1st December 2014

# Does experimental marking of wings influence resighting success in *Mesamphiagrion laterale* and *Erythrodiplax umbrata*? (Odonata: Coenagrionidae, Libellulidae)

Fredy Palacino-Rodríguez[1,2] & Natalia Andrea Contreras-Sánchez[1]

[1] Grupo de Investigación en Odonatos de Colombia, Laboratorio de Artrópodos-Biotecnología. Centro Internacional de Física (CIF), Universidad Nacional de Colombia, Bogotá D.C., Colombia;

[2] Departamento de Biología, Facultad de Ciencias, Universidad El Bosque, Bogotá D.C., Colombia; <odonata17@hotmail.com>

*Received 10th February 2014; revised and accepted 17th June 2014*

**Abstract.** To investigate if experimental marking affects the probability of resighting, 1,610 individuals of *Mesamphiagrion laterale* (Selys, 1876) and 630 individuals of *Erythrodiplax umbrata* (Linnaeus, 1758) were marked at two sites in Colombia and analysed with respect to marking variables as follows: marking colour used, which wing was marked, and a combination, i.e. the interaction, of these two. The colour and the marked wing were varied, using a different wing each time, and red, black, blue, or green colour. The information was analyzed using contingency tables (Chi-square test) to compare the probability of resighting for individuals within a population marked with a specific colour or on a specific wing to the probability of resighting for all other individuals in the population. In *E. umbrata* the resighting probability ranged as follows: 90.1 to 95.7 % (marking colour type), 90.4 to 95.2 % (wing used), and 87.5 to 97.8 % (wing-colour combination). In the case of *M. laterale*, the resighting probability ranged as follows: 57.2 to 65.0 % (marking colour type), 58.8 to 65.6 % (wing used), and 51.0 to 82.0 % (wing-colour combination). The colour, wing, or combination of wing-colour used for marking didn't have an effect on the resighting probability, suggesting that the method and its variations are adequate to be used in mark–release–recapture studies on odonates. Recommendations are given on what has to be avoided to eliminate potential effects during the marking procedure.

**Key words.** Damselfly, dragonfly, Zygoptera, Anisoptera, South America, Colombia

## Introduction

Numerous methods for sampling wild populations have been developed (reviewed by Southwood & Henderson 2000). Of these, the technique of mark–release–recapture (MRR) has been widely used in demography and

behavioural studies in odonates (reviewed by Cordero & Stoks 2008). The most common method used to mark dragonflies involves the use of fine point permanent ink felt pens to apply unique marks, such as several digit codes on one wing, thus enabling rapid field identification of individuals (Watanabe et al. 2004).

Marking could have a significant impact on behaviour and survival and hence recapture rates. For example, marked individuals might avoid areas that they associate with unpleasant experiences (e.g., marking *per se*). Damage caused to the individuals by the marking process might increase mortality thus reducing the chances of an individual being resighted (Cordero & Stoks 2008). In mammals, birds, and amphibians, effects of marking on the behaviour of individuals have been reported (reviewed by Anderson et al. 2011). In odonates, adverse effects of marking have been demonstrated in several studies (Beukema 2002; Parr & Parr 1979; Banks & Thompson 1985; Fincke 1986), with the disappearance rate of marked individuals increasing in the days after marking. Additionally, it has been found that handling during marking may impact negatively on mating success (Grether 1996), foraging success (Grether & Grey 1996), survival (Grether 1997), and territorial behaviour (Anderson & Grether 2010), thus creating a bias in the estimation of these parameters (Anderson et al. 2011).

The aim of this study is to evaluate if there is a measurable effect associated with marking a particular wing, colour used in marking, or wing-colour combination in the two species, *Mesamphiagrion laterale* and *Erythrodiplax umbrata*, in Colombia.

