Erythrodiplax fervida*	M	7/30/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00385	*Erythrodiplax fervida*	M	7/30/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00392	*Erythrodiplax fervida*	M	7/27/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00396	*Erythrodiplax fervida*	M	8/5/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00403	*Erythrodiplax fervida*	M	7/30/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station splashmins field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00404	*Erythrodiplax fervida*	M	7/28/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station splashmins field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00405	*Erythrodiplax fervida*	M	7/28/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00415	*Erythrodiplax fervida*	M	7/28/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station; Farm With Kids	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00416	*Erythrodiplax fervida*	M	7/28/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00417	*Erythrodiplax fervida*	M	7/31/2011	Guyana	Demerara-Mahaica	CEIBA Biological Station; Boardwalk	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00513	*Erythrodiplax fervida*	M	8/16/2012	Guyana	Demerara-Mahaica	CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00517	*Erythrodiplax fervida*	M	8/18/2012	Guyana	Demerara-Mahaica	CEIBA (Blacklight Trap)		DAG, WRK	
WRK-WS-00529	*Erythrodiplax fervida*	M	8/16/2012	Guyana	Demerara-Mahaica	CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00530	*Erythrodiplax fervida*	M	8/16/2012	Guyana	Demerara-Mahaica	CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00531	*Erythrodiplax fervida*	M	8/14/2012	Guyana	Demerara-Mahaica	CEIBA		DAG, WRK	
WRK-WS-00532	*Erythrodiplax fervida*	M	8/19/2012	Guyana	Demerara-Mahaica	Sosdyke-Lynden Highway		DAG, WRK	
WRK-WS-00533	*Erythrodiplax fervida*	M	8/19/2012	Guyana	Demerara-Mahaica	Sosdyke-Lynden Highway		DAG, WRK	
WRK-WS-00534	*Erythrodiplax fervida*	M	8/17/2012	Guyana	Demerara-Mahaica	CEIBA		DAG, WRK	
WRK-WS-00843	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667	Shaneeza	RU-N:WL:OdoD: 2013 00034
WRK-WS-00844	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00038
WRK-WS-00845	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00039
WRK-WS-00846	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00040
WRK-WS-00847	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00037
WRK-WS-00848	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00032
WRK-WS-00849	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00024
WRK-WS-00850	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00013
WRK-WS-00851	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00010
WRK-WS-00852	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00042
WRK-WS-00853	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00044
WRK-WS-00854	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00043
WRK-WS-00859	*Erythrodiplax fervida*	M	7/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00031
WRK-WS-00860	*Erythrodiplax fervida*	M	1/3/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6°33" N, 58°18" W	JLW, WRK, P Frandsen	RU-N:WL:OdoD: 2014 00994
WRK-WS-00861	*Erythrodiplax fervida*	M	9/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00007
WRK-WS-00863	*Erythrodiplax fervida*	M	9/1/2012	Guyana	Demerara-Mahaica	CEIBA Biological Station	6.4833333333, -58.2166666667	I Biazzo	RU-N:WL:OdoD: 2013 00066

WRK-WS-00864	*Erythrodiplax fervida*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667		RU-N:WL:OdoD: 2013 00064
WRK-WS-00865	*Erythrodiplax fervida*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667		
WRK-WS-00866	*Erythrodiplax fervida*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667	I Biazzo	
WRK-WS-00867	*Erythrodiplax fervida*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667		
WRK-WS-00870	*Erythrodiplax fervida*	M	6/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667		
WRK-WS-00886	*Erythrodiplax fervida*	M	8/6/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station (Outside Benab)	6°33" N, 58°18" W	JLW Team	RU-N:WL:OdoD: 2014 01017
WRK-WS-01611	*Erythrodiplax fusca*	F		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-001
WRK-WS-00440	*Erythrodiplax sp1*	M	7/27/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00441	*Erythrodiplax sp1*	M	7/27/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00442	*Erythrodiplax sp1*	M	7/27/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00443	*Erythrodiplax sp1*	M	7/27/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00444	*Erythrodiplax sp1*	M	7/27/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00445	*Erythrodiplax sp1*	M	7/27/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00446	*Erythrodiplax sp1*	M	7/27/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00447	*Erythrodiplax sp1*	M	7/28/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00448	*Erythrodiplax sp1*	M	8/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00449	*Erythrodiplax sp1*	M	8/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00450	*Erythrodiplax sp1*	M	8/4/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00451	*Erythrodiplax sp1*	M	8/11/2012	Guyana	Demerara-Mahaica		Boat to Santa Mission (farm) COORD APPROX	6°29'57.75"N,58°13'7.28"W	JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00543	*Erythrodiplax sp1*	M	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway ET		DAG, WRK	
WRK-WS-00544	*Erythrodiplax sp2*	M	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway ET		DAG, WRK	
WRK-WS-00545	*Erythrodiplax sp3*	M	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway ET		DAG, WRK	
WRK-WS-00546	*Erythrodiplax sp4*	M	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway ET		DAG, WRK	
WRK-WS-00547	*Erythrodiplax sp5*	M	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway ET		DAG, WRK	
WRK-WS-00548	*Erythrodiplax sp6*	M	8/19/2012	Guyana	Demerara-Mahaica		Sosdyke-Lynden Highway ET		DAG, WRK	
WRK-WS-00090	*Erythrodiplax umbrata*	F	8/11/2011	Guyana	Demerara-Mahaica		Guyana, CEIBA, Bounty farm		Ware Lab	
WRK-WS-00485	*Erythrodiplax umbrata*	M	8/17/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W		
WRK-WS-00486	*Erythrodiplax umbrata*	M	8/17/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station, chicken coop field		WRK, DAG	
WRK-WS-00487	*Erythrodiplax umbrata*	M	8/16/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins	6°29'57.75"N,58°18'7.28"W	WRK, DAG	
WRK-WS-00488	*Erythrodiplax umbrata*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	I Biazzo	
WRK-WS-00489	*Erythrodiplax umbrata*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	I Biazzo	
WRK-WS-00490	*Erythrodiplax umbrata*	M	9/2/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins	6°29'57.75"N,58°18'7.28"W		
WRK-WS-00491	*Erythrodiplax umbrata*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	I Biazzo, DAG, J Evangelista	
WRK-WS-00492	*Erythrodiplax umbrata*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	I Biazzo	
WRK-WS-00493	*Erythrodiplax umbrata*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	I Biazzo	
WRK-WS-00494	*Erythrodiplax umbrata*	M	1/2/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins	6°29'57.75"N,58°18'7.28"W		
WRK-WS-00495	*Erythrodiplax umbrata*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00496	*Erythrodiplax umbrata*	M	8/4/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Andrew's Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00497	*Erythrodiplax umbrata*	M	8/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00498	*Erythrodiplax umbrata*	M	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Garbage Canal near Splashmins	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00499	*Erythrodiplax umbrata*	M	8/4/2011	Guyana	Demerara-Mahaica		CEIBA; Trail to AF	6°29'57.75"N,58°18'7.28"W	Mr MSH	
WRK-WS-00500	*Erythrodiplax umbrata*	M	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00501	*Erythrodiplax umbrata*	M	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Farm	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00502	*Erythrodiplax umbrata*	M	8/11/2011	Guyana	Demerara-Mahaica		Bounty Farm		JLW, DAG, MKK, MSH, I Biazzo, N Sroczynski	
WRK-WS-00019	*Ladona deplanata*	F	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-01873	*Ladona deplanata*	F	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-00017	*Ladona deplanata*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-00018	*Ladona deplanata*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-00020	*Ladona deplanata*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-00021	*Ladona deplanata*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-00022	*Ladona deplanata*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-00024	*Ladona deplanata*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-00023	*Ladona exusta*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	
WRK-WS-00025	*Ladona exusta*	M	5/6/2012	USA	NJ	Altantic	NJ, Atlantic Co., Webbs Mill Boardwalk		A Collins, DAG, WRK	

WRK-WS-02333	*Ladona julia*	F	6/6/2014	USA	NJ	Sussex	Edison Pond			
WRK-WS-02334	*Ladona julia*	F	6/6/2014	USA	NJ	Sussex	Edison Pond			
WRK-WS-02335	*Ladona julia*	F	6/6/2014	USA	NJ	Sussex	Edison Pond			
WRK-WS-02174	*Ladona julia*	M	6/17/2015	USA	NJ	morris	Weldon Brook Lake at Rockaway River WMA	41.0065 N 74.5882W	WRK, R Pranter	
WRK-WS-02175	*Ladona julia*	M	6/17/2015	USA	NJ	morris	Weldon Brook Lake at Rockaway River WMA	41.0065 N 74.5882W	WRK, R Pranter	
WRK-WS-02176	*Ladona julia*	M	6/17/2015	USA	NJ	morris	Weldon Brook Lake at Rockaway River WMA	41.0065 N 74.5882W	WRK, R Pranter	
WRK-WS-02177	*Ladona julia*	M	6/17/2015	USA	NJ	morris	Weldon Brook Lake at Rockaway River WMA	41.0065 N 74.5882W	WRK, R Pranter	
WRK-WS-00083	*Leucorrhinia frigida*	F		USA		Alton/Belknap	NH, Mt. Major 0182		A Collins, WRK	
WRK-WS-01752	*Leucorrhinia intacta*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D
WRK-WS-01753	*Leucorrhinia intacta*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01754	*Leucorrhinia intacta*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-02291	*Leucorrhinia intacta*	F	06/2015							
WRK-WS-02292	*Leucorrhinia intacta*	F	06/2015							
WRK-WS-02293	*Leucorrhinia intacta*	F	06/2015							
WRK-WS-02294	*Leucorrhinia intacta*	F	06/2015							
WRK-WS-01755	*Leucorrhinia intacta*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01756	*Leucorrhinia intacta*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01858	*Leucorrhinia intacta*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01859	*Leucorrhinia intacta*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01860	*Leucorrhinia intacta*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01861	*Leucorrhinia intacta*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-01862	*Leucorrhinia intacta*	M	5/29/2015	USA	NJ	Sussex	Allamuchy Mountain Park/Sussex branch trail near Jefferson lake	40.92622N, 74,73925 W	I Furman, WRK, R Pranter, MW	
WRK-WS-02282	*Leucorrhinia intacta*	M	6/6/2014							
WRK-WS-02283	*Leucorrhinia intacta*	M	6/6/2014							A13
WRK-WS-02284	*Leucorrhinia intacta*	M	6/6/2014							
WRK-WS-02285	*Leucorrhinia intacta*	M	6/6/2014							
WRK-WS-02286	*Leucorrhinia intacta*	M	6/6/2014							
WRK-WS-02287	*Leucorrhinia intacta*	M	06/2015							
WRK-WS-02288	*Leucorrhinia intacta*	M	06/2015							
WRK-WS-02289	*Leucorrhinia intacta*	M	06/2015							
WRK-WS-02290	*Leucorrhinia intacta*	M	06/2015							
WRK-WS-02324	*Leucorrhinia intacta*	M	6/6/2014	USA	NJ	Morris	Pond across Jefferson H.S.			
WRK-WS-02325	*Leucorrhinia intacta*	M	6/17/2015	USA	NJ	Morris	Pond across Weldon RD from Jefferson Twp HS	41.0186N, 74.5523 W	WRK, R Pranter	
WRK-WS-00007	*Libellula axilena*	M	7/1/2011	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park		Aim High Students (RU-N)	
WRK-WS-00039	*Libellula axilena*	M	6/25/2012	USA	TX	Titus	TX, Lake Bob Sandlin State Rec. Area, 0177	33°2.999'N,95°5.626'W	WRK	
WRK-WS-00043	*Libellula axilena*	M	6/6/2012	USA	NJ	Hunterdon	NJ, Voorhees SP		WRK	
WRK-WS-02323	*Libellula axilena*	M	8/9/2012							
WRK-WS-02212	*Libellula cyanea*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-02213	*Libellula cyanea*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-00029	*Libellula cyanea*	M	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-02210	*Libellula cyanea*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-02211	*Libellula cyanea*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-02317	*Libellula cyanea*	M	06/2014							
WRK-WS-01644	*Libellula herculea*	M		Peru			Pozuzo		MSH	RU-N:WL:OdoD: 2014 01360; MSH-LIB-26
WRK-WS-00054	*Libellula incesta*	M	6/12-17/16	USA	TX	Walker	Huntsville SP, Prairie Branch Loop & Chinquapin Trail at N end of Lake Raven, 0163	30.6208N, 95.5347W	WRK	
WRK-WS-00094	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00095	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00096	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00097	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	

WRK-WS-00098	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00099	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00100	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00101	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00102	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00103	*Libellula incesta*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00104	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00105	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00106	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00107	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00108	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00109	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00110	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00111	*Libellula incesta*	M	7/16/2012	USA	NJ	Hudson	Liberty State Park, Nature Center	40.6982,-74.0538	Aim High Students (RU-N)
WRK-WS-00112	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00113	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00114	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00115	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00116	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00117	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00118	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00119	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00120	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00121	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00122	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00123	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00124	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00125	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00126	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00127	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00128	*Libellula incesta*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00567	*Libellula incesta*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team
WRK-WS-00568	*Libellula incesta*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team
WRK-WS-00569	*Libellula incesta*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team
WRK-WS-00570	*Libellula incesta*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team
WRK-WS-00571	*Libellula incesta*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team
WRK-WS-02205	*Libellula incesta*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02206	*Libellula incesta*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02207	*Libellula incesta*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02208	*Libellula incesta*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02209	*Libellula incesta*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02329	*Libellula incesta*	M	6/25/2012	USA	TX		Lake Bob Sandlin State Rec. Area	33.2999N,95.56626W	
WRK-WS-02192	*Libellula luctuosa*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02193	*Libellula luctuosa*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02195	*Libellula luctuosa*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02197	*Libellula luctuosa*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02198	*Libellula luctuosa*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02199	*Libellula luctuosa*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter

WRK-WS-00050	*Libellula luctuosa*	M	6/9/2012	USA	VA	Montgomery	VA, Montgomery Co., Pandapas Pond		WRK
WRK-WS-00195	*Libellula luctuosa*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00196	*Libellula luctuosa*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00197	*Libellula luctuosa*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00198	*Libellula luctuosa*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00199	*Libellula luctuosa*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00200	*Libellula luctuosa*	M	7/11/2012	USA	NJ	Union	Watchung Reservation, Lake Surprise	40.6937,-74.3701	Aim High Students (RU-N)
WRK-WS-00201	*Libellula luctuosa*	M	7/11/2012	USA	NJ	Union	Watchung Reservation, Lake Surprise	40.6937,-74.3701	Aim High Students (RU-N)
WRK-WS-00202	*Libellula luctuosa*	M	7/11/2012	USA	NJ	Union	Watchung Reservation, Lake Surprise	40.6937,-74.3701	Aim High Students (RU-N)
WRK-WS-00203	*Libellula luctuosa*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)
WRK-WS-00204	*Libellula luctuosa*	M	7/11/2012	USA	NJ	Union	Watchung Reservation, Lake Surprise	40.6937,-74.3701	Aim High Students (RU-N)
WRK-WS-00205	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00206	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00207	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00208	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00209	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00210	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00211	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00212	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00213	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00214	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00215	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00216	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00217	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00218	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00219	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00220	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00221	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00222	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00223	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00224	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00234	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00235	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-00236	*Libellula luctuosa*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)
WRK-WS-02191	*Libellula luctuosa*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02194	*Libellula luctuosa*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02196	*Libellula luctuosa*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02200	*Libellula luctuosa*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-02201	*Libellula luctuosa*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter
WRK-WS-00503	*Libellula needhami*	M	7/16/2012	USA	NJ	Hudson	Hudson Co. Liberty St. Park, Nature Center	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00504	*Libellula needhami*	M	7/16/2011	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00505	*Libellula needhami*	M	7/19/2011	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00506	*Libellula needhami*	M	7/19/2011	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00507	*Libellula needhami*	M	7/19/2011	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00508	*Libellula needhami*	M	7/18/2011	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00509	*Libellula needhami*	M	7/16/2012	USA	NJ	Hudson	Hudson Co. Liberty St. Park, Nature Center	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00510	*Libellula needhami*	M	7/17/2012	USA	NJ	Hudson	Hudson Co. Liberty St. Park, Nature Center	40.6982°N, 74.0538°W	Aim High Students (RU-N)
WRK-WS-00511	*Libellula needhami*	M	7/17/2012	USA	NJ	Hudson	Hudson Co. Liberty St. Park, Nature Center	40.6982°N, 74.0538°W	
WRK-WS-01379	*Libellula pulchella*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK
WRK-WS-01381	*Libellula pulchella*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK
WRK-WS-01354	*Libellula quadrimaculata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK
WRK-WS-01355	*Libellula quadrimaculata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK
WRK-WS-01356	*Libellula quadrimaculata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK

WRK-WS-01357	*Libellula quadrimaculata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01358	*Libellula quadrimaculata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01359	*Libellula quadrimaculata*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-02330	*Libellula semifasciata*	M	6/6/2014	USA	NJ	Sussex	Edison Pond			
WRK-WS-02331	*Libellula semifasciata*	M	6/6/2014	USA	NJ	Sussex	Edison Pond			
WRK-WS-02332	*Libellula semifasciata*	M	6/6/2014	USA	NJ	Morris	Rockaway River State Wildlife			
WRK-WS-02015	*Libellula vibrans*	M	6/7/2015	USA	NJ	Essex	South Mountain Reservation/near stone bridge&hidden field	40.74332 N, 74.30091 W	WRK	
WRK-WS-02016	*Libellula vibrans*	M	6/7/2015	USA	NJ	Essex	South Mountain Reservation/near stone bridge&hidden field	40.74332 N, 74.30091 W	WRK	
WRK-WS-00621	*Macrothemis extensa*	M	6/7/2013	Guyana	Rupununi		Karanambo Camp			
WRK-WS-00622	*Macrothemis extensa*	M	6/7/2013	Guyana	Rupununi		Karanambo		DAG, O Ambrose, MW	
WRK-WS-00577	*Miathyria marcella*	M	8/16/2012	Guyana	Demerara-Mahaica		splashmins			
WRK-WS-00578	*Miathyria marcella*	M	8/14/2012	Guyana	Demerara-Mahaica		splashmins, 0196			
WRK-WS-00623	*Miathyria marcella*	M	6/12/2013	Guyana	Rupununi		Karanambo		DAG, O Ambrose, MW	
WRK-WS-00884	*Miathyria marcella*	M	9/1/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station	6.4833333333, -58.2166666667	JLW, WRK, P Frandsen	RU-N:WL:OdoD: 2013 00017
WRK-WS-00579	*Miathyria simplex*	M	8/16/2012	Guyana	Demerara-Mahaica		CEIBA		WRK, DAG	
WRK-WS-00580	*Miathyria simplex*	M	8/14/2012	Guyana	Demerara-Mahaica		splashmins, 0916		WRK	
WRK-WS-01063	*Miathyria simplex*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29' 57.75" N; 58° 13' 7.28" W	JLW Team	RU-N:WL:OdoD: 2013 00207
WRK-WS-00583	*Misagria parana*	M	8/18/2012	Guyana	Demerara-Mahaica		CEIBA, Secret Garden			
WRK-WS-00585	*Misagria parana*	M	8/18/2012	Guyana	Demerara-Mahaica		CEIBA, Secret Garden			
WRK-WS-00586	*Nephepeltia phryne*	M	8/19/2012	Guyana	Demerara-Mahaica		CEIBA, Old Pineapple Field, 0200c			
WRK-WS-00588	*Nephepeltia phryne*	M	8/19/2012	Guyana	Demerara-Mahaica		CEIBA, 0200c			
WRK-WS-01618	*Orthemis discolor*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-001
WRK-WS-00602	*Orthemis feiruginea*	M	8/9/2013	USA	TX	Comal	River House, River Road, New Braunfels			
WRK-WS-00603	*Orthemis feiruginea*	M	8/9/2013	USA	TX	Comal	River House, River Road, New Braunfels			
WRK-WS-01604	*Orthemis schmidti*	F		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-007
WRK-WS-01612	*Orthemis schmidti*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-007
WRK-WS-01615	*Orthemis schmidti*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-007
WRK-WS-01616	*Orthemis schmidti*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-007
WRK-WS-01617	*Orthemis schmidti*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-007
WRK-WS-00027	*Pachydiplax longipennis*	F	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-00237	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00238	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00239	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00240	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00241	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00242	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00243	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00244	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00245	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00246	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00247	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00248	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00249	*Pachydiplax longipennis*	F	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00265	*Pachydiplax longipennis*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00266	*Pachydiplax longipennis*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00561	*Pachydiplax longipennis*	F	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00563	*Pachydiplax longipennis*	F	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-00565	*Pachydiplax longipennis*	F	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-02295	*Pachydiplax longipennis*	F	06/2015							
WRK-WS-02296	*Pachydiplax longipennis*	F	06/2015							
WRK-WS-02297	*Pachydiplax longipennis*	F	06/2015							
WRK-WS-02298	*Pachydiplax longipennis*	F	06/2015							
WRK-WS-00001	*Pachydiplax longipennis*	M	7/1/2011	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park		Aim High Students (RU-N)	
WRK-WS-00002	*Pachydiplax longipennis*	M	7/1/2011	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park		Aim High Students (RU-N)	
WRK-WS-00003	*Pachydiplax longipennis*	M	7/1/2011	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park		Aim High Students (RU-N)	
WRK-WS-00004	*Pachydiplax longipennis*	M	7/1/2011	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park		Aim High Students (RU-N)	