## Material and methods

### Study subjects and areas

*Mesamphiagrion laterale* (Selys, 1876) is a medium-sized coenagrionid damselfly endemic to the Eastern Cordillera (Colombia) and the Mérida Cordillera (Venezuela), at elevations between 750 and 2,850 m a.s.l. Mature adults show brown or black colours with light blue over postocular spots, thoracic stripes, the internal region of the femur and the dorsal region of S7–S9, their wings are hyaline, without bands. The marking of this species was conducted along a transect (50 m) in the Tominé impoundment, Guatavita municipality, at 04°56'N, 73°50'W and an elevation of 2,600 m a.s.l.,

in the Cundinamarca department, Colombia (Fig. 1). The predominant vegetation in this area is *Acacia* sp. (Fabaceae), *Commelina* sp. (Commelinaceae), *Eichhornia crassipes* (Pontederiaceae), and *Brachiaria* sp. (Poaceae).

*Erythrodiplax umbrata* (Linnaeus, 1758) is a large libellulid dragonfly distributed from southern U.S.A. to northern Argentina. Males and females display two forms, one of which has a dark band in the four wings. In our study, the band was present only in males. The marking was conducted along a transect (200 m) inside a rice crop (*Oriza sativa* Linnaeus) in Pachaquiaro, Puerto López, located at 04°05'N; and 75°53'W, at an elevation of 178 m a.s.l. in the Meta department, Colombia (Fig. 1).

**Collection and marking**

In this study 1,610 individuals of *M. laterale* and 630 individuals of *E. umbrata* were captured and marked. The wing marked and colour were chosen randomly. For *E. umbrata* we used three-digit codes from 001 to 630 that were applied in the prenodal region on one of their wings, thus avoiding the dark wing patch present in the males, while the *M. laterale* individuals were captured and marked in the postnodal region on one of their wings, using four-digit codes between 0001 and 1,610, with fine point makers Sharpie® in red, black, blue, or green colours. The colours were selected from the range

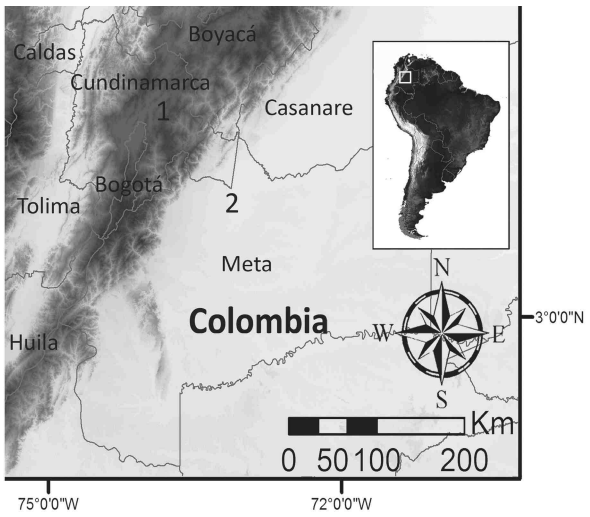


**Figure 1.** Situation of the study sites in Colombia. (1) Guatavita in the Cundinamarca department, where *Mesamphiagrion laterale* was studied; (2) Pachaquiaro, Puerto López, in the Meta department, where *Erythrodiplax umbrata* was studied.

offered by the brand (www.sharpie.com). Only mature adults were marked, and handling did not last longer than one minute.

For both species, the order of wings and colours used for marking was predetermined randomly following the procedure proposed by Anderson et al. (2011). Firstly, all possible colour (red, black, blue, or green) and wing (fore wing right-left; hind wing right-left) combinations were listed, secondly, the RAND function in Microsoft Excel® was used, and then, both columns were sorted by the random column command. In the case of *E. umbrata*, the fieldwork was conducted as follows: 21–24-vi-2010; 02–06-v-2011 and 10–29--iii-2012, from 09:00 to 17:00 h COT (= UTC-5). For *M. laterale*, field work was conducted in 2013 on the following days: 17-, 19-, 21-, 24-, 25-, and 28-iii; 02-, 03-, 05-, 07-, 09-, 12-, 15-, 23- and 29-iv; 02-, 06- and 27-v; 01- and 04-vi-2013, from 09:00 to 18:00 h COT. These dates included rainy and dry periods in each area. For both species, mark–release–recapture (MRR) was performed on each date. The procedure and the variations used for marking were consistent with MRR model assumptions proposed by Arnason et al. (1998) and adapted by Cordero & Stoks (2008).