WRK-WS-00041	*Pachydiplax longipennis*	M	6/9/2012	USA	VA	Montgomery	VA, Montgomery Co., Pandapas Pond		WRK	
WRK-WS-00250	*Pachydiplax longipennis*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park	40.7567,-74.1827	Aim High Students (RU-N)	
WRK-WS-00251	*Pachydiplax longipennis*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park	40.7567,-74.1827	Aim High Students (RU-N)	
WRK-WS-00252	*Pachydiplax longipennis*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park	40.7567,-74.1827	Aim High Students (RU-N)	
WRK-WS-00253	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00254	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00255	*Pachydiplax longipennis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00256	*Pachydiplax longipennis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00257	*Pachydiplax longipennis*	M	7/11/2012	USA	NJ	Union	Watchung Reservation, Lake Surprise	40.6937,-74.3701	Aim High Students (RU-N)	
WRK-WS-00258	*Pachydiplax longipennis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00259	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00260	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00261	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00262	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00263	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00264	*Pachydiplax longipennis*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00267	*Pachydiplax longipennis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00268	*Pachydiplax longipennis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00269	*Pachydiplax longipennis*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00564	*Pachydiplax longipennis*	M	7/14/2012	USA	NJ	Sussex	Lake Wawayanda, Wawayanda S.P.		JLW Team	
WRK-WS-01097	*Pachydiplax longipennis*	M	7/19/2011	USA	NJ		Liberty State Park, Jersey City		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00194
WRK-WS-01101	*Pachydiplax longipennis*	M	7/19/2011	USA	NJ		Liberty State Park, Jersey City		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00193
WRK-WS-01123	*Pachydiplax longipennis*	M	7/18/2011	USA	NJ		Liberty State Park, Jersey City		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00229
WRK-WS-01124	*Pachydiplax longipennis*	M								RU-N:WL:OdoD: 2013 00230
WRK-WS-00418	*Pantala flavescens*	F	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00421	*Pantala flavescens*	F	7/30/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00422	*Pantala flavescens*	F	7/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00423	*Pantala flavescens*	F	7/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00438	*Pantala flavescens*	F	7/11/2012	USA	NJ	Union	Watchung Reservation, Lake Surprise	40.6937,-74.3701	Aim High Students (RU-N)	
WRK-WS-00537	*Pantala flavescens*	F	8/16/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins		DAG, WRK	
WRK-WS-00538	*Pantala flavescens*	F	8/16/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins		WRK, DAG	
WRK-WS-00539	*Pantala flavescens*	F	8/19/2012	Guyana	Demerara-Mahaica		CEIBA - DPF - OZOOC		DAG, WRK	
WRK-WS-00540	*Pantala flavescens*	F	8/18/2012	Guyana	Demerara-Mahaica		CEIBA - DPF - Dusk		DAG, WRK	
WRK-WS-00541	*Pantala flavescens*	F	8/18/2012	Guyana	Demerara-Mahaica		CEIBA - DPF - Dusk		DAG, WRK	
WRK-WS-00542	*Pantala flavescens*	F	8/18/2012	Guyana	Demerara-Mahaica		CEIBA - DPF		DAG, WRK	
WRK-WS-01701	*Pantala flavescens*	F		Guyana	Kurupukari Crossing				DAG	IWO-007
WRK-WS-01731	*Pantala flavescens*	F	no date	USA	NJ	Essex	Branch Brook Park/Pond adjacent to ball fields, Newark	40.7611N, 74.1818W	no name	RU-N:WL:OdoD: 2015 00024
WRK-WS-01732	*Pantala flavescens*	F	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00025
WRK-WS-00419	*Pantala flavescens*	M	8/3/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; CEIBA Road	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00420	*Pantala flavescens*	M	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00424	*Pantala flavescens*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00425	*Pantala flavescens*	M	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00426	*Pantala flavescens*	M	8/5/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00427	*Pantala flavescens*	M	7/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00428	*Pantala flavescens*	M	8/10/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station, Garbage Canal near Splashmins	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00429	*Pantala flavescens*	M	8/21/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00430	*Pantala flavescens*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00431	*Pantala flavescens*	M	7/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00432	*Pantala flavescens*	M	7/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00433	*Pantala flavescens*	M	7/27/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00434	*Pantala flavescens*	M	7/28/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station; Splashmins Field	6°29'57.75"N,58°18'7.28"W	JLW, MSH, DAG	
WRK-WS-00435	*Pantala flavescens*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00436	*Pantala flavescens*	M	8/2/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00437	*Pantala flavescens*	M	8/4/2011	Guyana	Demerara-Mahaica		CEIBA Biological Station	6°29'57.75"N,58°18'7.28"W	JLW Team	
WRK-WS-00535	*Pantala flavescens*	M	8/16/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins		WRK, DAG	
WRK-WS-00536	*Pantala flavescens*	M	8/16/2012	Guyana	Demerara-Mahaica		CEIBA Biological Station,Splashmins		DAG, WRK	

WRK-WS-00615	*Pantala flavescens*	M	8/9/2013	USA	TX	Comal	River House, River Road, New Braunfels				
WRK-WS-00616	*Pantala flavescens*	M	8/9/2013	USA	TX	Comal	River House, River Road, New Braunfels				
WRK-WS-01626	*Pantala flavescens*	M		Guyana	Kurupukari Crossing		Iwokrama			DAG	IWO-003
WRK-WS-01630	*Pantala flavescens*	M		Guyana	Kurupukari Crossing		Iwokrama			DAG	IWO-005
WRK-WS-01631	*Pantala flavescens*	M		Guyana	Kurupukari Crossing		Iwokrama			DAG	IWO-007
WRK-WS-01633	*Pantala flavescens*	M		Guyana	Kurupukari Crossing		Iwokrama			DAG	IWO-003
WRK-WS-01640	*Pantala flavescens*	M		Guyana	Kurupukari Crossing		Iwokrama			DAG	IWO-B00
WRK-WS-01698	*Pantala flavescens*	M		Guyana	Kurupukari Crossing					DAG	IWO-001
WRK-WS-01730	*Pantala flavescens*	M	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00026
WRK-WS-00006	*Pantala hymenaea*	F	7/1/2011	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park			Aim High Students (RU-N)	
WRK-WS-00082	*Pantala hymenaea*	F	7/31/2012	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park			DAG	
WRK-WS-01719	*Pantala hymenaea*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation, Campbell's Pond/Rahway River	40.7371N, 74.3057W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00435
WRK-WS-01724	*Pantala hymenaea*	F	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00305
WRK-WS-01729	*Pantala hymenaea*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation, Campbell's Pond/Rahway River	40.7371N, 74.3057W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00212
WRK-WS-02110	*Pantala hymenaea*	F	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00962
WRK-WS-02111	*Pantala hymenaea*	F	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00964
WRK-WS-02112	*Pantala hymenaea*	F	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00965
WRK-WS-02113	*Pantala hymenaea*	F	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00968
WRK-WS-02114	*Pantala hymenaea*	F	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00969
WRK-WS-02115	*Pantala hymenaea*	F	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00970
WRK-WS-02116	*Pantala hymenaea*	F	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00971
WRK-WS-02121	*Pantala hymenaea*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00976
WRK-WS-02122	*Pantala hymenaea*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00977
WRK-WS-02123	*Pantala hymenaea*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00978
WRK-WS-02124	*Pantala hymenaea*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00979
WRK-WS-02125	*Pantala hymenaea*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00980
WRK-WS-02126	*Pantala hymenaea*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00981
WRK-WS-02129	*Pantala hymenaea*	F	8/9/2013	USA	TX	Comal	River House/New Braunfels				RU-N:WL:OdoD: 2013 00280
WRK-WS-02132	*Pantala hymenaea*	F	7/17/2013	USA	NJ		Lake Surprise/Watchung Reservation/Mountainside,NJ				RU-N:WL:OdoD: 2013 00985
WRK-WS-02133	*Pantala hymenaea*	F	7/14/2011	USA	NJ		Meadowlands			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00990
WRK-WS-02135	*Pantala hymenaea*	F	7/11/2013	USA	NJ		Lake Surprise/Watchung Reservation/Mountainside,NJ			Manpreet	RU-N:WL:OdoD: 2013 00984
WRK-WS-02143	*Pantala hymenaea*	F	7/19/2012	USA	NJ	Essex	Branch Brook Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00997
WRK-WS-01718	*Pantala hymenaea*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation, Campbell's Pond/Rahway River	40.7371N, 74.3057W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00434
WRK-WS-01720	*Pantala hymenaea*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation, Campbell's Pond/Rahway River	40.7371N, 74.3057W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00437
WRK-WS-01721	*Pantala hymenaea*	M	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00211
WRK-WS-01722	*Pantala hymenaea*	M	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00438
WRK-WS-01723	*Pantala hymenaea*	M	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00040
WRK-WS-01725	*Pantala hymenaea*	M	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00043
WRK-WS-01726	*Pantala hymenaea*	M	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00041
WRK-WS-01727	*Pantala hymenaea*	M	7/17&7/22/14	USA	NJ	Essex	Branch Brook Park	40.7611N, 74.1818W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00042
WRK-WS-01728	*Pantala hymenaea*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation, Campbell's Pond/Rahway River	40.7371N, 74.3057W		Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00210
WRK-WS-02117	*Pantala hymenaea*	M	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00972
WRK-WS-02118	*Pantala hymenaea*	M	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00973
WRK-WS-02119	*Pantala hymenaea*	M	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00974
WRK-WS-02120	*Pantala hymenaea*	M	7/23/2013	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00975
WRK-WS-02127	*Pantala hymenaea*	M	7/9/2013	USA	NJ	Hudson	Laurel Hill Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00982
WRK-WS-02130	*Pantala hymenaea*	M	05/2012	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00992
WRK-WS-02131	*Pantala hymenaea*	M	05/2012	USA	NJ	Essex	Branch Brook Park				RU-N:WL:OdoD: 2013 00991
WRK-WS-02134	*Pantala hymenaea*	M	7/14/2011	USA	NJ		Meadowlands			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00989
WRK-WS-02136	*Pantala hymenaea*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00987
WRK-WS-02137	*Pantala hymenaea*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park			Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00986

WRK-WS-02138	*Pantala hymenaea*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01006
WRK-WS-02139	*Pantala hymenaea*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 00988
WRK-WS-02140	*Pantala hymenaea*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01002
WRK-WS-02141	*Pantala hymenaea*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01003
WRK-WS-02142	*Pantala hymenaea*	M	7/19/2012	USA	NJ	Essex	Branch Brook Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01000
WRK-WS-02144	*Pantala hymenaea*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01019
WRK-WS-01627	*Perithemis lais*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-007
WRK-WS-01638	*Perithemis lais*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-005
WRK-WS-01668	*Perithemis lais*	M							MSH	MIT-82
WRK-WS-00298	*Perithemis tenera*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00299	*Perithemis tenera*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00300	*Perithemis tenera*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00301	*Perithemis tenera*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00302	*Perithemis tenera*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00303	*Perithemis tenera*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00304	*Perithemis tenera*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00005	*Perithemis tenera*	M	7/1/2011	USA	NJ	Essex	NJ, Essex Co., Branch Brook Park		Aim High Students (RU-N)	
WRK-WS-00305	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00306	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00307	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00308	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00309	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00310	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00311	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00312	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00313	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00314	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00315	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00316	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00317	*Perithemis tenera*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00318	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00319	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00320	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00321	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00322	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00323	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00324	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00325	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00326	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00327	*Perithemis tenera*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00604	*Perithemis tenera*	M	8/9/2013	USA	TX	Walker	Parent's House, McMillan Lake, Dodge			
WRK-WS-00092	*Perithemis thais*	M	8/3/2011	Guyana	Demerara-Mahaica		Guyana, CEIBA, Boardwalk pond		Ware Lab	
WRK-WS-01628	*Perithemis thais*	M		Guyana	Kurupukari Crossing		Iwokrama		DAG	IWO-007
WRK-WS-00028	*Plathemis lydia*	F	5/20/2012	USA	NJ	Morris	NJ, Great Swamp National Wildlife Refuge		DAG, N Dharithreesan, WRK	
WRK-WS-00040	*Plathemis lydia*	F	6/6/2012	USA	NJ	Hunterdon	NJ, Voorhees SP		WRK	
WRK-WS-00051	*Plathemis lydia*	F	6/12/2012	USA	TX	Walker	TX, Sam Houston NF, grassing clearing, 0162	30.73500N,95.42243W	WRK	
WRK-WS-00052	*Plathemis lydia*	F	6/12/2012	USA	TX	Walker	TX, Sam Houston NF, grassing clearing, 0162	30.73500N,95.42243W	WRK	
WRK-WS-00053	*Plathemis lydia*	F	6/12/2012	USA	TX	Walker	TX, Sam Houston NF, grassing clearing, 0162	30.73500N,95.42243W	WRK	
WRK-WS-00293	*Plathemis lydia*	F	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-01867	*Plathemis lydia*	F	5/24/2015	USA	NJ	Sussex	Appalachian Trail near Prices Switch	41.22786N, 74.46734	WRK, A Collins	
WRK-WS-01870	*Plathemis lydia*	F								
WRK-WS-01871	*Plathemis lydia*	F								
WRK-WS-02012	*Plathemis lydia*	F	6/7/2015	USA	NJ	Essex	South Mountain Reservation/near stone bridge&hidden field	40.74332 N, 74.30091 W	WRK	
WRK-WS-02013	*Plathemis lydia*	F	6/7/2015	USA	NJ	Essex	South Mountain Reservation/near stone bridge&hidden field	40.74332 N, 74.30091 W	WRK	
WRK-WS-02014	*Plathemis lydia*	F	6/7/2015	USA	NJ	Essex	South Mountain Reservation/near stone bridge&hidden field	40.74332 N, 74.30091 W	WRK	

WRK-WS-02202	*Plathemis lydia*	F	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-00270	*Plathemis lydia*	M	7/16/2012	USA	NJ	Hudson	Liberty State Park Nature Center	40.6982,-74.0538	Aim High Students (RU-N)	
WRK-WS-00271	*Plathemis lydia*	M	7/16/2012	USA	NJ	Hudson	Liberty State Park Nature Center	40.6982,-74.0538	Aim High Students (RU-N)	
WRK-WS-00272	*Plathemis lydia*	M	7/16/2012	USA	NJ	Hudson	Liberty State Park Nature Center	40.6982,-74.0538	Aim High Students (RU-N)	
WRK-WS-00273	*Plathemis lydia*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00274	*Plathemis lydia*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00275	*Plathemis lydia*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00276	*Plathemis lydia*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00277	*Plathemis lydia*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00278	*Plathemis lydia*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	
WRK-WS-00279	*Plathemis lydia*	M					unknown			
WRK-WS-00280	*Plathemis lydia*	M		USA	NJ	Passaic or Middlesex	Davidson Mills or Barbour pond		Aim High Students (RU-N)	
WRK-WS-00281	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00282	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00283	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00284	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00285	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00286	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00287	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00288	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00289	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00290	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00291	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00292	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00294	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00295	*Plathemis lydia*	M	7/12/2012	USA	NJ	Passaic	Garret Mtn. Reservation, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	
WRK-WS-00296	*Plathemis lydia*	M					unknown			
WRK-WS-01868	*Plathemis lydia*	M								
WRK-WS-01869	*Plathemis lydia*	M								
WRK-WS-01872	*Plathemis lydia*	M								
WRK-WS-02203	*Plathemis lydia*	M	6/17/2015	USA	NJ	morris	Sparta Twp off Edison Rd along powerline right-of-way	40.0635N, 74.5707W	WRK, R Pranter	
WRK-WS-00627	*Tholymis citrina*	M	6/12/2013	Guyana	Rupununi		Mobe Pond, Karanambo		DAG, O Ambrose, MW	
WRK-WS-00617	*Tramea carolina*	M	8/9/2013	USA	TX	Comal	River House, River Road, New Braunfels			
WRK-WS-02366	*Tramea carolina*	M	7/12/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	ru-N:WL:OdoD: 2013 01235
WRK-WS-02367	*Tramea lacerata*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1831	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01224
WRK-WS-02368	*Tramea lacerata*	F	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1832	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01223
WRK-WS-02379	*Tramea lacerata*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01229
WRK-WS-02380	*Tramea lacerata*	F	7/9/2013	USA	NJ	Hudson	Laurel Hill Park		Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01230
WRK-WS-02381	*Tramea lacerata*	F		USA	NJ	Essex	Branch Brook Park			RU-N:WL:OdoD: 2013 00304
WRK-WS-02382	*Tramea lacerata*	F	7/11/2013	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982° N, 74.0538° W		RU-N:WL:OdoD: 2013 01228
WRK-WS-02386	*Tramea lacerata*	F	9/23/2012	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982° N, 74.0538° W	WRK	RU-N:WL:OdoD: 2013 01227
WRK-WS-02369	*Tramea lacerata*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1833	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01220
WRK-WS-02370	*Tramea lacerata*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1834	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01218
WRK-WS-02371	*Tramea lacerata*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1835	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01217
WRK-WS-02372	*Tramea lacerata*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1836	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01219
WRK-WS-02373	*Tramea lacerata*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1837	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01222
WRK-WS-02374	*Tramea lacerata*	M	7/12/2012	USA	NJ	Passaic	Garret Mountain, Barbour Pond	40.8991,-74.1838	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01221
WRK-WS-02375	*Tramea lacerata*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01214
WRK-WS-02376	*Tramea lacerata*	M	7/18/2012	USA	NJ	Middlesex	Davidson Mills Pond Co. Park	40.4105,-74.4972	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01215
WRK-WS-02377	*Tramea lacerata*	M	7/23/2013	USA	NJ	Essex	Branch Brook Park			RU-N:WL:OdoD: 2013 01231
WRK-WS-02378	*Tramea lacerata*	M	7/23/2013	USA	NJ	Essex	Branch Brook Park			RU-N:WL:OdoD: 2013 01232
WRK-WS-02383	*Tramea lacerata*	M	7/16/2012	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982° N, 74.0538° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01225
WRK-WS-02384	*Tramea lacerata*	M	8/9/2012	USA	New York		Cranberry Lake Preserve			RU-N:WL:OdoD: 2013 01226
WRK-WS-02385	*Tramea lacerata*	M	7/19/2011	USA	NJ	Hudson	Liberty State Park, Jersey City	40.6982° N, 74.0538° W	Aim High Students (RU-N)	RU-N:WL:OdoD: 2013 01233
WRK-WS-02387	*Tramea lacerata*	M								RU-N:WL:OdoD: 2013 01234

WRK-WS-00629	*Tramea rustica*	M	6/6/2013	Guyana	Rupununi		CEIBA		Shaneeza, Sherry-Anne Ashanti, & Abigail (from CEIBA)	
WRK-WS-00630	*Tramea rustica*	M	6/21/2013	Guyana	Rupununi		Karanambo		MW, DAG, O Ambrose	
WRK-WS-00589	*Uracis imbuta*	M	8/19/2012	Guyana	Demerara-Mahaica		S.L. Highway			
WRK-WS-00590	*Uracis imbuta*	M	8/17/2012	Guyana	Demerara-Mahaica		CEIBA			
WRK-WS-00591	*Uracis imbuta*	M	8/17/2012	Guyana	Demerara-Mahaica		CEIBA			
WRK-WS-00592	*Uracis imbuta*	M	8/14/2012	Guyana	Demerara-Mahaica		CEIBA, 0915			
WRK-WS-01709	*Uracis ovipositrix*	F		Guyana	Kurupukari Crossing				DAG	IWO-004
WRK-WS-01710	*Uracis ovipositrix*	F		Guyana	Kurupukari Crossing				DAG	IWO-004
WRK-WS-01711	*Uracis ovipositrix*	M		Guyana	Rupununi				DAG	KBO-002
WRK-WS-01712	*Uracis ovipositrix*	M		Guyana	Rupununi				DAG	KBO-002
WRK-WS-01713	*Uracis ovipositrix*	M		Guyana	Kurupukari Crossing				DAG	IWO-007
WRK-WS-01716	*Uracis ovipositrix*	M		Guyana					DAG	unknown
WRK-WS-00085	*Zenithoptera viola*	F	7/31/2011	Guyana	Demerara-Mahaica		Guyana, CEIBA, path by field	5°29'57"N,58°13'07.23"W	I Biazzo	
WRK-WS-00593	*Zenithoptera viola*	M	8/17/2012	Guyana	Demerara-Mahaica		CEIBA			
WRK-WS-00594	*Zenithoptera viola*	M	8/18/2012	Guyana	Demerara-Mahaica		CEIBA			
WRK-WS-00595	*Zenithoptera viola*	M	8/19/2012	Guyana	Demerara-Mahaica		S.L. Highway			
WRK-WS-00596	*Zenithoptera viola*	M	8/19/2012	Guyana	Demerara-Mahaica		S.L. Highway			
WRK-WS-00597	*Zenithoptera viola*	M	8/14/2012	Guyana	Demerara-Mahaica		CEIBA			
WRK-WS-00598	*Zenithoptera viola*	M	8/14/2012	Guyana	Demerara-Mahaica		CEIBA, 0195			
WRK-WS-00632	*Zenithoptera viola*	M	1/5/2012	Guyana	Demerara-Mahaica		Splashmins, CEIBA		JLW, WRK, P Frandsen	
Anisoptera	**Macromiidae**									
WRK-WS-00801	*Didymops transversa*	M	5/17/2013	USA	NJ	Sussex	Stokes State Forest			RU-N:WL:OdoD: 2013 00364
WRK-WS-00802	*Didymops transversa*	M	5/17/2013	USA	NJ	Sussex	Stokes State Forest			RU-N:WL:OdoD: 2013 00373
WRK-WS-00653	*Macromia alleghaniensis*	M	7/12/1985	USA	NC	Moore	Carthage McLendon Creek		R D Cuyler	
WRK-WS-00466	*Macromia amphigena*	F	4/29/1994	Japan			Kochi, Nakamura		M Sugimura	
WRK-WS-00467	*Macromia amphigena*	M	8/13/1985	Japan			Hokkaido, Akan-cho		Kato	
WRK-WS-00154	*Macromia annulata*	F	7/13/2001	USA	TX	Edwards/Real	Nueces River, S Barksdate, HWY 55		KJ Tennessen	
WRK-WS-00841	*Macromia annulata*	F	8/9/2013	USA	TX	Comal	River House, New Braunfels	29.79101, -98.15204		RU-N:WL:OdoD: 2013 00281
WRK-WS-00650	*Macromia annulata*	M	7/12/2001	USA	TX	Uvalde	Nueces River, Park Chalk Bluff, off Hwy. 55		KJ Tennessen	
WRK-WS-00161	*Macromia aureozona*	M	7/1/1963	Congo	Moyen		Kelle Forest		Unknown, FL State Coll of Arthropods	
WRK-WS-00162	*Macromia bifasciata*	M	5/10/1982	Zambia			Luanshya, 4000'		RJ Murphy	
WRK-WS-00649	*Macromia daimoji*	F	8/1/1988	Japan			Aichi Pref. ; Wachihara, Azuri River		S Ugai	
WRK-WS-00465	*Macromia daimoji*	M	6/26/1992	Japan			Gifu, Misano, Mitaka-cho		K Fujimoto	
WRK-WS-00468	*Macromia illinoiensis*	F	6/15/2005	USA	TN	Cumberland	Daddys Creek, I-40		KJ Tennessen	
WRK-WS-00469	*Macromia illinoiensis*	F	6/29/1996	Canada	New Brunswick	Charlotte	St. Croix River, Hwy. 745		KJ Tennessen	
WRK-WS-00641	*Macromia illinoiensis*	F	8/1/1994	USA	NC	Edge combe	Tar River at access area, Rt 42, Old Sparta		R Duncan Cuyler	
WRK-WS-01397	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01398	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01400	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01401	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01402	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01403	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01404	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01406	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01733	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01736	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01737	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01738	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01743	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01744	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	unknown
WRK-WS-01746	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D3
WRK-WS-01747	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01749	*Macromia illinoiensis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-00065	*Macromia illinoiensis*	M	6/13/2012	USA	TX	Gonzalez	TX, Palmetto SP		WRK	
WRK-WS-00470	*Macromia illinoiensis*	M	6/29/1996	Canada	New Brunswick	Charlotte	St. Croix River, Hwy. 745		KJ Tennessen	
WRK-WS-00471	*Macromia illinoiensis*	M	7/10/2005	Canada	Ontario	Nipissing Dist.	Barron river, Squirrel Rapids, Algonquin Prov. Pk		KJ Tennessen	

WRK-WS-00472	*Macromia illinoiensis*	M	9/5/1993	USA	PA	Susquehanna	Susquehanna R. at Hallstead		T Donnelly	
WRK-WS-00473	*Macromia illinoiensis*	M	6/28/1993	USA	PA	Wayne	Delaware River Damascus		KJ Tennessen	
WRK-WS-00474	*Macromia illinoiensis*	M	6/9/2003	USA	TN	Lawrence	Bluewater Creek, Hwy. 227, E of Loretto		KJ Tennessen	
WRK-WS-00475	*Macromia illinoiensis*	M	6/6/2007	USA	TN	Polk	Conasauga River, near confluence w/ Jacks River		KJ Tennessen	
WRK-WS-00480	*Macromia illinoiensis*	M	7/22/1989	USA	NC	Durham	Durham , southwesten edge		R Duncan Cuyler	
WRK-WS-00481	*Macromia illinoiensis*	M	7/31/1986	USA	NC	Durham	Durham , southwesten edge		R Duncan Cuyler	
WRK-WS-00638	*Macromia illinoiensis*	M	8/12/1990	USA	NC	Lincoln	near Catawba River, Rt. 73		RD Cuyler	
WRK-WS-00639	*Macromia illinoiensis*	M	7/1/1986	USA	NC	Durham	Durham , southwesten edge		R Duncan Cuyler	
WRK-WS-00640	*Macromia illinoiensis*	M	8/24/1993	USA	NC	Duplin	Northeast Cape Fear River, RT. 41-50, Chinquapin		R Duncan Cuyler	
WRK-WS-01405	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01407	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01734	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01735	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01739	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01740	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01741	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01742	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01745	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01748	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01750	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-01751	*Macromia illinoiensis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	D2
WRK-WS-00476	*Macromia irata*	F	05/1981	India			Mysore State- Agumbe Ghat, Shimoga, Elev 2000		TRS Nathan	
WRK-WS-00478	*Macromia magnifica*	M	6/21/2003	USA	CA	Napa	Butts Creek; elev 243m	N38°41'59", W122° 27'6"	KJ Tennessen	
WRK-WS-00658	*Macromia magnifica*	M	6/28/1977	USA	CA	Fresno	Willow Creek at San Joaquin River		S W Dunkle	
WRK-WS-00659	*Macromia magnifica*	M	7/18/1993	USA	OR	Crook	South Fork, Crooked River ; 14 miles east, Post		R D Cuyler	
WRK-WS-00660	*Macromia magnifica*	M	6/23/1983	USA	WA	Walla Walla	Touchet River, Touchet Road 9 miles north of Touchet		Jerrell J Daigle	
WRK-WS-00463	*Macromia manchurica*	M	8/5/1982	Russia			Ussuri region, Anutshino	46° N, 134° E	G Petrovsky	
WRK-WS-00643	*Macromia margarita*	F	6/3/1977	USA	VA	Floyd	Little River at Rt. 615		B C Kondratieff, F L Carle	
WRK-WS-00647	*Macromia margarita*	F	7/31/1986	USA	AL	Lauderdale	Shoal Creek, Co. Hwy. 8, "Goose Shoals"		KJ Tennessen	
WRK-WS-00462	*Macromia margarita*	M	6/6/1999	USA	NC	Cleveland	Knob Creek, Rt. 10, east of Casar		RD Cuyler	
WRK-WS-00645	*Macromia margarita*	M	6/3/1994	USA	NC	Burke	Upper Creek, nr. Jct. Forest Rd. 982 & 197		KJ Tennessen	
WRK-WS-00646	*Macromia margarita*	M	6/14/1992	USA	TN	Leiws	Little Swan Creek, off Natchez Trace Parkway, near Meriwhether Lweis		R D Cuyler	
WRK-WS-00477	*Macromia melpomene*	M	3/1-4/4/1939				Araucaria Camp, Basin of Araucaria R., Netherlands New Guinea		LJ Toxopeus	
WRK-WS-00642	*Macromia monoceros*	M	12/6/1982				Chinteche Forest, 2,000 ft, Africa: Malawi		RJ Murphy	
WRK-WS-00644	*Macromia monoceros*	M	5/1/1984				Chinteche Forest, Chinteche, Afroca: Malawi		R J Murphy	
WRK-WS-00464	*Macromia moorei*	M	9/22/1978	India	UP		Bhimtal		Carl Cook	
WRK-WS-00648	*Macromia moorei*	M	5/21/1996	Thailand			Cieng Mai Prov.; Siriphum waterfall, nr Doi Inthanon	18°32.8'N 98°30.9'E	T Donnelly	
WRK-WS-00226	*Macromia onerata*	M	3/2/1985	Malawi			Mt. Dedza, evel 5500'		RJ Murphy	
WRK-WS-00153	*Macromia pacifica*	F	5/29/1990	USA	AR	Montgomery	Caddo River, Caddo Gap		KJ Tennessen	
WRK-WS-00155	*Macromia pacifica*	M	7/16/1986	USA	MO	Madison	Marble Creek, Mark Twain National Forest		KJ Tennessen	
WRK-WS-00156	*Macromia pacifica*	M	6/10/1978	USA	TX	McLennan	South Bosque River		Curtis WRKiams	
WRK-WS-00662	*Macromia pacifica*	M	5/19/1990	USA	AR	Montgomery	Caddo River, Caddo Gap		KJ Tennessen	
WRK-WS-00230	*Macromia pinratani*	M	5/28-6/1/96	Vietnam	Vinh Phu Province		Tam Dao, elev 900 m, waterfall	21° 27.4', 105° 38.6'	T Donnelly	
WRK-WS-00479	*Macromia rickeri*	F	6/29/1972	Canada	British Columbia	Vancauver Island	Nanaimo River, Wellington		Richard Guppy	
WRK-WS-00231	*Macromia sophia*	F	11/21/1982	Zambia			Shiwa Ngandv., elev 4500 ft		RJ Murphy	
WRK-WS-00669	*Macromia splendens*	M	7/2/1995	France			Herault., Genges		DAL Davies	
WRK-WS-00670	*Macromia splendens*	M	6/13/1995	Spain			Overense: Avion; along forest path, 2.51pm		A Cordero-Rivera	
WRK-WS-00671	*Macromia splendens*	M	7/5/1931	France			Lot Department, Lahors		K Morton	
WRK-WS-00663	*Macromia taeniolata*	M	5/24/1999	USA	AL	Bibb	Bibb County Lake, N of Centreville		KJ Tennessen	
WRK-WS-00664	*Macromia taeniolata*	M	8/18/1998	USA	GA	Bryan	Fort Stewart-Ogeechee River at landing 16, Training area C-16		D Stevenson	
WRK-WS-00665	*Macromia taeniolata*	M	10/26/1988	USA	FL	Putnam	Redwater Lake		H V Weems	
WRK-WS-00666	*Macromia taeniolata*	M	7/24/1998	USA	TN	Fayette	Wolf River, Bateman Rd.		KJ Tennessen	
WRK-WS-00667	*Macromia taeniolata*	M	8/1/1993	USA	TX	Bowie	North Shore, Sulphur River, Rt. 59, SW of Texarcana		R D Cuyler	
WRK-WS-00157	*Macromia tillyardi*	F	1/25/1997	Australia	Queensland		Barron River, Kuranda		DAL Davies	

WRK-WS-00158	*Macromia tillyardi*	M	1/5/1992	Australia	Queensland		Rossvale, 20 mi. S of Cooktown		DAL Davies	
WRK-WS-00225	*Macromia urania*	F	7/3/1994	Japan	Okinawa		Ishigaki Island		K Fujimoto	
WRK-WS-00668	*Macromia wabashensis*	F	8/22/1995	USA	TX	Caldwell	San Marcos River, Rt 80, 1 mi. S of Luling		R D Cuyler	
WRK-WS-00159	*Macromia wabashensis*	M	8/22/1995	USA	TX	Caldwell	San Marcos River, Rt 80, 1 mi. S of Luling		RD Cuyler	
WRK-WS-00160	*Macromia wabashensis*	M	8/22/1995	USA	TX	Caldwell	San Marcos River, Rt 80, 1 mi. S of Luling		RD Cuyler	
Anisoptera	**Petaluridae**									
WRK-WS-00836	*Tachopteryx thoreyi*	M	6/9/2014				Pandapas			RU-N:WL:OdoD: 2013 00127
WRK-WS-02327	*Tachopteryx thoreyi*	M	6/18/2012	USA	TX		South from National Forest	130*33.356'N, 95*39.104'		
WRK-WS-02328	*Tachopteryx thoreyi*	M					Huntsville State Park	30.6208N, 95.5347W	WRK	
Zygoptera	**Calopterygidae**									
WRK-WS-01331	*Calopteryx aequabilis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01337	*Calopteryx aequabilis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01341	*Calopteryx aequabilis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01342	*Calopteryx aequabilis*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01332	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01333	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01334	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01335	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01336	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01338	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01339	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01340	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01343	*Calopteryx aequabilis*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-00063	*Calopteryx maculata*	F	6/7/2012	USA	NJ	Essex	NJ, Eagle Rock Res.		WRK	
WRK-WS-02348	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00188
WRK-WS-02349	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00189
WRK-WS-02350	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00138
WRK-WS-02351	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00140
WRK-WS-02352	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00192
WRK-WS-02353	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00190
WRK-WS-02354	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00178
WRK-WS-02355	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00179
WRK-WS-02356	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00181
WRK-WS-02357	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00182
WRK-WS-02358	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00183
WRK-WS-02359	*Calopteryx maculata*	F	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00184
WRK-WS-02360	*Calopteryx maculata*	F	7/28/2014	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA/Along Raritan River	40.6919N, 74.8756	Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00481
WRK-WS-02336	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00175
WRK-WS-02337	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00176
WRK-WS-02338	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00172
WRK-WS-02339	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00173

WRK-WS-02340	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00445
WRK-WS-02341	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00446
WRK-WS-02342	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00201
WRK-WS-02343	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00139
WRK-WS-02344	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00145
WRK-WS-02345	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00146
WRK-WS-02346	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00147
WRK-WS-02347	*Calopteryx maculata*	M	7/16/2014	USA	NJ	Essex	South Mountain Reservation/Campbells'd Pond/Runway River	40.737N, 74.3057W	Aim High Students (RU-N)	Ru-N:WL:OdoD: 2015 00148
WRK-WS-02361	*Calopteryx maculata*	M	7/28/2014	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA/Along Raritan River	40.6919N, 74.8756	Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00480
WRK-WS-02362	*Calopteryx maculata*	M	7/28/2014	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA/Along Raritan River	40.6919N, 74.8756	Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00086
WRK-WS-02363	*Calopteryx maculata*	M	7/28/2014	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA/Along Raritan River	40.6919N, 74.8756	Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00087
WRK-WS-02364	*Calopteryx maculata*	M	7/28/2014	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA/Along Raritan River	40.6919N, 74.8756	Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00088
WRK-WS-02365	*Calopteryx maculata*	M	7/28/2014	USA	NJ	Hunterdon	Ken Lockwood Gorge WMA/Along Raritan River	40.6919N, 74.8756	Aim High Students (RU-N)	RU-N:WL:OdoD: 2015 00482
WRK-WS-01642	*Hetaerina caja*	M		Peru			Tarapoto		MSH	RU-N:WL:OdoD: 2014 01362; MSH-HET-222
WRK-WS-01658	*Hetaerina caja*	M		Peru			Tarapoto		MSH	RU-N:WL:OdoD: 2014 01314; MSH-HET-200
WRK-WS-01590	*Hetaerina capitalis*	F		Colombia					MSH	MSH-304
WRK-WS-01587	*Hetaerina capitalis*	M		Colombia					MSH	MSH-300
WRK-WS-01588	*Hetaerina capitalis*	M		Colombia					MSH	MSH-302
WRK-WS-01589	*Hetaerina capitalis*	M		Colombia					MSH	MSH-301
WRK-WS-01584	*Hetaerina duplex*	M		Colombia			Chirajara		MSH	MSH-305
WRK-WS-01585	*Hetaerina duplex*	M		Colombia			Chirajara		MSH	MSH-306
WRK-WS-01586	*Hetaerina duplex*	M		Colombia			Chirajara		MSH	MSH-307
WRK-WS-01315	*Hetaerina occisa*	F							MSH	MSH-HET-113
WRK-WS-01326	*Hetaerina occisa*	F							MSH	MSH-HETE-59
WRK-WS-01536	*Hetaerina occisa*	F		Colombia	Dagua	Alto Anchicaya			MSH	MSH-252
WRK-WS-01537	*Hetaerina occisa*	F		Colombia	Dagua	Alto Anchicaya			MSH	MSH-251
WRK-WS-01539	*Hetaerina occisa*	F		Colombia	Dagua	Alto Anchicaya			MSH	MSH-271
WRK-WS-01561	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-270
WRK-WS-01562	*Hetaerina occisa*	F							MSH	MSH-287
WRK-WS-01563	*Hetaerina occisa*	F							MSH	MSH-282
WRK-WS-01564	*Hetaerina occisa*	F							MSH	MSH-279
WRK-WS-01565	*Hetaerina occisa*	F							MSH	MSH-276
WRK-WS-01566	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-278
WRK-WS-01567	*Hetaerina occisa*	F							MSH	MSH-274
WRK-WS-01568	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-247
WRK-WS-01569	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-246
WRK-WS-01571	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-254
WRK-WS-01573	*Hetaerina occisa*	F							MSH	MSH-242
WRK-WS-01574	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-233
WRK-WS-01577	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-235
WRK-WS-01581	*Hetaerina occisa*	F							MSH	MSH-239
WRK-WS-01582	*Hetaerina occisa*	F							MSH	MSH-237
WRK-WS-01593	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-256
WRK-WS-01594	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-257
WRK-WS-01597	*Hetaerina occisa*	F		Colombia	Dagua				MSH	MSH-280
WRK-WS-01643	*Hetaerina occisa*	F		Peru			Tarapoto		MSH	RU-N:WL:OdoD: 2014 01337; MSH-HET-190
WRK-WS-01645	*Hetaerina occisa*	F		Peru			Tarapoto		MSH	RU-N:WL:OdoD: 2014 01338; MSH-HET-191
WRK-WS-01317	*Hetaerina occisa*	M							MSH	MSH-HET-62
WRK-WS-01318	*Hetaerina occisa*	M							MSH	MSH-HET-61
WRK-WS-01319	*Hetaerina occisa*	M							MSH	MSH-HET-97

WRK-WS-01320	*Hetaerina occisa*	M							MSH	MSH-HET-60
WRK-WS-01321	*Hetaerina occisa*	M							MSH	MSH-HET-93
WRK-WS-01325	*Hetaerina occisa*	M							MSH	MSH-HET-63
WRK-WS-01327	*Hetaerina occisa*	M							MSH	MSH-HET-99
WRK-WS-01328	*Hetaerina occisa*	M							MSH	MSH-HET-95
WRK-WS-01330	*Hetaerina occisa*	M							MSH	MSH-HET-64
WRK-WS-01467	*Hetaerina occisa*	M		Peru			MSH-HET-170		MSH	
WRK-WS-01468	*Hetaerina occisa*	M		Peru			MSH-HET-106		MSH	
WRK-WS-01469	*Hetaerina occisa*	M					MSH-HET-168		MSH	
WRK-WS-01470	*Hetaerina occisa*	M					MSH-HET-171		MSH	
WRK-WS-01471	*Hetaerina occisa*	M					MSH-HET-169		MSH	
WRK-WS-01534	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-264
WRK-WS-01535	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-265
WRK-WS-01538	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-290
WRK-WS-01543	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-269
WRK-WS-01544	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-268
WRK-WS-01545	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-267
WRK-WS-01546	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-266
WRK-WS-01547	*Hetaerina occisa*	M		Colombia	Dagua	Alto Anchicaya			MSH	MSH-289
WRK-WS-01548	*Hetaerina occisa*	M		Colombia	Pance				MSH	MSH-288
WRK-WS-01549	*Hetaerina occisa*	M							MSH	MSH-287
WRK-WS-01550	*Hetaerina occisa*	M		Colombia	Pance				MSH	MSH-286
WRK-WS-01551	*Hetaerina occisa*	M		Colombia	Pance				MSH	MSH-285
WRK-WS-01552	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-283
WRK-WS-01553	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-275
WRK-WS-01554	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-272
WRK-WS-01555	*Hetaerina occisa*	M							MSH	MSH-273
WRK-WS-01556	*Hetaerina occisa*	M							MSH	MSH-277
WRK-WS-01557	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-245
WRK-WS-01558	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-248
WRK-WS-01559	*Hetaerina occisa*	M							MSH	MSH-243
WRK-WS-01560	*Hetaerina occisa*	M							MSH	MSH-244
WRK-WS-01570	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-253
WRK-WS-01572	*Hetaerina occisa*	M							MSH	MSH-238
WRK-WS-01575	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-232
WRK-WS-01576	*Hetaerina occisa*	M							MSH	MSH-234
WRK-WS-01578	*Hetaerina occisa*	M							MSH	MSH-236
WRK-WS-01579	*Hetaerina occisa*	M							MSH	MSH-241
WRK-WS-01580	*Hetaerina occisa*	M							MSH	MSH-240
WRK-WS-01583	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-249
WRK-WS-01595	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-259
WRK-WS-01596	*Hetaerina occisa*	M		Colombia	Dagua				MSH	MSH-258
WRK-WS-01654	*Hetaerina occisa*	M		Peru			Tarapoto		MSH	RU-N:WL:OdoD: 2014 01326; MSH-HET-172
WRK-WS-01655	*Hetaerina occisa*	M		Peru			Tarapoto		MSH	RU-N:WL:OdoD: 2014 01329; MSH-HET-175
WRK-WS-01656	*Hetaerina occisa*	M		Peru			Tarapoto		MSH	RU-N:WL:OdoD: 2014 01316; MSH-HET-187
WRK-WS-01657	*Hetaerina occisa*	M		Peru			Pozuzo		MSH	RU-N:WL:OdoD: 2014 01317; MSH-HET-39
WRK-WS-01669	*Mnesarete metallica*	M							MSH	MIT-130
WRK-WS-01671	*Mnesarete metallica*	M							MSH	MIT-127
WRK-WS-01675	*Mnesarete metallica*	M							MSH	MIT-125
Zygoptera	**Coenagrionidae**									
WRK-WS-02171	*Argia apicalis*	F	6/17/2015	USA	NJ	Morris	Weldon Brook Lake at Rockaway River WMA	41.0065 N 74.5882W	WRK, R Pranter	
Zygoptera	**Euphaeidae**									
WRK-WS-00813	*Dysphaea ethela*	M		India			Sita Mata Wildlife Sanctuary; Pratapgarh, Rajasthan		Manpreet	RU-N:WL:OdoD: 2013 00394
Zygoptera	**Lestidae**									
WRK-WS-01411	*Lestes dryas*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01412	*Lestes dryas*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01413	*Lestes dryas*	F	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	