**Statistical Analysis**

To work with an inadequate sample might affect the significance of the results. For these reason, the total number of individuals needed to develop our analysis was estimated using the equation for data which the main variable is qualitative in finite populations (Badii 2011). The usage of this equation required knowing the population size of each species to determine the sample size needed for statistical analysis (confidence level: 95 %).

According to previous studies (e.g., Hagan & Reed 1988; Anderson et al. 2011) contingency tables (Pearson chi-square tests) were used to compare the resighting probability of marked individuals with the resighting probability for the rest of the individuals of the population, using the marking variations described. The analyses were done with the software Statistica 8.0 (www.statsoft.com).

## Results

In the case of *Mesamphiagrion laterale*, 1,610 individuals (1,229 males, 381 females) were marked. The resighting probability, related to a colour, wing,

or combination colour-wing showed the following ranges: 57.2 to 65 % (colour), 58.8 to 65.6 % (wing), and 51.0 to 82.0 % (wing-colour combination). In *Erythrodiplax umbrata*, 630 individuals (106 males, 524 females) were marked, the resighting probability, by a colour, wing, or combination colour-wing, was in the following range: 90.1 to 95.7 % (colour), 90.4 to 95.2 % (wing), and 87.5 to 97.8 % (wing-colour combination). According to Pearson chi square tests (Tabs 1 and 2), for none of the species, the colour, wing (Tab. 1) or wing-colour combination (Tab. 2) used for marking were associated to the resighting probability. The number of individuals marked here is adequate to perform the statistics tests, since the results from the equation for data where the main variable is qualitative in finite populations, which estimated only *M. laterale* 269 individuals were required out of the 1,610 individuals that were marked, while 167 individuals of *E. umbrata* were necessary out of 630 individuals marked of this species.

The sex ratio in the recapture rate showed bias towards *M. laterale* males (3:1), and towards the *E. umbrata* females (1:5), however, there was no significant difference among sexes for both species ($p = 0.30$ and $p = 0.98$, respectively).

## Discussion

Beirinckx et al. (2006) and Cordero & Stoks (2008) found that in odonates the likelihood of recapture is higher for males, which could be relevant to evaluate the effect of marking. Even though the sex ratio showed bias towards *M. laterale* males (3:1) and towards *E. umbrata* females (1:5), there was no significant difference in the recapture rate among sexes for species in our study.

According to Mallet et al. (1987), handling during the marking procedure could increase mortality or induce dispersive behaviour, resulting in a decreasing likelihood of recapturing marked individuals. Cordero (1994) found that the immediate mortality after marking is almost nil, so it is probable that the individuals leaving the reproductive sites are stressed by the handling during this procedure.

Manly (1971) evaluated the effect of wing marking in the marking–recapture data of *Enallagma cyathigerum* (Charpentier, 1840), concluding that there was no negative effect from the marking over the total of the sam-

**Table 1.** Resighting probabilities of *Mesamphiagrion laterale* and *Erythrodiplax umbrata* in this study according to colour type of mark and marked wing. N – number of individuals; RC – number of individuals recaptured; PR – probability of resighting; FW – fore wing; HW – hind wing. *P*-values are from $X^2$-contingency tests. The probability of resighting according to the contingency tests is given in parentheses.