WRK-WS-01408	*Lestes dryas*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01409	*Lestes dryas*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
WRK-WS-01410	*Lestes dryas*	M	6/13-15/2014	USA	WI	Rusk	Ladysmith		MSH, WRK	
Zygoptera	**Polythoridae**									
WRK-WS-01492	*Chalcopteryx rutilans*	M	21/11/91	Brazil	Rondonia				MJWestfall	FSCA11
WRK-WS-01496	*Chalcopteryx rutilans*	M	11/11/1990	Brazil	Rondonia	Cacaulandia			TDonnely	FSCA204
WRK-WS-01497	*Chalcopteryx rutilans*	M	11/11/1990	Brazil	Rondonia	Cacaulandia			TCEmmel	FSCA51
WRK-WS-01691	*Chalcopteryx rutilans*	M							MSH	MIT-52
WRK-WS-01524	*Chalcopteryx scintillans*	F	8/2/1979	Brazil	Amazonas St		Igarape		HMSavage	FSCA89
WRK-WS-01523	*Chalcopteryx scintillans*	M	11/7/1974	Peru	Loreto		near Mishana		PAHolzbauer	FSCA103
WRK-WS-01532	*Cora avrea*	M	10/5/2008	Colombia	Dagua		Alto Anchicaya		Fabio Sarria	Py002
WRK-WS-01491	*Cora chirripa*	M	6/24/1967	Costa Rica	Alajuela		Varablanca		MJWestfall	FSCA107
WRK-WS-01512	*Cora chirripa*	M	6/24/1967	Costa Rica	Alajuela		streams and waterfalls		MJ, DN Westfall	FSCA106
WRK-WS-01519	*Cora chirripa*	M	3/26/2006	Costa Rica	San Jose		small river		Bill Mauffray	FSCA381
WRK-WS-01529	*Cora chirripa*	M	3/27/2006	Costa Rica	San Jose		Bosque del Tolomuco		FC Sibley	FSCA380
WRK-WS-01518	*Cora cyane*	M	9/29/1989	Venezuela	Aragua State		Guatopo		JSalcedo & L Jaspe	FSCA123
WRK-WS-01520	*Cora cyane*	M	10/15/1974	Venezuela	Trujillo		Cuicas		JTeran & MGelvez	FSCA126
WRK-WS-01508	*Cora inca*	F	11/20/1997	Ecuador	Napo		Baeza		Bill Mauffray	FSCA 140
WRK-WS-01506	*Cora inca*	M	9/18/2005	Ecuador	Morona-Santiago		Macas		Bill Mauffray	FSCA 144
WRK-WS-01507	*Cora inca*	M	11/20/1997	Ecuador	Napo		Baeza		Bill Mauffray	FSCA 138
WRK-WS-01504	*Cora irene*	F	11/19/1999	Bolivia	Cochabamba		E of Rio Carmen		Bill Mauffray	FSCA146
WRK-WS-01490	*Cora irene*	M	5/25/1989	Bolivia	Sud Yungas		Chulumani		TC Emmel	FSCA155
WRK-WS-01503	*Cora irene*	M	5/25/1989	Bolivia	Dept La Paz		Sud Yungas		TC Emmer	FSCA 156
WRK-WS-01505	*Cora irene*	M	11/19/1999	Bolivia	Cochabamba		E of Rio Carmen		Bill Mauffray	FSCA145
WRK-WS-01488	*Cora jocosa*	M	11/11/1997	Ecuador	Pastaza		Puyo		Bill Mauffray	FSCA160
WRK-WS-01489	*Cora marina*	M	07/145/92	Mexico	Veracruz		Laguna escondida		KJ Tennessen	FSCA162
WRK-WS-01494	*Cora marina*	M	7/23/1983	Belize	Cayo District		Mountain Pine Ridge		TDonnely	FSCA203
WRK-WS-01495	*Cora marina*	M	7/24/1983	Belize	Cayo District		Mountain Pine Ridge		TDonnely	FSCA203
WRK-WS-01501	*Cora marina*	M	7/23/1990	Guatemala	El Progreso		Finca La Cajeta		TDonnelly	FSCA226
WRK-WS-01502	*Cora marina*	M	7/15/1992	Mexico	Los Tuxlos		Laguna escondida		WF Mauffray	FSCA167
WRK-WS-01509	*Cora marina*	M	8/13/1976	Honduras	Atlantida		El Naranjo		AJDonelly	FSCA 250
WRK-WS-01514	*Cora notoxantha*	M	4/22/1988	Costa Rica	Colon		El Rodeo		C Esquivel	FSCA361
WRK-WS-01513	*Cora semiopaca*	M	3/15/2006	Costa Rica	Puntarenas		Coto Brus Canton		FC Sibley	FSCA374
WRK-WS-01515	*Cora semiopaca*	M	3/19/2006	Costa Rica	Puntarenas		Coto Brus Canton		FC Sibley	FSCA372
WRK-WS-01526	*Euthore fasciata*	M	7/26/1989	Venezuela	Merida		La Azulita		TDonnelly	FSCA394
WRK-WS-01527	*Euthore fasciata*	M	7/26/1989	Venezuela	Merida		La Azulita		TDonnelly	FSCA394
WRK-WS-01522	*Euthore merdiana*	M	3/21/1981	Venezuela	State of Lara		via Yacambu		JMOsorio	FSCA415
WRK-WS-01493	*Euthore meridana*	M	3/21/1981	Venezuela	Sta FE		Lara		JMOsorio	FSCA409
WRK-WS-01516	*Miocora peraltica*	M	2/4/1971	Panama	Cerro Azul		Cerro jefe		CollES Morton & Donelly	FSCA 430
WRK-WS-01517	*Miocora peraltica*	M	2/4/1971	Panama	Cerro Azul		Cerro jefe		CollES Morton & Donelly	FSCA 430
WRK-WS-01525	*Miocora peraltica*	M	5/23/1970	Panama	Panama		Cerro Azul		ESMorton	FSCA429
WRK-WS-01521	*Miocora subapicalis*	F	8/23/1979	Colombia	Choco		Quiboo		MATidwell	FSCA440
WRK-WS-01475	*Polythore aurora*	M	3/31/1998	Peru	Loreto		Mishana		MJWestfall	FSCA469
WRK-WS-01472	*Polythore beata*	M	7/16/1990	Peru	Napo river				W Dunkle collection	FSCA 493
WRK-WS-01528	*Polythore beata*	M	7/4/1905						MS Herrera	Py006
WRK-WS-01466	*Polythore boliviana*	F	5/21/1989	Bolivia	La Paz		Sud Yungas		TEmmel	FSCA 505
WRK-WS-01541	*Polythore boliviana*	F	5/21/1989	Bolivia	Puente Villa		Sud Yungas			
WRK-WS-01465	*Polythore boliviana*	M	5/21/1989	Bolivia	La Paz		Sud Yungas		TEmmel	FSCA 505
WRK-WS-01479	*Polythore boliviana*	M	11/17/1999	Bolivia	Cochabamba		Villa Tunari	17.02.513S 65.39.232W	Bill Mauffray	FSCA548
WRK-WS-01542	*Polythore boliviana*	M	5/21/1989	Bolivia	Puente Villa		Sud Yungas			
WRK-WS-00687	*Polythore concinna*	F	11/15/2010	Ecuador	Napo		River Napo, Perto Ahuano		A Cordero-Rivera	ACR-00002
WRK-WS-01450	*Polythore concinna*	F	7/20/1996	Ecuador	Napo	Loreto			KJ Tennessen	FSCA564
WRK-WS-01464	*Polythore concinna*	F		Ecuador	Morona-Santiago			01° 57.0's, 77° 51.5'W 800M	KJ Tennessen	FSCA567
WRK-WS-02391	*Polythore concinna*	F		Ecuador						MSH-PC-286
WRK-WS-02395	*Polythore concinna*	F		Ecuador						MSH-PC-314
WRK-WS-02398	*Polythore concinna*	F		Ecuador						MSH-PC-321
WRK-WS-00692	*Polythore concinna*	M	11/16/2010	Ecuador	Napo		Misicocha, Puerto Ahuano		A Cordero-Rivera	ACR-00019
WRK-WS-00704	*Polythore concinna*	M	11/6/2010	Ecuador	Napo		Misicocha, Puerto Ahuano		A Cordero-Rivera	ACR-00013

WRK-WS-00705	*Polythore concinna*	M	11/16/2010	Ecuador	Napo		Misicocha, Puerto Ahuano		A Cordero-Rivera	ACR-00014
WRK-WS-00706	*Polythore concinna*	M	5/14/2011	Ecuador	Napo		Misicocha, Puerto Ahuano		A Cordero-Rivera	ACR-00044
WRK-WS-01446	*Polythore concinna*	M	5/14/2009	Ecuador	Sucumbios	Province		S00° 09' 59'' W076° 41' 30"	KJ Tennessen	FSCA 923 W/OUT database
WRK-WS-01448	*Polythore concinna*	M	9/11/1997	Ecuador	Morona-Santiago	Rio Pastaza			KJ Tennessen	FSCA565
WRK-WS-01453	*Polythore concinna*	M	1984 year	Ecuador	Tungurahua	Banos			T Emmel	FSCA584
WRK-WS-01454	*Polythore concinna*	M	14/05/09	Ecuador	Sucumbios	Shushufindi		S00° 09' 59'' W076° 41' 30"	KJ Tennessen	FSCA924
WRK-WS-01461	*Polythore concinna*	M	11/14/1997	Ecuador	Napo	Loreto			Bill Mauffray	FSCA559
WRK-WS-01462	*Polythore concinna*	M	12/14/2005	Ecuador	Napo	Pastaza			Bill Mauffray	FSCA578
WRK-WS-01463	*Polythore concinna*	M		Ecuador	Morona-Santiago			01° 57.0's, 77° 51.5'W 800M	KJ Tennessen	FSCA567
WRK-WS-01473	*Polythore concinna*	M	11/6/2001	Ecuador	Napo river				Bill Mauffray	FSCA 580
WRK-WS-01474	*Polythore concinna*	M	10/9/2009	Ecuador	Pastaza	N of Puyo		S01° 22' 33'' W077° 52' 02"	KJ Tennessen	FSCA926
WRK-WS-02392	*Polythore concinna*	M		Ecuador						MSH-PC-308
WRK-WS-02393	*Polythore concinna*	M		Ecuador						MSH-PC-309
WRK-WS-02394	*Polythore concinna*	M		Ecuador						MSH-PC-310
WRK-WS-02396	*Polythore concinna*	M		Ecuador						MSH-PC-315
WRK-WS-02397	*Polythore concinna*	M		Ecuador						MSH-PC-317
WRK-WS-00680	*Polythore derivata*	F	12/11/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00620; T112
WRK-WS-00690	*Polythore derivata*	F	11/16/2010	Ecuador	Napo		Misicocha, Puerto Ahuano		A Cordero-Rivera	ACR-0018
WRK-WS-00691	*Polythore derivata*	F	12/7/2012	Ecuador	Orellana		Centerdo Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00547
WRK-WS-01197	*Polythore derivata*	F								RU-N:WL:OdoD:2014 01351
WRK-WS-01214	*Polythore derivata*	F								RU-N:WL:OdoD:2014 01355
WRK-WS-01422	*Polythore derivata*	F	9/16/2005	Ecuador	Morona-Santiago	Macas	Coll: Bill Murray		Bill Mauffray	FSCA647
WRK-WS-01435	*Polythore derivata*	F	10/12/2009	Ecuador	Orellana	Loreto	K.J. Tennessen	S00° 37' 18" W077° 15' 36"	KJ Tennessen	FSCA927
WRK-WS-01436	*Polythore derivata*	F	9/20/2005	Ecuador	Pastaza	Mera	Bill Mauffray	S1° 29'' 31"W78°4' 21"	Bill Mauffray	FSCA932 w/oDB
WRK-WS-01486	*Polythore derivata*	F	9/17/2005	Ecuador	Morona-Santiago	Rio Pasanac			Bill Mauffray	FSCA660
WRK-WS-00673	*Polythore derivata*	M	11/15/2010	Ecuador	Napo		Rio Napo		A Cordero-Rivera	ACR-00004
WRK-WS-01182	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01347
WRK-WS-01183	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01345
WRK-WS-01184	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01346
WRK-WS-01193	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01358
WRK-WS-01194	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01359
WRK-WS-01195	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01357
WRK-WS-01196	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01352
WRK-WS-01198	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01350
WRK-WS-01199	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01349
WRK-WS-01200	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01348
WRK-WS-01201	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01343
WRK-WS-01202	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01342
WRK-WS-01203	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01354
WRK-WS-01204	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01353
WRK-WS-01205	*Polythore derivata*	M								RU-N:WL:OdoD:2014 01399
WRK-WS-01215	*Polythore derivata*	M								
WRK-WS-01216	*Polythore derivata*	M								
WRK-WS-01217	*Polythore derivata*	M								
WRK-WS-01266	*Polythore derivata*	M							MSH	MSH-PD-130
WRK-WS-01308	*Polythore derivata*	M							MSH	MSH-PD-225
WRK-WS-01309	*Polythore derivata*	M							MSH	MSH-PD-236
WRK-WS-01310	*Polythore derivata*	M							MSH	MSH-PD-231
WRK-WS-01311	*Polythore derivata*	M							MSH	MSH-PD-229
WRK-WS-01416	*Polythore derivata*	M	10/12/2009	Ecuador	Orellana	Loreto	Collection of K.J. Tennessen	S00°37'18"W077°15'36";elev. 1200 ft	KJ Tennessen	FSCA928 w/out DB
WRK-WS-01421	*Polythore derivata*	M	18/11/80	Ecuador	Napo	Limoncocha	Coll. by M.J. Westfall, Jr.		MJWestfall	FSCA619
WRK-WS-01423	*Polythore derivata*	M	9/16/2005	Ecuador	Morona-Santiago	Macas	Coll: Bill Murray		Bill Mauffray	FSCA647
WRK-WS-01424	*Polythore derivata*	M	14/11/97	Ecuador	Napo	Loreto	J.Tennessen	00° 37.1'S, 77° 17.7'W	KJ Tennessen	FSCA646
WRK-WS-01432	*Polythore derivata*	M	11/9/1997	Ecuador	Pastaza	Macas & Puyo	K.J. Tennessen	01° 54.0'S, 77° 48.2'W	KJ Tennessen	FSCA933
WRK-WS-01433	*Polythore derivata*	M	9/20/2005	Ecuador	Pastaza	"Los Copales"	K.J. Tennessen	78° 4'21"W	KJ Tennessen	FSCA 931 w/wot DB
WRK-WS-01434	*Polythore derivata*	M	5/16/2009	Ecuador	Orellana	Reserva Rio Bigal	K.J. Tennessen		KJ Tennessen	FSCA929w/outDB
WRK-WS-01437	*Polythore derivata*	M	9/21/2005	Ecuador	Pastaza	Mera	Bill Mauffray	S1° 29'' 31"W78°4' 21"	Bill Mauffray	FSCA932 w/oDB

WRK-WS-01445	*Polythore derivata*	M	7/18/1996	Ecuador	Napo	Yasuni			KJ Tennessen	FSCA645
WRK-WS-01449	*Polythore derivata*	M	12/10/2009	Ecuador	Orellana	Loreto		S00° 37' 18" W077° 15' 36"	KJ Tennessen	FSCA930W/ODB
WRK-WS-01482	*Polythore derivata*	M	11/8/2001	Ecuador	Tungurahua	Banos			TDonnely	FSCA664
WRK-WS-01483	*Polythore derivata*	M	5/1/2004	Ecuador	Sucumbios	San rafael		W 77 35' 09" S00 06' 03"	S Ribadendra	FSCA663
WRK-WS-01484	*Polythore derivata*	M	9/20/2005	Ecuador	Pastaza	Los copales		1° 29' 31" S° 78° 4' 21"w	KJ Tennessen	FSCA661
WRK-WS-01485	*Polythore derivata*	M	9/16/2005	Ecuador	Morona-Santiago	Rio Pasanac			Bill Mauffray	FSCA659
WRK-WS-00693	*Polythore gigantea*	F	5/14/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00244
WRK-WS-00694	*Polythore gigantea*	F	5/14/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00243
WRK-WS-00695	*Polythore gigantea*	F	5/14/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00245
WRK-WS-00696	*Polythore gigantea*	F	5/14/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00242
WRK-WS-00702	*Polythore gigantea*	F	5/14/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00246
WRK-WS-00703	*Polythore gigantea*	F	5/14/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00247
WRK-WS-00697	*Polythore gigantea*	M	5/7/2011	Ecuador	Pichincha		Rio Santa Rosa, Maquipucana		A Cordero-Rivera	ACR-00250
WRK-WS-00698	*Polythore gigantea*	M	5/14/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00253
WRK-WS-00699	*Polythore gigantea*	M	5/15/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00254
WRK-WS-00700	*Polythore gigantea*	M	5/7/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00249
WRK-WS-00701	*Polythore gigantea*	M	5/15/2011	Ecuador	Pichincha		Mindo		A Cordero-Rivera	ACR-00248
WRK-WS-01476	*Polythore gigantea*	M	5/13/1988	Ecuador	Sto.Domingo				TC Emmel	FSCA734
WRK-WS-01478	*Polythore gigantea*	M	2/15/1997	Ecuador	Cotopaxi	Pampas			Elicio Tapia	FSCA733
WRK-WS-02401	*Polythore gigantea*	M		Ecuador						MSH-PG-246D
WRK-WS-02402	*Polythore gigantea*	M		Ecuador						MSH-PG-246
WRK-WS-02403	*Polythore gigantea*	M		Ecuador						MSH-PG-252
WRK-WS-02404	*Polythore gigantea*	M		Ecuador						MSH-PG-253
WRK-WS-02405	*Polythore gigantea*	M		Ecuador						MSH-PG-254
WRK-WS-02406	*Polythore gigantea*	M		Ecuador						MSH-PG-255
WRK-WS-01477	*Polythore manua*	M	9/23/1989	Peru	Manu	Madre de Dios		11° 56' S:'71° 18' W	Jon Gelhaus	FSCA743
WRK-WS-01540	*Polythore manua*	M	9/19/1989	Peru	Manu	Pakitza			MSH	
WRK-WS-00672	*Polythore mutata*	F	12/7/2012	Ecuador	Orellana		Sendero Chorongo		A Cordero-Rivera, MSH	ACR-00542; T49
WRK-WS-00676	*Polythore mutata*	F	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00538; T45
WRK-WS-00679	*Polythore mutata*	F	12/11/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00619; T111
WRK-WS-00681	*Polythore mutata*	F	12/12/2012	Ecuador	Orellana		tiputini		A Cordero-Rivera, MSH	ACR-00622; T118
WRK-WS-00686	*Polythore mutata*	F	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00544; T51
WRK-WS-00707	*Polythore mutata*	F	6/23/2013	Ecuador	Orellana		Quebrada en Guacamayo, Tiputini		A Cordero-Rivera	ACR-00441
WRK-WS-00674	*Polythore mutata*	M	12/4/2012	Ecuador	Orellana		Quebrada Harpia		A Cordero-Rivera, MSH	ACR-00478; T2
WRK-WS-00675	*Polythore mutata*	M	12/6/2012	Ecuador	Orellana		Sendero Harpia, Tiputini		A Cordero-Rivera, MSH	ACR-00529; T37
WRK-WS-00677	*Polythore mutata*	M	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00539; T46
WRK-WS-00678	*Polythore mutata*	M	12/9/2012	Ecuador	Orellana		Claro en Quebrada, Tiputini		A Cordero-Rivera, MSH	ACR-00577; T78
WRK-WS-00682	*Polythore mutata*	M	12/12/2012	Ecuador	Orellana		Riputini		A Cordero-Rivera, MSH	ACR-00623; T119
WRK-WS-00683	*Polythore mutata*	M	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00546; T53
WRK-WS-00684	*Polythore mutata*	M	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00545; T52
WRK-WS-00685	*Polythore mutata*	M	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00541; T48
WRK-WS-00688	*Polythore mutata*	M	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00540; T47
WRK-WS-00689	*Polythore mutata*	M	12/7/2012	Ecuador	Orellana		Sendero Chorongo, Tiputini		A Cordero-Rivera, MSH	ACR-00543; T50
WRK-WS-01418	*Polythore mutata*	M	12/10/1988	Ecuador	Napo	La Selva Coca	International Odonata Research Institute		SWDunkle	FSCA786
WRK-WS-01430	*Polythore mutata*	M	5/14/2009	Ecuador	Sucumbios	Shushufindi	K.J. Tennessen	S00°09' 59" W076° 41' 30"	KJ Tennessen	FSCA936
WRK-WS-01431	*Polythore mutata*	M	25/11/97	Ecuador	Napo	La Selva lodge	J.W.Donnelly	00 ° 29.9' S 76° 22.4'W	TWDonnelly	FSCA805
WRK-WS-01480	*Polythore mutata*	M	5/12/2009	Ecuador	Sucumbios	Shushufindi			KJ Tennessen	FSCA935
WRK-WS-00778	*Polythore neopicta*	F	10/3/2013	Peru			Pozuzo	9 54.1720, -75031.750	MSH	MSH-PN-125
WRK-WS-01234	*Polythore neopicta*	F							MSH	MSH-PN-55
WRK-WS-01237	*Polythore neopicta*	F							MSH	MSH-PN-15
WRK-WS-01259	*Polythore neopicta*	F							MSH	MSH-PN-107
WRK-WS-01263	*Polythore neopicta*	F							MSH	MSH-PN-56
WRK-WS-01286	*Polythore neopicta*	F							MSH	MSH-PT?-183
WRK-WS-01297	*Polythore neopicta*	F							MSH	MSH-PT?-180
WRK-WS-01420	*Polythore neopicta*	F	18/11/97	Ecuador	Napo	Loreto	Ex Bill Murray Collection		Bill Mauffray	FSCA 806
WRK-WS-00770	*Polythore neopicta*	M	9/28/2013	Peru			Pozuzo	9.917765, -75.52699	MSH	MSH-PN-40
WRK-WS-00771	*Polythore neopicta*	M	9/28/2013	Peru			Pozuzo	9.917765, -75.52699	MSH	MSH-PN-41
WRK-WS-00772	*Polythore neopicta*	M	9/28/2013	Peru			Pozuzo	9.917765, -75.52699	MSH	MSH-PN-42