| Colour or wing | *M. laterale* | | | | Colour or Wing | *E. umbrata* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | RC | PR | *P* | | N | RC | PR | *P* |
| Black (90.2 %) | 368 | 227 | 0.6 | 0.2 | Black (61.9 %) | 174 | 19 | 0.1 | 0.05 |
| No black | 1,242 | 799 | 0.6 | | No black | 456 | 28 | 0.06 | |
| Blue (94.8 %) | 509 | 273 | 0.5 | 0.1 | Blue (65.1 %) | 183 | 10 | 0.05 | 0.2 |
| No blue | 1,101 | 744 | 0.6 | | No blue | 447 | 37 | 0.08 | |
| Green (95.7 %) | 373 | 254 | 0.6 | 0.1 | Green (59.5 %) | 135 | 6 | 0.04 | 0.3 |
| No green | 1,237 | 763 | 0.6 | | No green | 495 | 41 | 0.08 | |
| Red (92.0 %) | 364 | 272 | 0.7 | 0.1 | Red (57.2 %) | 138 | 12 | 0.08 | 0.1 |
| No red | 1,246 | 745 | 0.6 | | No red | 492 | 35 | 0.07 | |
| FW right (93.6 %) | 398 | 279 | 0.7 | 0.1 | FW right (58.8 %) | 160 | 11 | 0.07 | 0.2 |
| No FW right | 1,212 | 733 | 0.6 | | No FW right | 470 | 36 | 0.07 | |
| FW left (93.3 %) | 378 | 262 | 0.7 | 0.1 | FW left (59.1 %) | 152 | 11 | 0.07 | 0.2 |
| No FW left | 1,232 | 750 | 0.6 | | No FW left | 478 | 36 | 0.07 | |
| HW right (95.2 %) | 528 | 277 | 0.5 | 0.1 | HW right (65.6 %) | 158 | 8 | 0.05 | 0.2 |
| No HW right | 1,082 | 735 | 0.6 | | No HW right | 472 | 39 | 0.08 | |
| HW left (90.4 %) | 311 | 194 | 0.6 | 0.2 | HW left (61.6 %) | 160 | 17 | 0.1 | 0.07 |
| No HW left | 1,299 | 818 | 0.6 | | No HW left | 470 | 30 | 0.06 | |

ple studied. Nonetheless, Manly (1971) found a type of temporal marking effect, which reduces the survival of the organisms, specifically in the first days after marking has begun. Although he did not explain the possible causes leading to this effect, we infer that this might be a consequence of a "learning curve" during which the investigator is gaining experience in manipulating the organisms carefully.

Although Manly (1971) did not find an effect of marking over the whole sample, other authors have reported the effect of this technique (Parr & Parr 1979; Banks & Thompson 1985; Fincke 1986) in studies with other odonate species. Hannon & Hafernik (2007) explained that the effect of marking in their study could be a consequence of two situations: Firstly, prolonged han-

**Table 2.** Resighting probabilities of *Mesamphiagrion laterale* and *Erythrodiplax umbrata* in this study for marked wing-colour type. N – number of individuals; RC – number of individuals recaptured; PR – probability of resighting; FW – fore wing; HW – hind wing. *P*-values are from $X^2$-contingency tests. The probability of resighting according to the contingency tests is given in parentheses.