WRK-WS-01206	*Polythore neopicta*	M							RU-N:WL:OdoD:2014 01400
WRK-WS-01212	*Polythore neopicta*	M							RU-N:WL:OdoD:2014 01398
WRK-WS-01218	*Polythore neopicta*	M						MSH	MSH-PN-126
WRK-WS-01220	*Polythore neopicta*	M						MSH	MSH-PN-44
WRK-WS-01221	*Polythore neopicta*	M						MSH	MSH-PN-46
WRK-WS-01222	*Polythore neopicta*	M						MSH	MSH-PN-45
WRK-WS-01223	*Polythore neopicta*	M						MSH	MSH-PN-36
WRK-WS-01224	*Polythore neopicta*	M						MSH	MSH-PN-53
WRK-WS-01225	*Polythore neopicta*	M						MSH	MSH-PN-48
WRK-WS-01226	*Polythore neopicta*	M						MSH	MSH-PN-67
WRK-WS-01227	*Polythore neopicta*	M						MSH	MSH-PN-14
WRK-WS-01228	*Polythore neopicta*	M						MSH	MSH-PN-35
WRK-WS-01229	*Polythore neopicta*	M						MSH	MSH-PN-51
WRK-WS-01230	*Polythore neopicta*	M						MSH	MSH-PN-37
WRK-WS-01231	*Polythore neopicta*	M						MSH	MSH-PN-114
WRK-WS-01232	*Polythore neopicta*	M						MSH	MSH--PN-127
WRK-WS-01233	*Polythore neopicta*	M						MSH	MSH-PN-21
WRK-WS-01235	*Polythore neopicta*	M						MSH	MSH-PN-65
WRK-WS-01236	*Polythore neopicta*	M						MSH	MSH-PN-34
WRK-WS-01238	*Polythore neopicta*	M						MSH	MSH-PN-38
WRK-WS-01242	*Polythore neopicta*	M						MSH	MSH-PN-20
WRK-WS-01244	*Polythore neopicta*	M						MSH	MSH-PN-18
WRK-WS-01245	*Polythore neopicta*	M						MSH	MSH-PN-66
WRK-WS-01247	*Polythore neopicta*	M						MSH	MSH-PN-22
WRK-WS-01249	*Polythore neopicta*	M						MSH	MSH-PN-33
WRK-WS-01250	*Polythore neopicta*	M						MSH	MSH-PN-68
WRK-WS-01251	*Polythore neopicta*	M						MSH	MSH-PN-54
WRK-WS-01252	*Polythore neopicta*	M						MSH	MSH-PN-57
WRK-WS-01253	*Polythore neopicta*	M						MSH	MSH-PN-115
WRK-WS-01255	*Polythore neopicta*	M						MSH	MSH-PN-117
WRK-WS-01256	*Polythore neopicta*	M						MSH	MSH-PN-11
WRK-WS-01258	*Polythore neopicta*	M						MSH	MSH-PN-108
WRK-WS-01260	*Polythore neopicta*	M						MSH	MSH-PN-50
WRK-WS-01261	*Polythore neopicta*	M						MSH	MSH-PN-43
WRK-WS-01262	*Polythore neopicta*	M						MSH	MSH-PN-49
WRK-WS-01264	*Polythore neopicta*	M						MSH	MSH-PN-47
WRK-WS-01271	*Polythore neopicta*	M						MSH	MSH-PN-52
WRK-WS-01287	*Polythore neopicta*	M						MSH	MSH-PE-16
WRK-WS-01304	*Polythore neopicta*	M						MSH	MAH-RNA-6
WRK-WS-01419	*Polythore neopicta*	M	7/11/1997	Ecuador	Morona-Santiago		Ex Bill Murray Collection	Bill Mauffray	FSCA810
WRK-WS-01426	*Polythore neopicta*	M	6/21/1985	Peru	Huanuco	Tingo Maria	T. Emmel	T Emmel	FSCA935
WRK-WS-01444	*Polythore neopicta*	M	6/21/1985	Peru	Huanuco	Tingo Maria		T Emmel	FSCA934
WRK-WS-00722	*Polythore ornata*	F	9/30/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-01; P-29
WRK-WS-00728	*Polythore ornata*	F	9/30/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-02; P-28
WRK-WS-00729	*Polythore ornata*	F	10/1/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-02; P-28
WRK-WS-00730	*Polythore ornata*	F	10/2/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-02; P-28
WRK-WS-00734	*Polythore ornata*	F	9/30/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-03; P-33
WRK-WS-00736	*Polythore ornata*	F	9/30/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-02
WRK-WS-00737	*Polythore ornata*	F	9/30/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-02
WRK-WS-00739	*Polythore ornata*	F	9/30/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-04; P-37
WRK-WS-00742	*Polythore ornata*	F	9/30/2008	Peru			Pampa Hermoza, San Ramon	MSH	PMH-01
WRK-WS-01265	*Polythore ornata*	F						MSH	MSH-PO-131
WRK-WS-01273	*Polythore ornata*	F						MSH	msh-po!-129
WRK-WS-01276	*Polythore ornata*	F						MSH	MSH-PO-143
WRK-WS-01284	*Polythore ornata*	F						MSH	MSH-PO-142
WRK-WS-01285	*Polythore ornata*	F						MSH	MSH-PO-160
WRK-WS-01300	*Polythore ornata*	F						MSH	MSH-PO-146
WRK-WS-01313	*Polythore ornata*	F						MSH	MSH-PO-135

WRK-WS-01314	*Polythore ornata*	F							MSH	MSH-PO-136
WRK-WS-00721	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-01; P-29
WRK-WS-00723	*Polythore ornata*	M	10/1/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-03; P-34
WRK-WS-00724	*Polythore ornata*	M	10/2/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-03; P-34
WRK-WS-00725	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-02; P-23
WRK-WS-00726	*Polythore ornata*	M	10/1/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-02; P-23
WRK-WS-00727	*Polythore ornata*	M	10/2/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-02; P-23
WRK-WS-00731	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-02; P-27
WRK-WS-00732	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-02; P-27
WRK-WS-00733	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-02; P-27
WRK-WS-00735	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-03; P-33
WRK-WS-00738	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-04; P-37
WRK-WS-00740	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-03
WRK-WS-00741	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	PMH-03; P-36
WRK-WS-00757	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	P-35; PMH-03
WRK-WS-00758	*Polythore ornata*	M	9/30/2008	Peru			Pampa Hermoza, San Ramon		MSH	P-35; PMH-03
WRK-WS-01267	*Polythore ornata*	M							MSH	MSH-PO-158
WRK-WS-01268	*Polythore ornata*	M							MSH	MSH-PO-159
WRK-WS-01269	*Polythore ornata*	M							MSH	MSH-PO-141
WRK-WS-01270	*Polythore ornata*	M							MSH	MSH-PO-132
WRK-WS-01272	*Polythore ornata*	M							MSH	MSH-PO-164
WRK-WS-01274	*Polythore ornata*	M							MSH	MSH-PO-165
WRK-WS-01275	*Polythore ornata*	M							MSH	MSH-PO-145
WRK-WS-01277	*Polythore ornata*	M							MSH	MSH-PO-156
WRK-WS-01278	*Polythore ornata*	M							MSH	MSH-PO-162
WRK-WS-01279	*Polythore ornata*	M							MSH	MSH-PO-157
WRK-WS-01280	*Polythore ornata*	M							MSH	MSH-PO-163
WRK-WS-01281	*Polythore ornata*	M							MSH	MSH-PO-133
WRK-WS-01282	*Polythore ornata*	M							MSH	MSH-PO-161
WRK-WS-01283	*Polythore ornata*	M							MSH	MSH-PO-140
WRK-WS-01302	*Polythore ornata*	M							MSH	MSH-PO-167
WRK-WS-01312	*Polythore ornata*	M							MSH	MSH-PO-133
WRK-WS-00713	*Polythore picta*	F	7/12/2008	Peru			Pozuzo		MSH	P-74; POZ-22
WRK-WS-00714	*Polythore picta*	F	9/24/2008	Peru			Pozuzo		MSH	POZ-22
WRK-WS-00720	*Polythore picta*	F	9/24/2008	Peru			Pozuzo		MSH	POZ-17
WRK-WS-01452	*Polythore picta*	F	4/1/2010	Peru	Junin	Campamiento			Carl Cook Collection	FSCA940
WRK-WS-00710	*Polythore picta*	M	7/16/2008	Peru			Pozuzo		MSH	POZ-22
WRK-WS-00711	*Polythore picta*	M	7/17/2008	Peru			Pozuzo		MSH	POZ-22
WRK-WS-00712	*Polythore picta*	M	7/14/2008	Peru			Pozuzo		MSH	POZ-22
WRK-WS-00753	*Polythore picta*	M	7/12/2008	Peru			Pozuzo		MSH	p-75; POZ-22
WRK-WS-00754	*Polythore picta*	M	9/24/2008	Peru			Pozuzo		MSH	P-17; POZ-15
WRK-WS-00755	*Polythore picta*	M	9/26/2008	Peru			Pozuzo		MSH	p-6; POZ-30
WRK-WS-00756	*Polythore picta*	M	9/26/2008	Peru			Pozuzo		MSH	p-6; POZ-30
WRK-WS-01451	*Polythore picta*	M	4/1/2010	Peru	Junin	Campamiento			Carl Cook Collection	FSCA940
WRK-WS-01428	*Polythore procera*	F	4/1/2008	Ecuador	Zamora Chinchipe	Zamora	K.J. Tennessen	S3° 57' 30" W079° 01' 44"	KJ Tennessen	FSCA942
WRK-WS-01429	*Polythore procera*	F	2/27/2010	Ecuador	Santo Doming		K.J. Tennessen	S00°20' 01" W078° 52' 12"	KJ Tennessen	FSCA941
WRK-WS-01481	*Polythore procera*	F	9/15/2005	Ecuador	Morona-Santiago	Macas		S2° 16' 23" W078° 11' 38"	Bill Mauffray	FSCA689
WRK-WS-01487	*Polythore procera*	F	9/21/2005	Ecuador	Pastaza	Rio Anzu		S1° 25' 5.3" W78° 3' 9.5"	Bill Mauffray	FSCA690
WRK-WS-02400	*Polythore procera*	F		Ecuador						MSH-PP-332
WRK-WS-00780	*Polythore procera*	M		Colombia			Boyaca		MSH	BOY-01
WRK-WS-00781	*Polythore procera*	M		Colombia			Boyaca		MSH	BOY-01
WRK-WS-02399	*Polythore procera*	M		Ecuador						MSH-PP-330
WRK-WS-00759	*Polythore spaeteri*	F	7/23/2008	Peru			Panguana		MSH	PAN-15
WRK-WS-00761	*Polythore spaeteri*	F	7/19/2008	Peru			Panguana		MSH	P-56; PAN-08
WRK-WS-00762	*Polythore spaeteri*	F	7/16/2008	Peru			Panguana		MSH	P-92; PAN-01
WRK-WS-00763	*Polythore spaeteri*	F	7/16/2008	Peru			Panguana		MSH	P-91; PAN-01
WRK-WS-00767	*Polythore spaeteri*	F	7/24/2008	Peru			Panguana		MSH	P-99; Pan-13
WRK-WS-00760	*Polythore spaeteri*	M	7/17/2008	Peru			Panguana		MSH	PAN-02

WRK-WS-00764	*Polythore spaeteri*	M	7/23/2008	Peru			Panguana		MSH	P-96; PAN-75
WRK-WS-00765	*Polythore spaeteri*	M	7/24/2008	Peru			Panguana		MSH	P-97; PAN-13
WRK-WS-00766	*Polythore spaeteri*	M	7/24/2008	Peru			Panguana		MSH	P-98; PAN-13
WRK-WS-00768	*Polythore spaeteri*	M	7/24/2008	Peru			Panguana		MSH	P-100; PAN-13
WRK-WS-01415	*Polythore terminata*	F	9/12/2005	Ecuador	Morona-Santiago	Macas	RU Melissa	S2° 16' 13.8" W78° 11' 3	Bill Mauffray	FSCA 707
WRK-WS-02407	*Polythore terminata*	F		Ecuador						MSH-PT-343
WRK-WS-02409	*Polythore terminata*	F		Ecuador						MSH-PT-294
WRK-WS-01417	*Polythore terminata*	M	4/4/2008	Ecuador	Zamora	Guayayme alto	Collection of K.J. Tennessen	S3°52'40"W078°53'34";elev.880m	KJ Tennessen	FSCA939 w/ DB
WRK-WS-01425	*Polythore terminata*	M	4/2/2008	Ecuador	Zamora	Podocarpus	Coll. K.J.Tennessen		KJ Tennessen	FSCA938 WDB
WRK-WS-01427	*Polythore terminata*	M	9/17/2005	Ecuador	Morona-Santiago	Macas	Bill Mauffray	S2°16' 13.8" W78° 11' 3	Coll Bill Mauffray	FSCA937
WRK-WS-01447	*Polythore terminata*	M	9/17/2005	Ecuador	Morona-Santiago	Macas		S2° 09' 59'' W076° 41' 30"	Bill Mauffray	FSCA706
WRK-WS-02408	*Polythore terminata*	M		Ecuador						MSH-PT-344
WRK-WS-00715	*Polythore victoria*	F	9/23/2008	Peru			Pozuzo		MSH	POZ-13
WRK-WS-00719	*Polythore victoria*	F	9/27/2008	Peru			Pozuzo		J Grados	POZ-12
WRK-WS-00748	*Polythore victoria*	F	9/27/2008	Peru			Pozuzo		MSH	P-41; POZ-12
WRK-WS-01174	*Polythore victoria*	F								Ru-N:WL:OdoD:2014 01377
WRK-WS-01175	*Polythore victoria*	F								Ru-N:WL:OdoD:2014 01378
WRK-WS-01191	*Polythore victoria*	F								RU-N:WL:OdoD: 2014 01368
WRK-WS-01246	*Polythore victoria*	F							MSH	MSH-PV-87
WRK-WS-00716	*Polythore victoria*	M	9/23/2008	Peru			Pozuzo		MSH	POZ-13
WRK-WS-00717	*Polythore victoria*	M	7/10/2008	Peru			Pozuzo		MSH	P-71; POZ-13
WRK-WS-00718	*Polythore victoria*	M	9/27/2008	Peru			Pozuzo		J Grados	POZ-12
WRK-WS-00743	*Polythore victoria*	M	7/14/2008	Peru			Pozuzo		MSH	
WRK-WS-00744	*Polythore victoria*	M	9/27/2008	Peru			Pozuzo		MSH	P-42; POZ-12
WRK-WS-00745	*Polythore victoria*	M	9/27/2008	Peru			Pozuzo		MSH	P-42; POZ-12
WRK-WS-00746	*Polythore victoria*	M	9/27/2008	Peru			Pozuzo		MSH	P-42; POZ-12
WRK-WS-00747	*Polythore victoria*	M	7/10/2008	Peru			Pozuzo		MSH	P-70; POZ-13
WRK-WS-00749	*Polythore victoria*	M	9/23/2008	Peru			Pozuzo		MSH	p-22; POZ-12
WRK-WS-00750	*Polythore victoria*	M	9/24/2008	Peru			Pozuzo		MSH	p-1; POZ-22
WRK-WS-00751	*Polythore victoria*	M	7/7/2008	Peru			Pozuzo		MSH	p-64; POZ-11
WRK-WS-00752	*Polythore victoria*	M	7/10/2008	Peru			Pozuzo		MSH	p-80; POZ-13
WRK-WS-00769	*Polythore victoria*	M	9/28/2013	Peru			Pozuzo, near Pacha Falls	10.26641, 78.88043	MSH	MSH-PV-1
WRK-WS-00773	*Polythore victoria*	M	10/1/2013	Peru			Near Santa Cruz	10.02761, 75.62984	MSH	MSH-PV-84
WRK-WS-00774	*Polythore victoria*	M	10/1/2013	Peru			Near Santa Cruz	10.02761, 75.62984	MSH	MSH-PV-83
WRK-WS-00775	*Polythore victoria*	M	10/2/2013	Peru				9.95309,-75.51357	MSH	MSH-PV-104
WRK-WS-00776	*Polythore victoria*	M	10/1/2013	Peru			Near Santa Cruz	10.02761, 75.62984	MSH	MSH-PV-85
WRK-WS-00777	*Polythore victoria*	M	10/3/2013	Peru			Pozuzo	10 8.547 , 75 32.979	MSH	MSH-PV-120
WRK-WS-01176	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01371
WRK-WS-01177	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01376
WRK-WS-01178	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01375
WRK-WS-01179	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01374
WRK-WS-01180	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01373
WRK-WS-01181	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01372
WRK-WS-01185	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01369
WRK-WS-01186	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01365
WRK-WS-01187	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01366
WRK-WS-01188	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01364
WRK-WS-01189	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01370
WRK-WS-01190	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01367
WRK-WS-01192	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01363
WRK-WS-01207	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01394
WRK-WS-01208	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01396
WRK-WS-01209	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01380
WRK-WS-01210	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01395
WRK-WS-01211	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01379
WRK-WS-01213	*Polythore victoria*	M								RU-N:WL:OdoD:2014 01397
WRK-WS-01240	*Polythore victoria*	M							MSH	MSH-PN-123

WRK-WS-01241	*Polythore victoria*	M					MSH	MSH-PV-124
WRK-WS-01243	*Polythore victoria*	M					MSH	MSH-PV-119
WRK-WS-01248	*Polythore victoria*	M					MSH	MSH-PV-121
WRK-WS-01254	*Polythore victoria*	M					MSH	MSH-PV-90
WRK-WS-01257	*Polythore victoria*	M					MSH	MSH-PV-122
WRK-WS-01295	*Polythore victoria*	M					MSH	MSH-PE-190
WRK-WS-01301	*Polythore victoria*	M					MSH	MSH-RNA-4
WRK-WS-01303	*Polythore victoria*	M					MSH	MSH-RNA-3
WRK-WS-01306	*Polythore victoria*	M					MSH	MSH-RNA-5
WRK-WS-01307	*Polythore williamsoni*	M		Colombia	Huila	Estrecho del Magdalena, Huila	MSH	
WRK-WS-01414	*Polythore williamsoni*	M				PW-ERE (Melissa)	MSH	
WRK-WS-01511	*Stenocora percornuta*	F	6/5/1940	Peru	Junin Dept		Satipo	FSCA922
WRK-WS-01510	*Stenocora percornuta*	M	6/5/1940	Peru	Junin Dept		Satipo	FSCA922
Zygoptera	**Megapodagrionidae**							
WRK-WS-02442	*Heteragrion bickorum*	F		Ecuador				MSH-HETE-284
WRK-WS-02441	*Heteragrion bickorum*	M		Ecuador				MSH-HETE-285

Appendix B. Examples of odonate species used in this study

Here are shown examples of the wings of the dragonfly and damselfly species scanned for this study, divided into 16 plates. The images depicted in each plate are the standardized squares (see Chapter 3 Methods for further description) for an individual from each species. Images and plates are sorted by suborder, family, and species. Information about the localities from which species were collected can be found in Appendix A.