| Wing-colour combination | *M. laterale* | | | | Wing-colour combination | *E. umbrata* | | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | RC | PR | *P* | | N | RC | PR | *P* |
| FW right red (94.6 %) | 100 | 88 | 0.8 | 0.4 | FW right red (53.2 %) | 35 | 2 | 0.05 | 0.4 |
| No FW right red | 1,510 | 937 | 0.6 | | No FW right red | 595 | 47 | 0.07 | |
| FW left red (89.2 %) | 71 | 56 | 0.7 | 0.4 | FW left red (55.9 %) | 33 | 4 | 0.1 | 0.3 |
| No FW left red | 1,539 | 969 | 0.6 | | No FW left red | 597 | 45 | 0.07 | |
| HW right red (94.3 %) | 135 | 84 | 0.6 | 0.4 | HW right red (61.6 %) | 33 | 2 | 0.06 | 0.4 |
| No HW right red | 1,475 | 941 | 0.6 | | No HW right red | 597 | 47 | 0.07 | |
| HW left red (91.2 %) | 62 | 43 | 0.7 | 0.4 | HW left red (59.1 %) | 31 | 3 | 0.09 | 0.3 |
| No HW left red | 1,548 | 982 | 0.6 | | No HW left red | 599 | 46 | 0.07 | |
| FW right black (87.8 %) | 75 | 55 | 0.7 | 0.4 | FW right black (57.7 %) | 36 | 5 | 0.13 | 0.3 |
| No FW right black | 1,535 | 970 | 0.6 | | No FW right black | 595 | 44 | 0.07 | |
| FW left black (88.0 %) | 91 | 87 | 0.9 | 0.4 | FW left black (51.1 %) | 44 | 6 | 0.13 | 0.3 |
| No FW left black | 1,519 | 938 | 0.6 | | No FW left black | 586 | 43 | 0.07 | |
| HW right black (92.0 %) | 141 | 31 | 0.2 | 0.4 | HW right black (82.0 %) | 46 | 4 | 0.08 | 0.3 |
| No HW right black | 1,469 | 986 | 0.6 | | No HW right black | 584 | 45 | 0.3 | |
| HW left black (87.5 %) | 59 | 45 | 0.7 | 0.4 | HW left black (56.7 %) | 49 | 7 | 0.3 | 0.3 |
| No HW left black | 1,551 | 980 | 0.6 | | No HW left black | 581 | 42 | 0.07 | |
| FW right blue (94.7 %) | 113 | 72 | 0.6 | 0.4 | FW right blue (61.1 %) | 54 | 3 | 0.05 | 0.3 |
| No FW right blue | 1,497 | 953 | 0.6 | | No FW right blue | 576 | 46 | 0.08 | |
| FW left blue (91.5 %) | 93 | 38 | 0.4 | 0.4 | FW left blue (71.0 %) | 43 | 4 | 0.09 | 0.3 |
| No FW left blue | 1,517 | 987 | 0.6 | | FW left blue | 587 | 45 | 0.07 | |
| HW right blue (97.8 %) | 126 | 65 | 0.5 | 0.4 | HW right blue (66.0 %) | 44 | 1 | 0.02 | 0.4 |
| No HW right blue | 1,484 | 960 | 0.6 | | No HW right blue | 586 | 48 | 0.08 | |
| HW left blue (93.9 %) | 174 | 95 | 0.5 | 0.4 | HW left blue (64.7 %) | 46 | 3 | 0.06 | 0.3 |
| No HW left blue | 1,436 | 930 | 0.6 | | No HW left blue | 584 | 46 | 0.07 | |
| FW right green (97.8 %) | 110 | 64 | 0.5 | 0.4 | FW right green (63.2 %) | 33 | 0 | 0 | 0.4 |
| No FW right green | 1,500 | 961 | 0.6 | | No FW right green | 597 | 49 | 0.08 | |
| FW left green (94.3 %) | 123 | 81 | 0.6 | 0.4 | FW left green (60.3 %) | 33 | 2 | 0.06 | 0.4 |
| No FW left green | 1,487 | 944 | 0.6 | | No FW left green | 597 | 47 | 0.07 | |
| HW right green (94.4 %) | 120 | 97 | 0.8 | 0.4 | HW right green (55.3 %) | 34 | 2 | 0.05 | 0.4 |
| No HW right green | 1,490 | 928 | 0.6 | | No HW right green | 596 | 47 | 0.07 | |
| HW left green (94.7 %) | 16 | 11 | 0.6 | 0.4 | HW left green (59.3 %) | 36 | 2 | 0.05 | 0.4 |
| No HW left green | 1,594 | 1,014 | 0.6 | | No HW left green | 594 | 47 | 0.08 | |

dling time between marking and release, and secondly that the release did not occur in the capture site. Michiels & Dhondt (1989) did not find a marking effect, but they reported of damage on the wings of old individuals due to marking. Uéda & Iwasaki (1982), Nomakuchi et al. (1988), and Fincke (1988) found an increase in mortality due to handling during marking, probably as a consequence of the fact that in these studies several individuals were marked in the teneral state, in which they are susceptible to suffer damages because their integument is not hardened yet. In a population study (FPR & NACS unpubl. data) with *Euthore fasciata* (Hagen in Selys, 1853), we found that substances as liquid paper®, a correction fluid, produced a negative effect, possibly as a result of the increase in the weight of the organism.