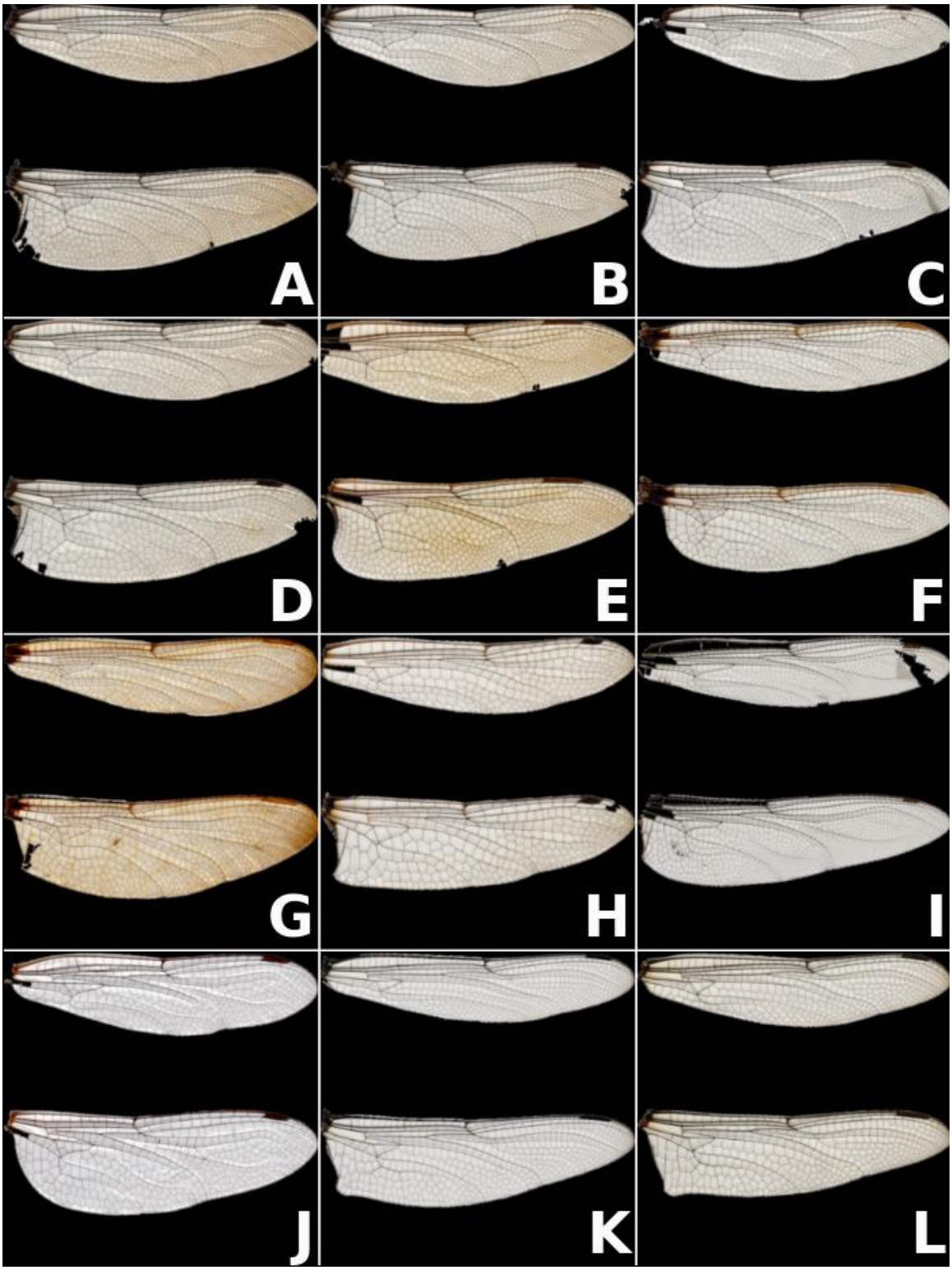

Plate 1. A: *Aeshna canadensis* ♂ (Anisoptera: Aeshnidae), B: *A. eremita* ♂, C: *A. interrupta* ♂, D: *A. juncea* ♂, E: *Anax junius* ♂, F: *Basiaeschna janata* ♀, G: *Boyeria vinosa* ♂, H: *Gomphaeschna furcillata* ♂, I: *Staurophlebia reticulata* ♂, J: *Triacanthagyna septima* ♀, K: *Cordulegaster erronea* ♂ (Cordulegastridae), L: *C. maculata* ♂.

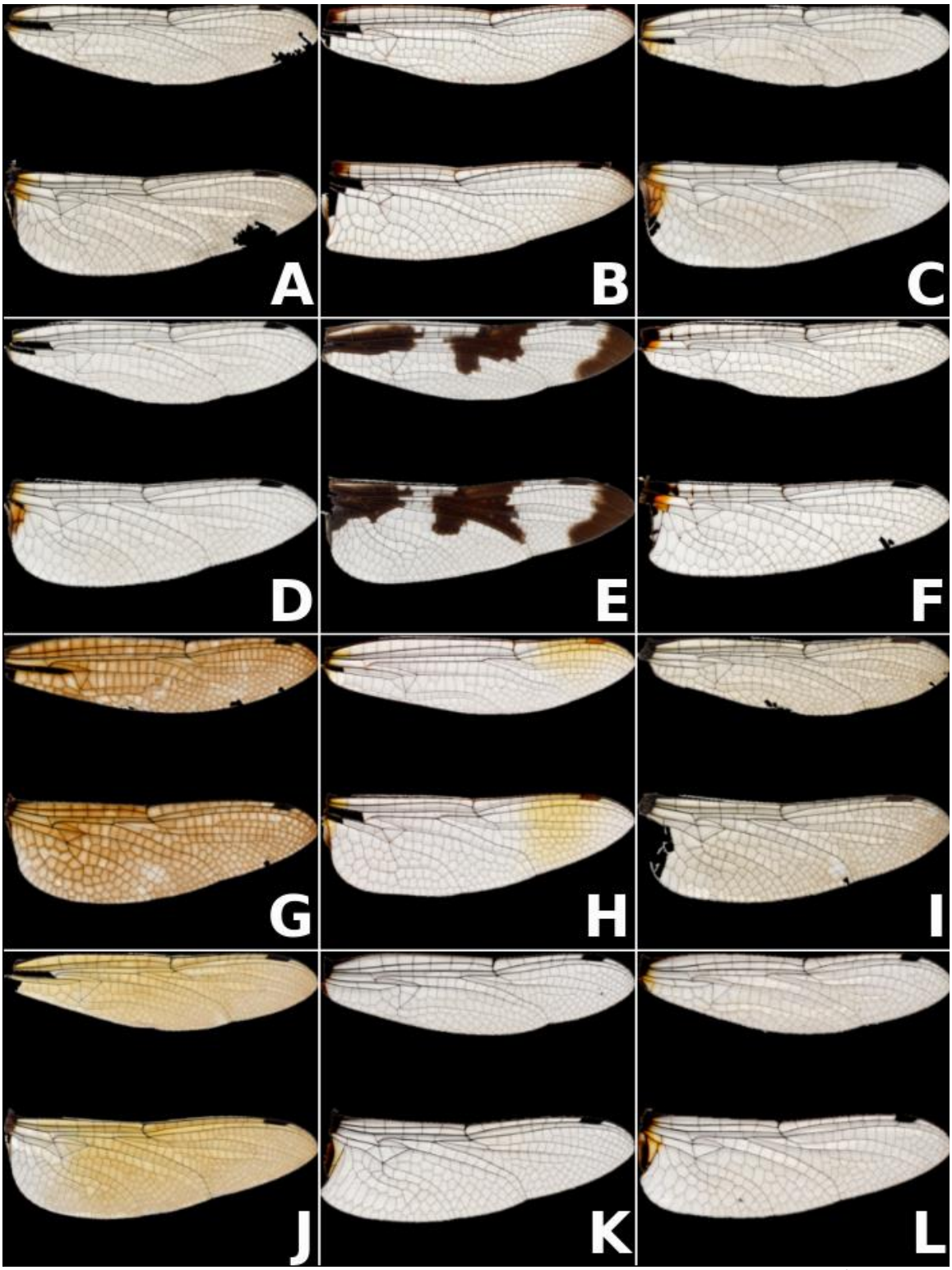

Plate 2. A: *Cordulia shurtleffii* ♀ (Corduliidae), B: *Didymops transversa* ♂, C: *Dorocordulia lepida* ♀, D: *D. libera* ♀, E: *Epitheca princeps* ♀, F: *Helocordulia uhleri* ♂, G: *Lauromacromia* sp1 ♀, H: *Phyllomacromia picta* ♀, I: *Somatochlora albicincta* ♀, J: *S. linearis* ♀, K: *S. margarita* ♂, L: *S. minor* ♂.

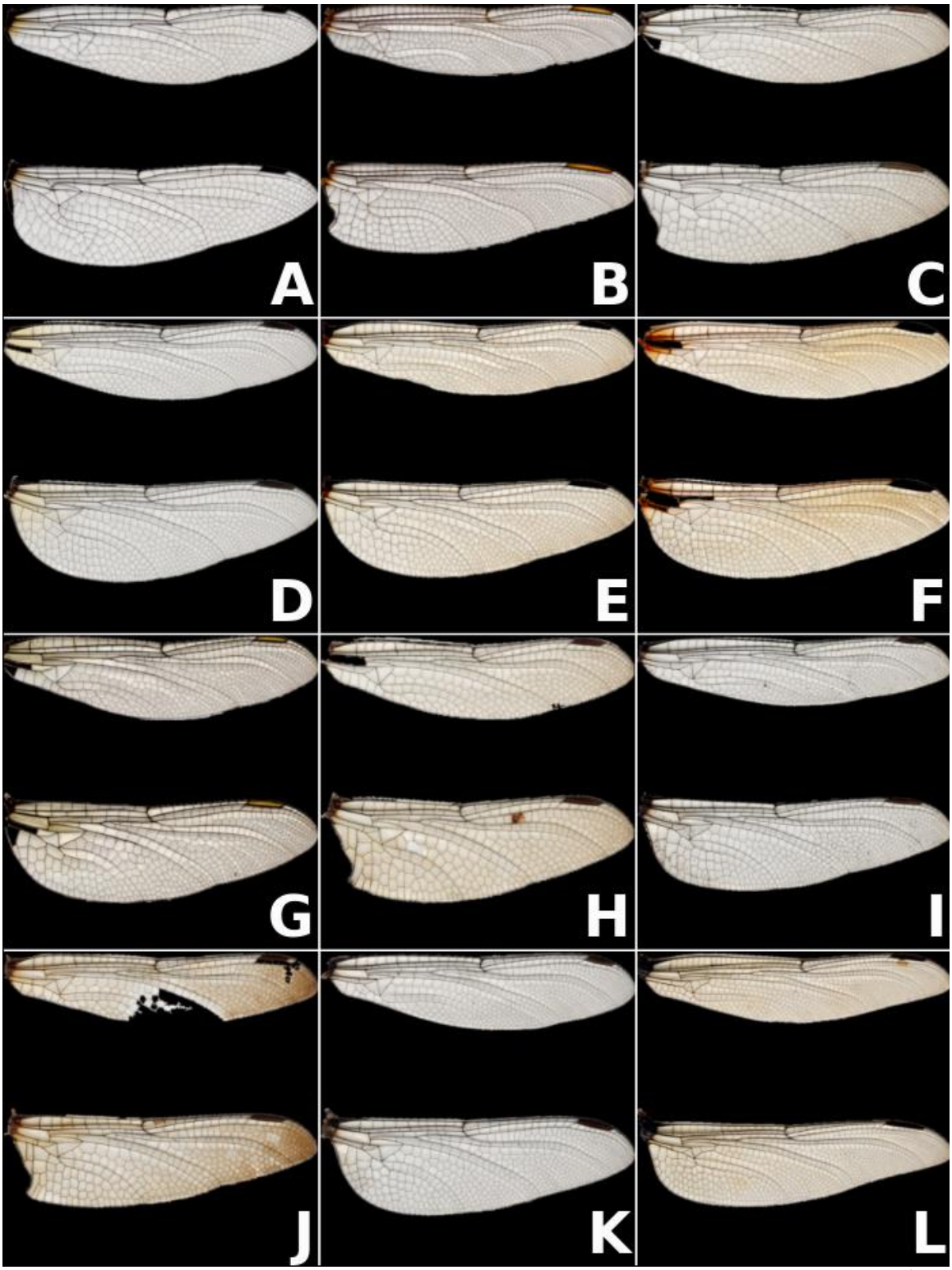

Plate 3. A: *Somatochlora tenebrosa* ♀ (Corduliidae), B: *Aphylla williamsonia* ♂ (Gomphidae), C: *Arigomphus villosipes* ♂, D: *Dromogomphus spinosus* ♀, E: *D. spoliatus* ♀, F: *Erpetogomphus designatus* ♀, G: *Gomphus abbreviatus* ♀, H: *G. exilis* ♂, I: *G. lineatifrons* ♀, J: *G. spicatus* ♂, K: *G. vastus* ♀, L: *Hagenius brevistylus* ♀.

Plate 4. A: *Phyllogomphoides pedunculus* ♂ (Gomphidae), B: *Progomphus obscurus* ♂, C: *Acisoma panarpoides* ♀ (Libellulidae), D: *Brachymesia furcata* ♂, E: *B. gravida* ♀, F: *B. herbida* ♀, G: *Brachythemis contaminata* ♀, H: *C. elisa* ♀, I: *C. eponina* ♀, J: *C. fasciata* ♀, K: *C. martha* ♂, L: *Crocothemis servilia* ♀.

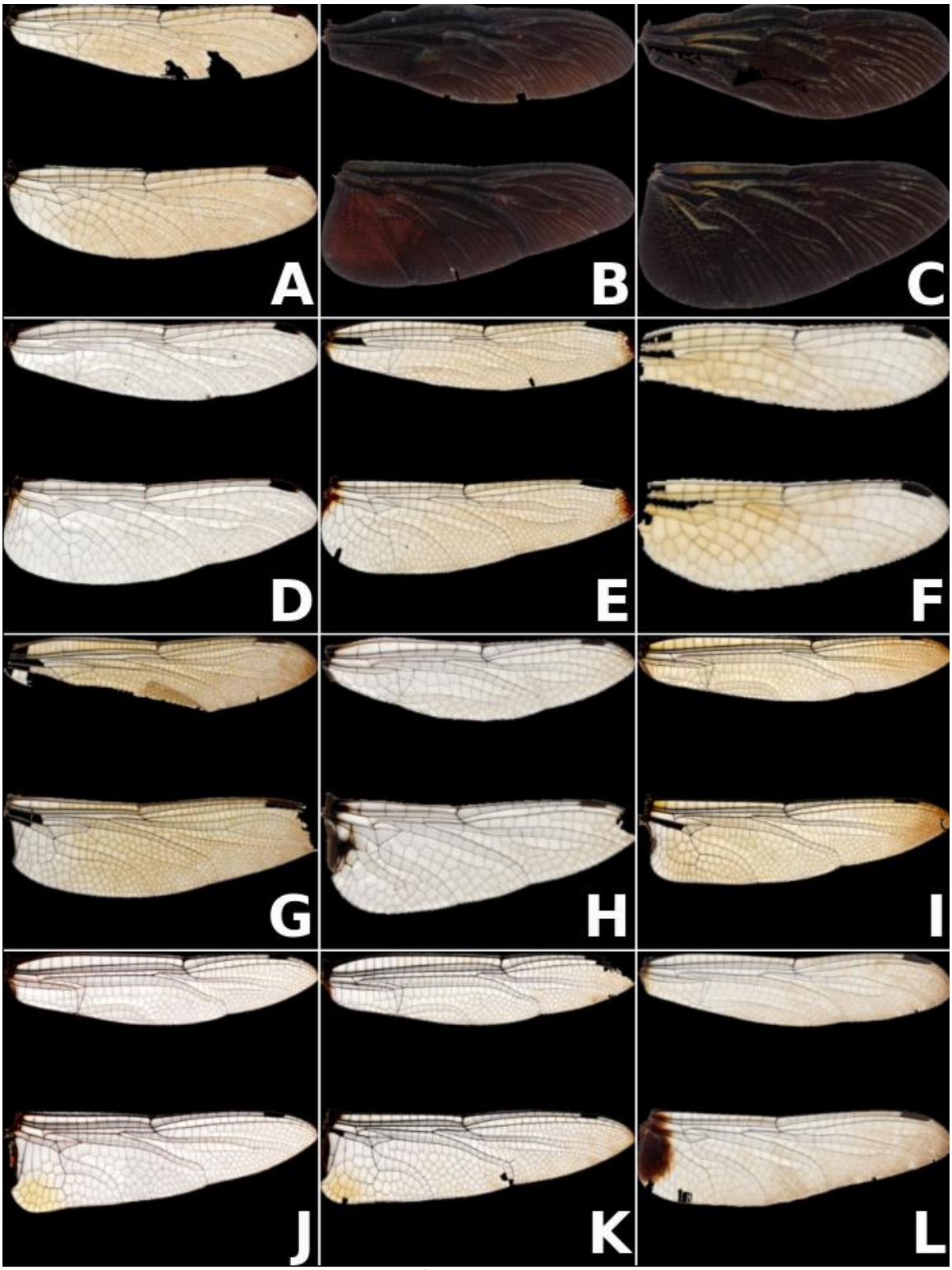

Plate 5. A: *Dasythemis esmeralda* ♂ (Libellulidae), B: *Diastatops intensa* ♀, C: *D. obscura* ♂, D: *Diplacodes trivialis* ♂, E: *Dythemis velox* ♂, F: *Elga longistyla* ♂, G: *Epiaeschna heros* ♂ (Aeshnidae), H: *Epitheca cynosura* ♂ (Corduliidae), I: *Epophthalmia elegans* ♀ (Libellulidae), J: *E. vittata* ♂, K: *E. vittigera* ♂, L: *Erythemis attala* ♀.

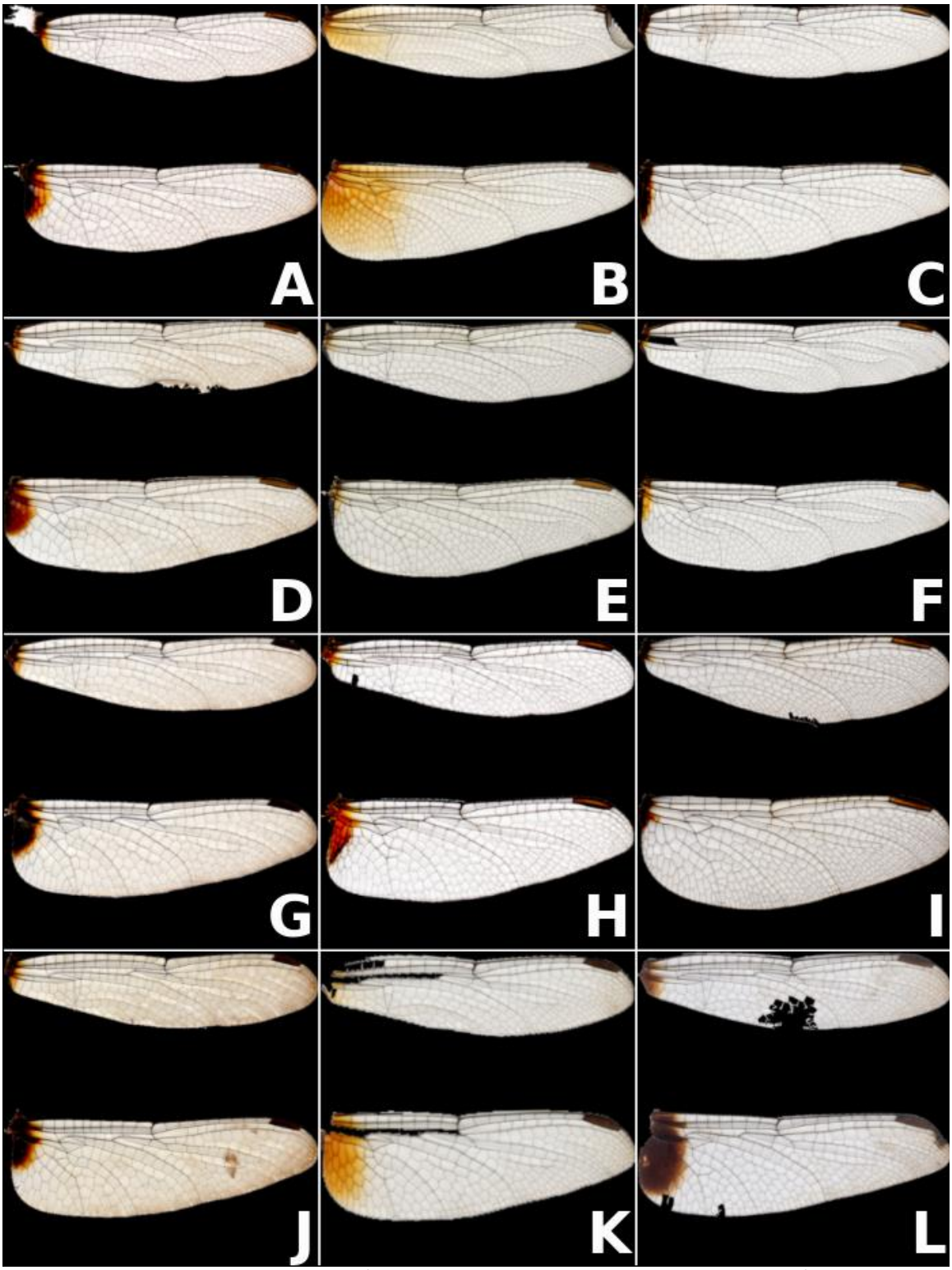

Plate 6. A: *Erythemis credula* ♂ (Libellulidae), B: *E. haematogastra* ♂, C: *E. peruviana* ♂, D: *E. plebeja* ♂, E: *E. simplicicollis* ♀, F: *E. vesiculosa* ♀, G: *Erythrodiplax amazonica* ♂, H: *E. basalis* ♂, I: *E. berenice* ♀, J: *E. fervida* ♂, K: *E. fusca* ♀, L: *E.* sp1 ♂.