In this study, we avoided using those methods discussed above which resulted in harm to the insects and recommend when conducting MRR on Odonata, to write unique codes of several digits on any of the wings with fine point and permanent ink markers in the colours used in this study. We also make the following recommendations:

i) Test the marking method before the beginning of the study, in order to practice the handling of the organisms and to corroborate that the method is effective to obtain the required data.
ii) Mark with permanent ink so the mark will endure until an individual's death.
iii) Do the marks with fine point markers just once; to re-write the codes might break or damage the wing, which will affect the behaviour and survival rate of an individual.
iv) The marks must be precise and easy to see; their rapid detection with binoculars, or other means, helps to reduce the manipulation of individuals during recapture.
v) Avoid handling individuals during marking for an extended period of time.
vi) The release must occur at the capture site.
vii) Do not mark individuals in a teneral state; they might be damaged and the marks can be erased.
viii) Do not use substances for marking that might increase the weight of an individual and, as a consequence, its behaviour and chance of survival.

## Acknowledgements

We are grateful to Andrea C. Penagos, Diego A. Palacino, Juan G. Martínez, and Laura Mesa for valuable assistance in the field. We thank Drs José Antonio Gómez-Anaya, Alexander Sabogal-González, Rodolfo Novelo-Gutiérrez, and Adolfo Cordero-Rivera for their scientific support. Thanks to Drs Alex Córdoba-Aguilar and Florian Weihrauch and biologist Cornelio A. Bota-Sierra for their corrections and suggestions during the editing of this manuscript. We furthermore thank the Grupo de Investigación en Odonatos de Colombia (GINOCO), Laboratorio de Artrópodos-Biotecnología del Centro Internacional de Física (CIF), Universidad Nacional de Colombia, and Departamento de Biología, Facultad de Ciencias, Universidad El Bosque (Bogotá, Colombia) for the scientific support.

## References

Anderson C.N. & Grether G.F. 2010. Interspecific aggression and character Displacement of competitor recognition in *Hetaerina* damselflies. *Proceedings of the Royal Society of London* [B, Biological Sciences] 277: 549-555

Anderson C.N., Córdoba-Aguilar A., Drury J.P. & Grether G.F. 2011. An assessment of marking techniques in the family Calopterygidae. *Entomologia experimentalis et applicata* 141: 258-261

Arnason N.A., Schwarz C.J. & Boyer G. 1998. POPAN-5. A data maintenance and analysis system for mark-recapture data. Department of Computer Science, University of Manitoba, Manitoba

Badii M.H., Guillen A., Cerna E. & Valenzuela J. 2011. Nociones introductorias de muestreo estadístico. *Daena: International Journal of good Conscience* 6: 89-105

Banks M.J. & Thompson D.J. 1985. Lifetime mating success in the damselfly *Coenagrion puella*. *Animal Behaviour* 33: 1175-1183

Beirinckx K., Van Gossum H., Lajeunesse J. & Forbes R. 2006. Sex biases in dispersal and philopatry: insights from a meta-analysis based on capture-mark-recapture studies of damselflies. *Oikos* 113: 539-547

Beukema J.J. 2002. Survival rates, site fidelity and homing ability in territorial *Calopteryx haemorrhoidalis* (Vander Linden) (Zygoptera: Calopterygidae). *Odonatologica* 31: 9-22

Cordero[-Rivera] A. 1994. The effect of sex and age on survivorship of adult damselflies in the laboratory (Zygoptera: Coenagrionidae). *Odonatologica* 23: 1-12