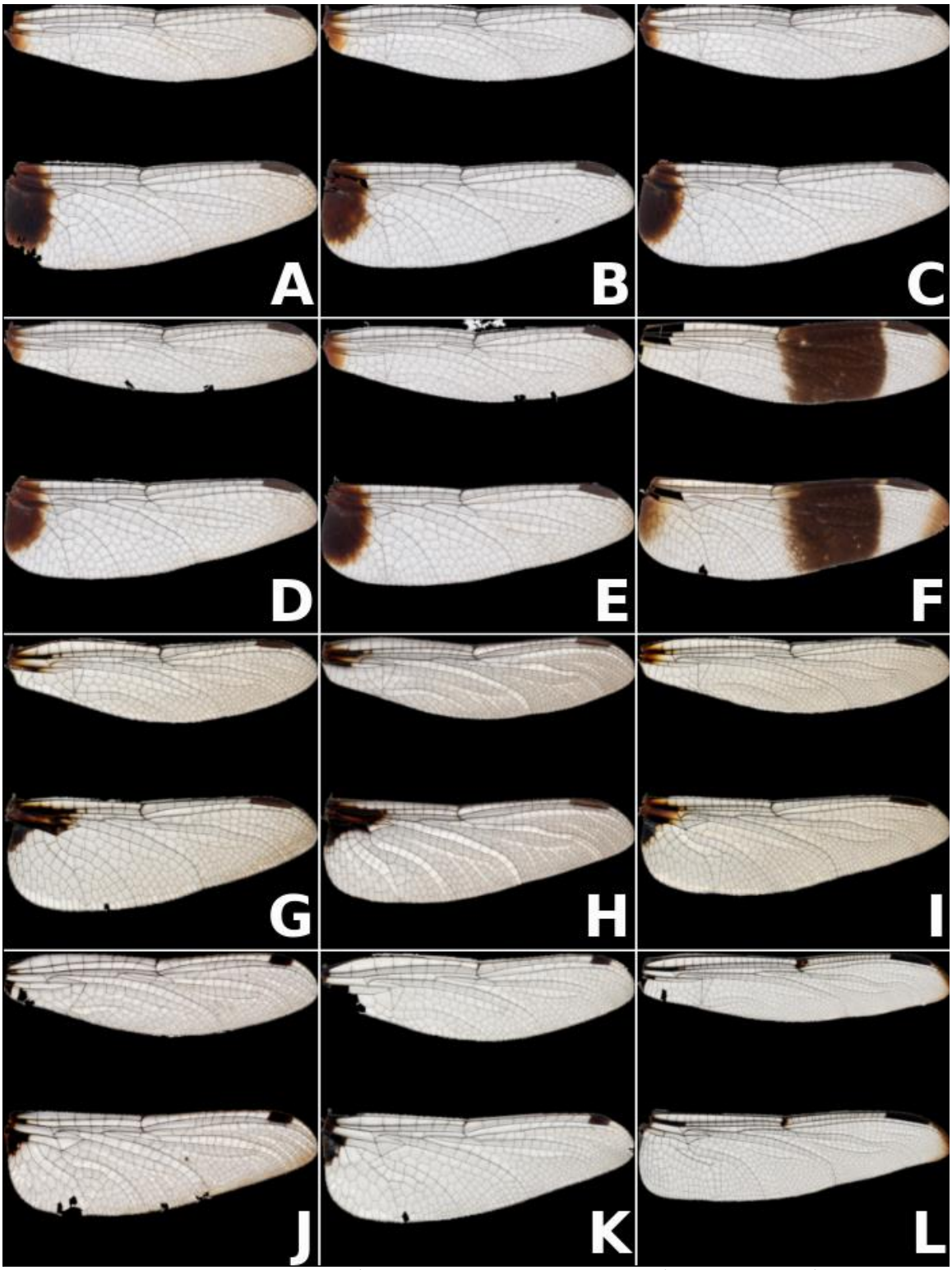

Plate 7. A: *Erythrodiplax* sp2 ♂ (Libellulidae), B: *E.* sp3 ♂, C: *E.* sp4 ♂, D: *E.* sp5 ♂, E: *E.* sp6 ♂, F: *E. umbrata* ♂, G: L*adona deplanata* ♀, H: *L. exusta* ♂, I: *L. julia* ♀, J: *Leucorrhinia frigida* ♀, K: *Leucorrhinia intacta* ♂, L: *Libellula axilena* ♂.

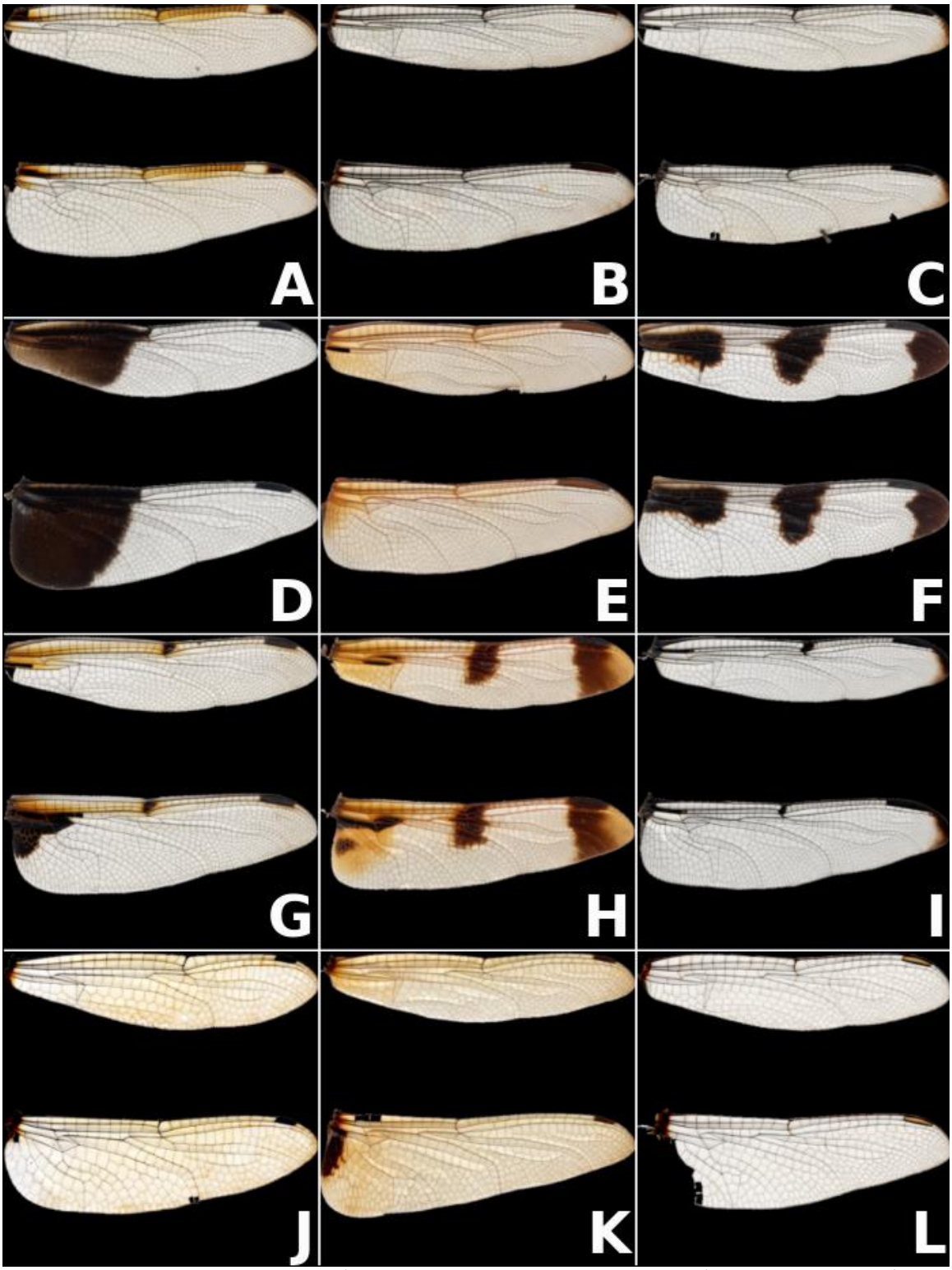

Plate 8. A: *Libellula cyanea* ♂ (Libellulidae), B: *L. herculea* ♂, C: *L. incesta* ♂, D: *L. luctuosa* ♂, E: *L. needhami* ♂, F: *L. pulchella* ♂, G: *L. quadrimaculata* ♀, H: *L. semifasciata* ♂, I: *L. vibrans* ♂, J: *Macrothemis extensa* ♂, K: *Miathyria marcella* ♂, L: *M. simplex* ♂.

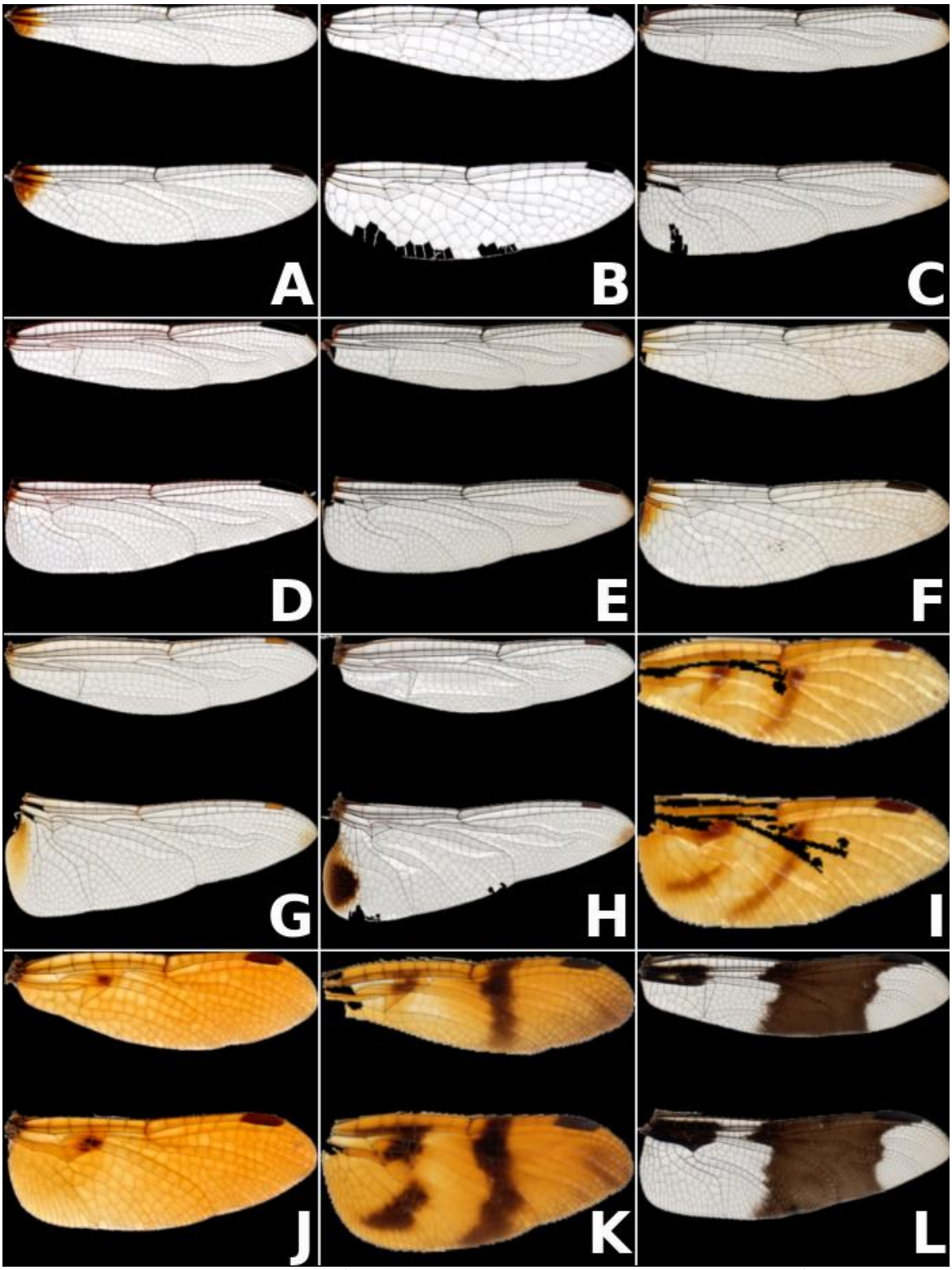

Plate 9. A: *Misagria parana* ♂ (Libellulidae), B: *Nephepeltia phryne* ♂, C: *Orthemis discolor* ♂, D: *O. feiruginea* ♂, E: *O. schmidti* ♂, F: *Pachydiplax longipennis* ♀, G: *Pantala flavescens* ♀, H: *P. hymenaea* ♂, I: *Perithemis lais* ♂, J: *P. tenera* ♂, K: *P. thais* ♂, L: *P. lydia* ♂.

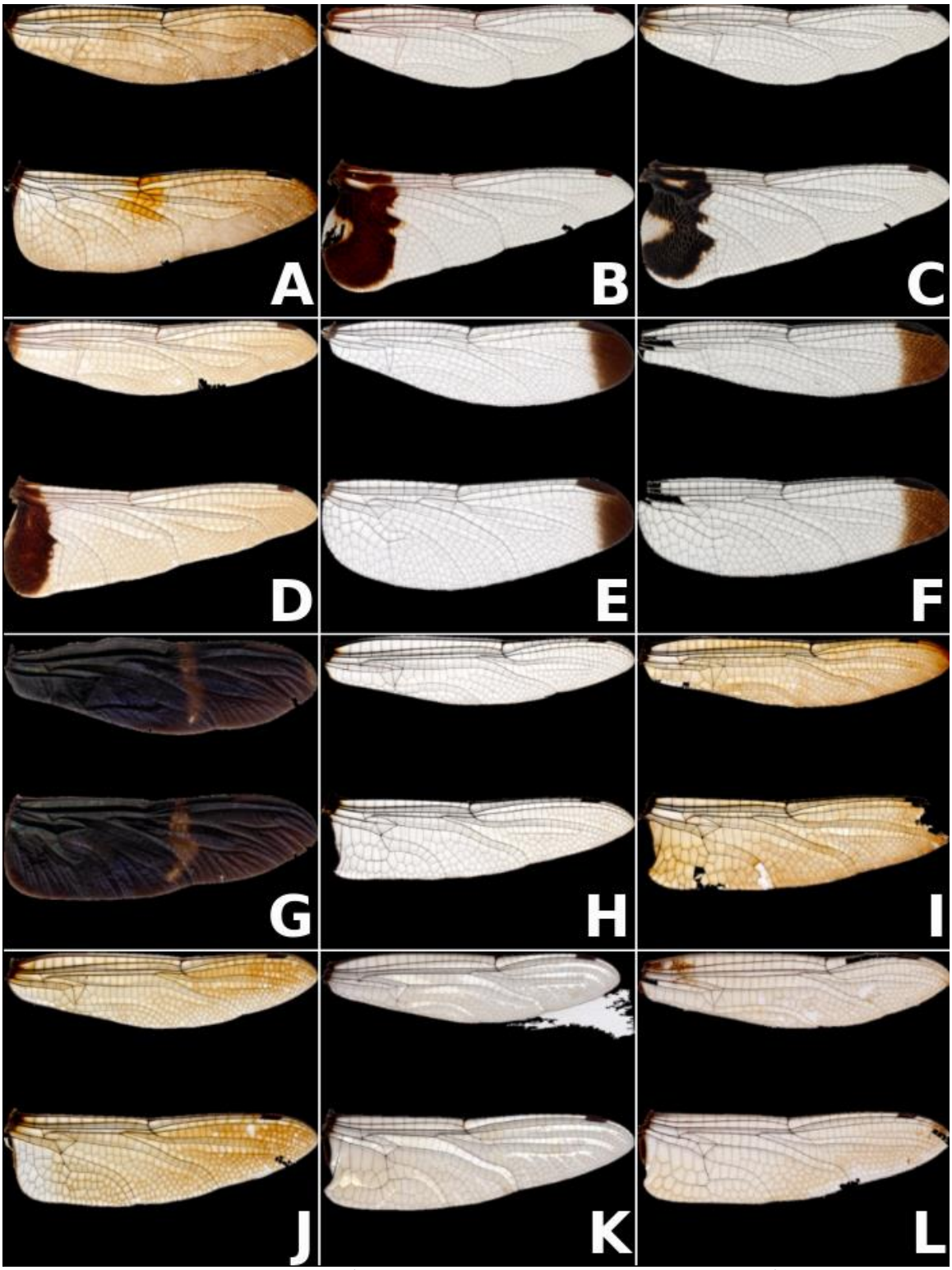

Plate 10. A: *Tholymis citrina* ♂ (Libellulidae), B: *Tramea carolina* ♂, C: *T. lacerata* ♂, D: *T. rustica* ♂, E: *Uracis imbuta* ♂, F: *U. ovipositrix* ♂, G: *Zenithoptera viola* ♂, H: *Macromia alleghaniensis* ♂ (Macromiidae), I: *M. amphigena* ♂, J: *M. annulata* ♀, K: *M. aureozona* ♂, L: *M. bifasciata* ♂.