Cordero-Rivera A. & Stoks R. 2008. Mark–recapture studies and demography. In: A. Córdoba-Aguilar (Ed.), Dragonflies and damselflies: Model individuals for ecological and evolutionary research: 7-20. Oxford University Press, Oxford

Fincke O.M. 1986. Lifetime reproductive success and the opportunity for selection in a nonterritorial damselfly (Odonata, Coenagrionidae). *Evolution* 40: 791-803

Fincke O.M. 1988. Sources of variation in lifetime reproductive success in a nonterritorial damselfly (Odonata: Coenagrionidae). In: T.H. Clutton-Brock (Ed.), Reproductive success: studies of individual variation of contrasting breeding systems: 24-43. The University of Chicago Press, Chicago, IL

Grether G.F. 1996. Sexual selection and survival selection on wing colouration and body size in the rubyspot damselfly *Hetaerina americana*. *Evolution* 50: 1939-1948

Grether G.F. 1997. Survival cost of an intrasexually selected ornament in a damselfly. *Proceedings of the Royal Society of London* [B, Biological Sciences] 264: 207-210

Grether G.F. & Grey R.M. 1996. Novel cost of a sexually selected trait in the rubyspot damselfly *Hetaerina americana*: conspicuousness to prey. *Behavioral Ecology* 7: 465-473

Hagan J.M. & Reed J.M. 1988. Red colour bands reduce fledgling success in red-cockaded woodpeckers. *The Auk* 105: 498-503

Hannon E.R. & Hafernik J.E. 2007. Reintroduction of the rare damselfly *Ischnura gemina* (Odonata: Coenagrionidae) into an urban California park. *Journal of Insect Conservation* 11: 141-149

Koenig W.D. & Albano S.S. 1985. Patterns of territoriality and mating success in the whitetailed skimmer *Plathemis lidia* (Odonata: Anisoptera). *The American Midland Naturalist* 114: 1-12

Koenig W.D. & Albano S.S. 1987. Lifetime reproductive success, selection, and the opportunity for selection in the whitetailed skimmer *Plathemis lidia* (Odonata: Libellulidae). *Evolution* 41: 22-36

Mallet J., Longino J.T., Murawski A. & Simpson De Gamboa A. 1987. Handling effects in *Heliconius*: where do all the butterflies go? *Journal of Animal Ecology* 56: 377-386

Manly B.F.J. 1971. Estimates of a marking effect with capture-recapture sampling. *Journal of applied Ecology* 8: 181-189

Michiels N. K. & Dhondt A.A. 1989. Effects of emergence characteristics on longevity and maturation in the dragonfly *Sympetrum danae* (Anisoptera: Libellulidae). *Hydrobiologia* 171: 149-158

Nomakuchi S., Higashi K. & Maeda M. 1988. Synchronization of reproductive period among the two male forms and female of the damselfly *Mnais pruinosa* Selys (Zygoptera: Calopterygidae). *Ecological Research* 3: 75-87

Palacino-Rodríguez F., Contreras N. & Córdoba-Aguilar A. 2012. Population structure in dry and rainy seasons in *Erythrodiplax umbrata* (Linnaeus, 1758) (Odonata: Libellulidae). *Odonatologica* 41: 245-249

Parr M.J. & Parr M. 1979. Some observations on *Ceriagrion tenellum* (De Villers) in southern England (Zygoptera: Coenagrionidae). *Odonatologica* 8: 171-194

Southwood T.R.E. & Henderson P.A. 2000. Ecological methods. 3rd ed. Blackwell Science, Oxford

Uéda T. & Iwasaki M. 1982. Changes in the survivorship, distribution and movement pattern during the adult life of a damselfly, *Lestes temporalis* (Zygoptera: Odonata). *Advances in Odonatology* 1: 281-291

Watanabe M., Matsuoka H. & Taguchi M. 2004. Habitat selection and population parameters of *Sympetrum infuscatum* (Selys) during sexually mature stages in a cool temperate zone of Japan (Anisoptera: Libellulidae). *Odonatologica* 33: 169-179