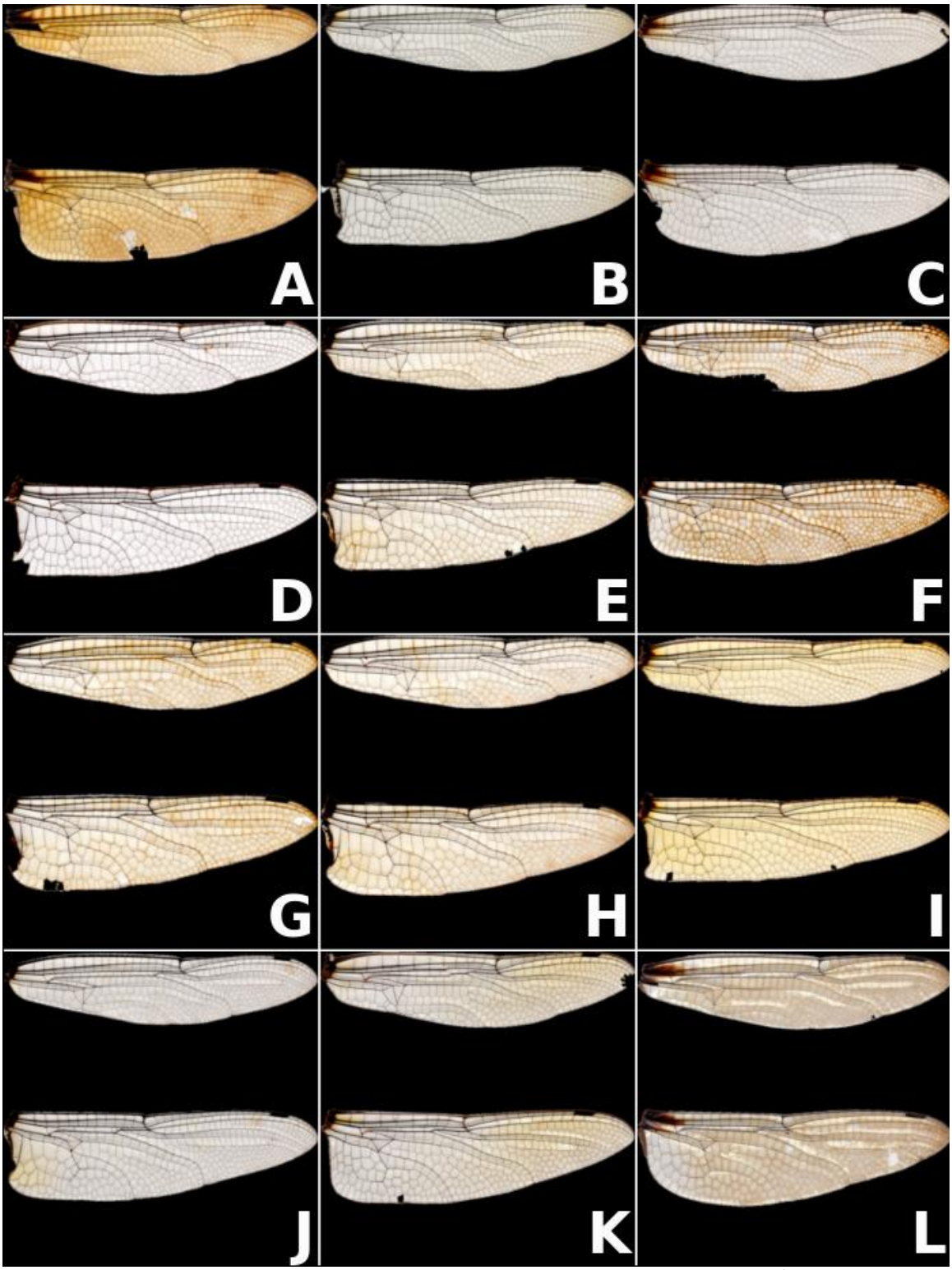

Plate 11. A: *Macromia daimoji* ♀ (Macromiidae), B: *M. illinoiensis* ♂, C: *M. irata* ♀, D: *M. magnifica* ♂, E: *M. manchurica* ♂, F: *M. margarita* ♀, G: *M. monoceros* ♂, H: *M. moorei* ♂, I: *M. pacifica* ♂, J: *M. pinratani* ♂, K: *M. rickeri* ♀, L: *M. sophia* ♀.

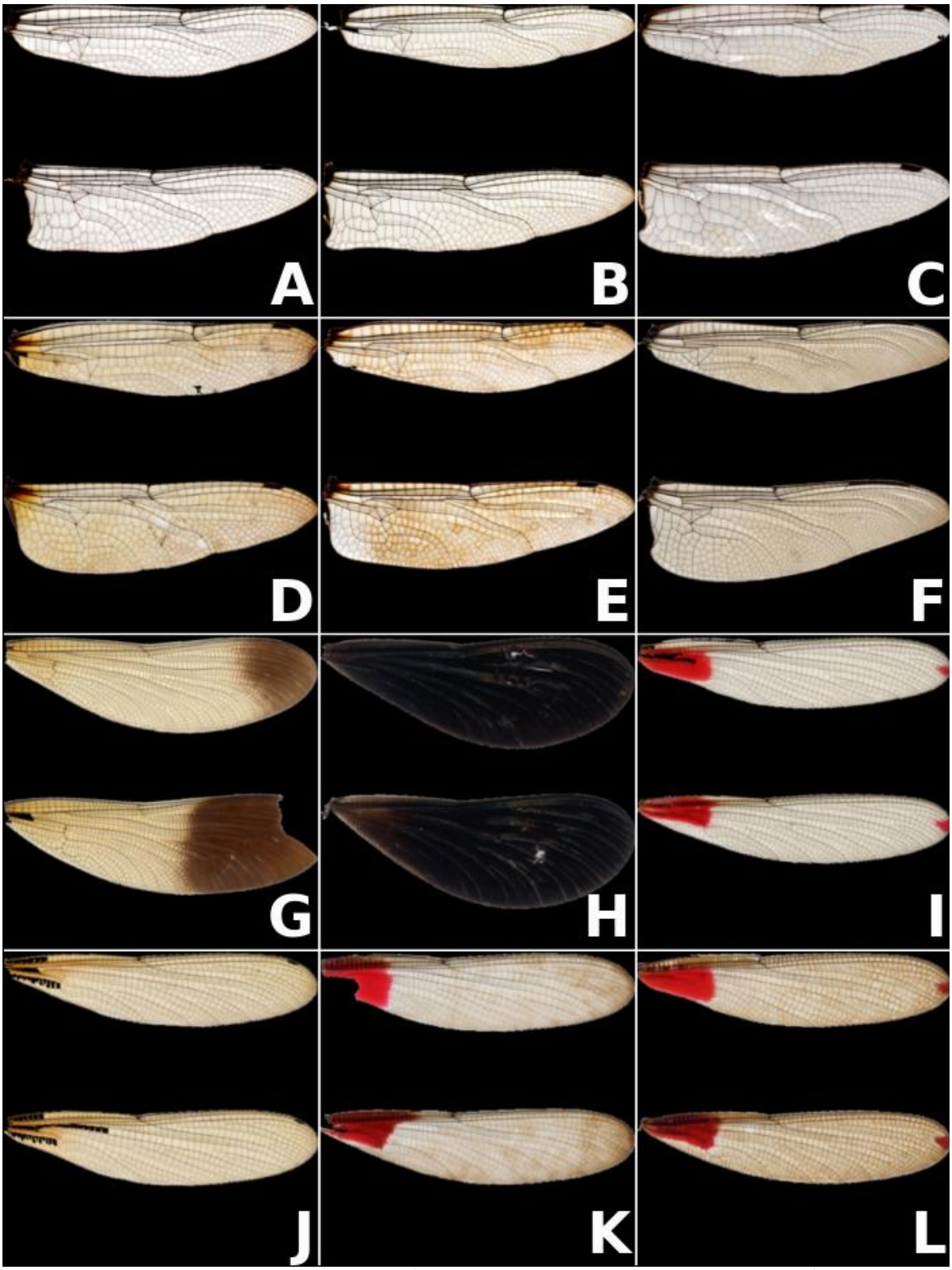

Plate 12. A: *Macromia splendens* ♂ (Macromiidae), B: *M. taeniolata* ♂, C: *M. tillyardi* ♂, D: *M. urania* ♀, E: *M. wabashensis* ♀, F: *Tachopteryx thoreyi* ♂ (Petaluridae), G: *Calopteryx aequabilis* ♂ (Zygoptera: Calopterygidae), H: *C. maculata* ♂, I: *Hetaerina caja* ♂, J: *H. capitalis* ♀, K: *H. duplex* ♂, L: *H. occisa* ♂.

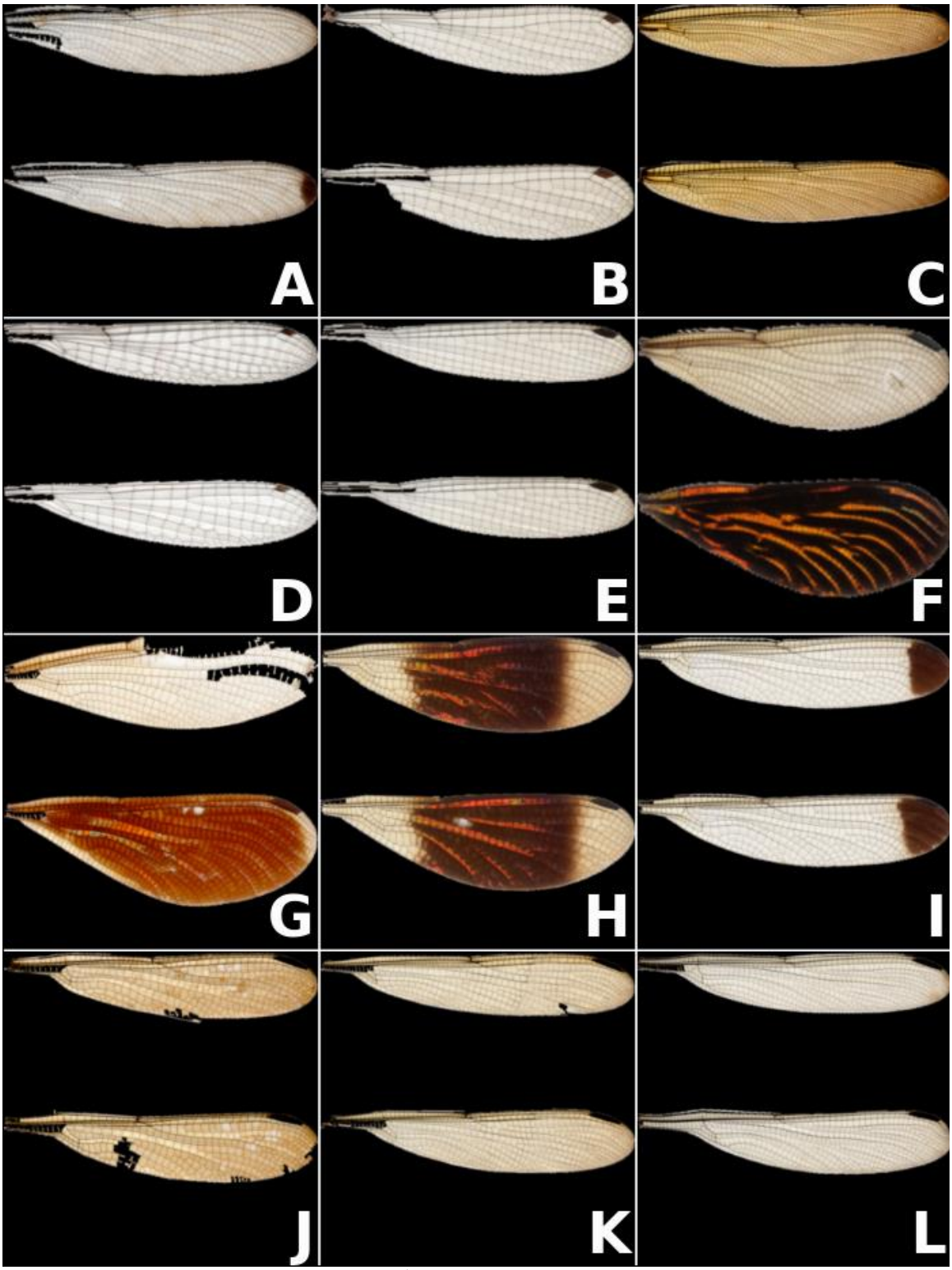

Plate 13. A: *Mnesarete metallica* ♂ (Calopterygidae), B: *Argia apicalis* ♀ (Coenagrionidae), C: *Dysphaea ethela* ♂ Euphaeidae), D: *Lestes dryas* ♀ (Lestidae), E: *Heteragrion bickorum* ♀ (Megapodagrionidae), F: *Chalcopteryx rutilans* ♂ (Polythoridae), G: *C. scintillans* ♀, H: *Cora avrea* ♂, I: *C. chirripa* ♂, J: *C. cyane* ♂, K: *C. inca* ♀, L: *C. irene* ♂.

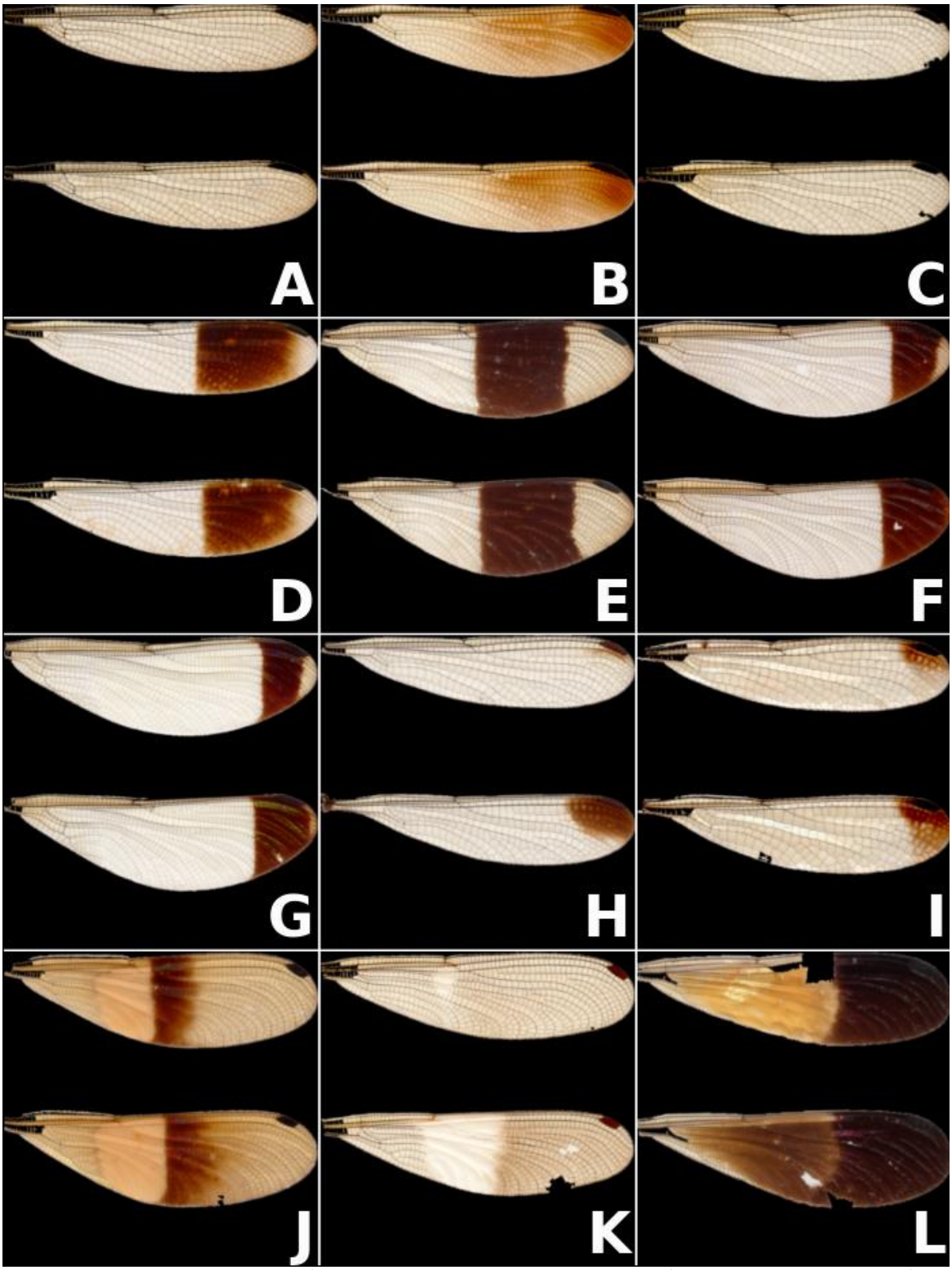

Plate 14. A: *Cora jocosa* ♂ (Polythoridae), B: *C. marina* ♂, C: *C. notoxantha* ♂, D: *C. semiopaca* ♂, E: *Euthore fasciata* ♂, F: *E. merdiana* ♂, G: *E. meridana* ♂, H: *Miocora peraltica* ♂, I: *M. subapicalis* ♀, J: *Polythore aurora* ♂, K: *P. beata* ♂, L: *P. boliviana* ♂.

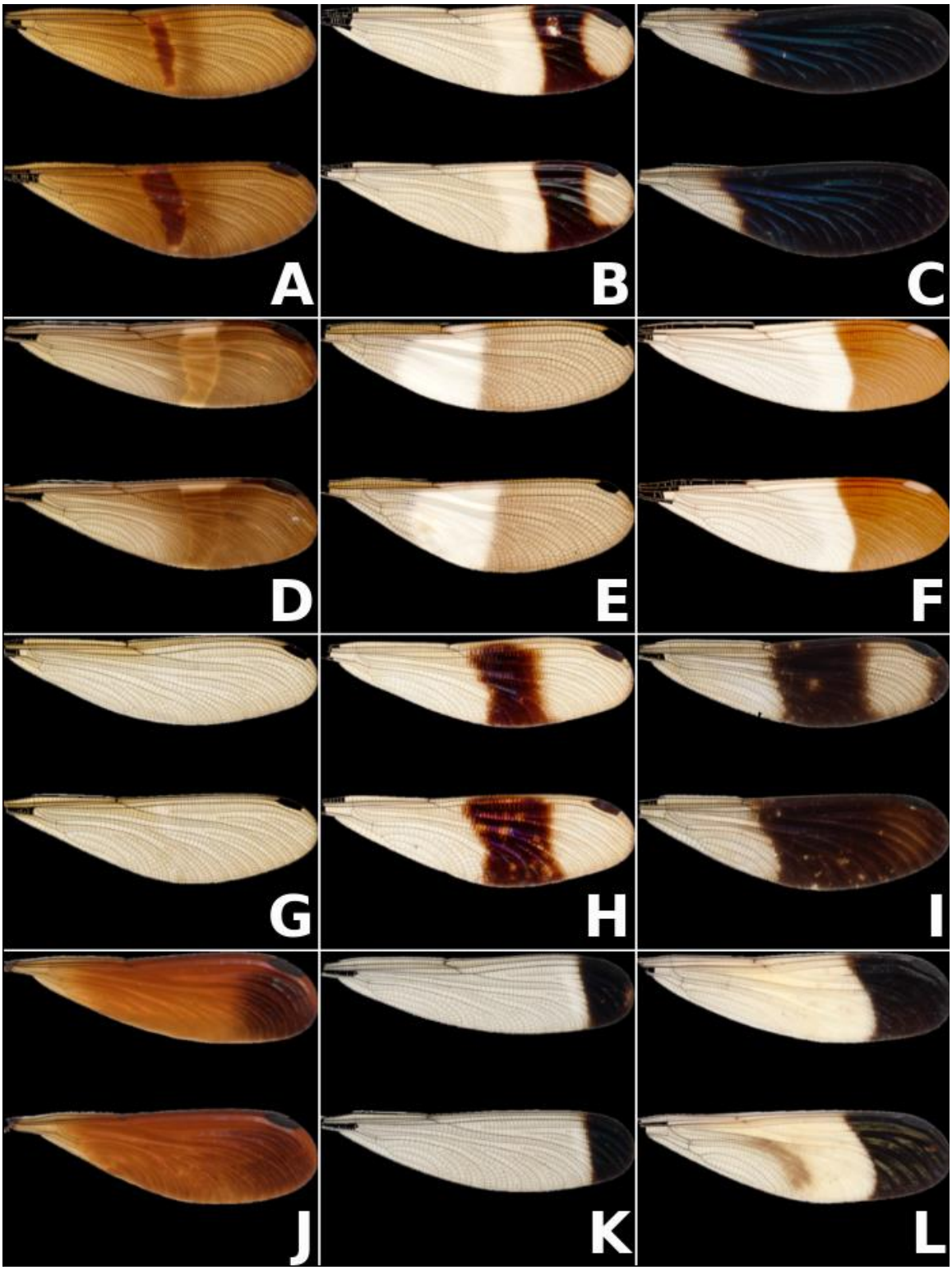

Plate 15. A: *Polythore concinna* ♀ (Polythoridae), B: *P. derivata* ♀, C: *P. gigantea* ♂, D: *Polythore manua* ♂, E: *P. mutata* ♂, F: *P. neopicta* ♂, G: *P. ornata* ♀, H: *P. picta* ♀, I: *Polythore procera* ♀, J: *P. spaeteri* ♂, K: *P. terminata* ♀, L: *P. victoria* ♂.

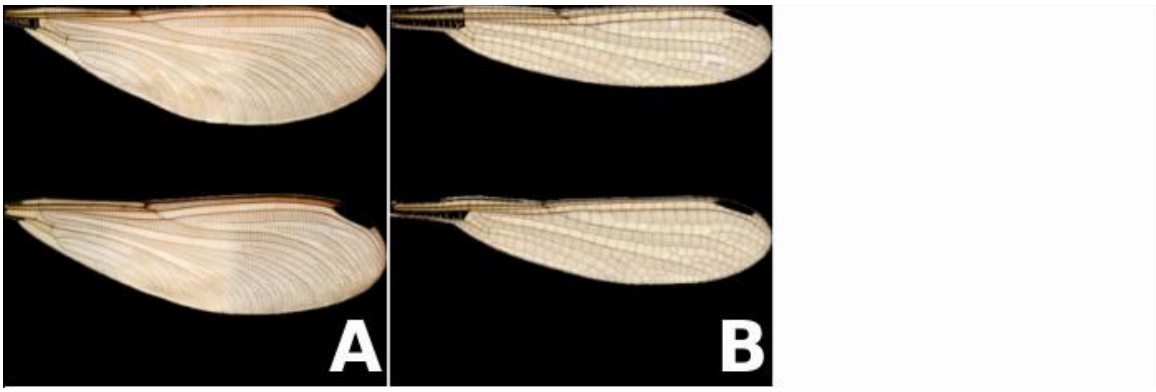

Plate 16. A: *Polythore williamsoni* ♂ (Polythoridae), B: *Stenocora percornuta* ♀.