

## An update on the distribution of threatened odonate species from the Greater Antilles

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(Received 4 February 2014; accepted 20 May 2014)

The Antilles harbour several island endemic odonate species, including some palaeoendemics, within a relatively small and anthropized area. Such attributes give this archipelago a special significance for the conservation of Odonata in the Neotropics. However, despite the importance of these islands, inadequately surveyed regions persist, mainly in the Greater Antilles, and there is not enough information to set IUCN threat categories for eight species supposed to be at risk, which are currently classified as data deficient (DD). To update the distribution of endangered (EN), vulnerable (VU) and DD species, we conducted a series of field surveys in Dominican Republic, Jamaica and Cuba, and compiled data from literature, museum collections as well as personal communications. We sampled a total of 37 species, including *Microneura caligata*, *Phyllestes ethelae* and *Hypolestes clara* (EN); *H. trinitatis* (VU); and *Diceratobasis macrogaster*, *Neoneura maria* and *Protoneura capillaris* (DD). We provide new locality records for *M. caligata*, *N. carnatica* (DD), *N. maria* (DD), *P. capillaris*, *H. clara*, *H. trinitatis* and *Erythrodiplax bromeliicola* (DD). According to our results, we suggest changing the category of *D. macrogaster*, *D. melanogaster*, *N. carnatica*, *N. maria* and *P. capillaris* to VU.

**Keywords:** Odonata; dragonfly; West Indies; distribution; conservation

### Introduction

The archipelago of the Antilles represents one of the most important centres of endemism, biodiversity and speciation in the world (Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000). It extends from south-east of the Florida peninsula (USA) and east of the Yucatan (Mexico) in North America, to near the west of Venezuela in South America; and comprises the archipelagos of the Bahamas, the Greater and the Lesser Antilles (Figure 1).

This region constitutes a priority region for the conservation of odonates in the Neotropics, due to the high number of endemic species restricted to a small area with a very intense anthropogenic pressure (Paulson, 2004). From a phylogeographic perspective, the Antilles are of great interest since they host isolated taxa such as *Hypolestes*, the only member of the Megapodagrionidae

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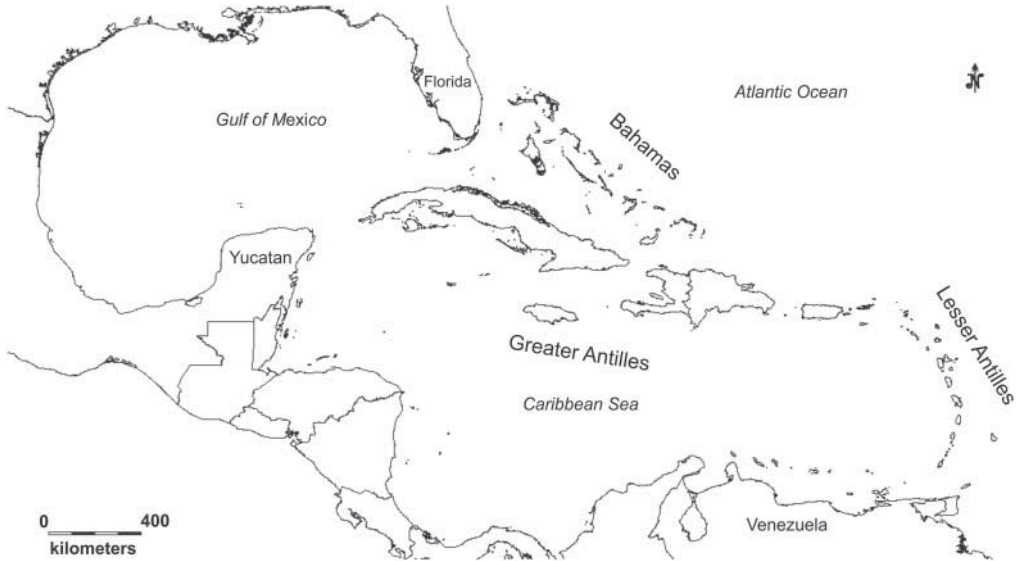


Figure 1. Location of the Antilles (Bahamas, Greater Antilles, and Lesser Antilles). © 2014 Bjørn Sandvik. This content is licensed under a [Commons Attribution-Share Alike License 3.0](https://creativecommons.org/licenses/by-sa/3.0/).

*s. lat.* in this region, and *Phyllestes ethelae*, the only representative of Synlestidae in the New World (Westfall & May, 2006). Also of particular relevance is the monotypic genus *Microneura*, confined to the mountains of central Cuba (Ramos & Rodríguez, 2012; Trapero-Quintana & Naranjo López, 2003). Furthermore, some of these island endemics show unusual life histories, such as *Diceratobasis macrogaster* and *D. melanogaster*, which breed in phytotelmata (Garrison, 1986).

The Greater Antilles (Cuba, Hispaniola, Jamaica and Puerto Rico) are the largest and oldest of these islands (Iturralde-Vinent & McPhee, 1999), and they harbour the highest diversity of freshwater habitats. These are probably the reasons they have the highest odonate species richness: 98 out of the 111 species found in the Antilles inhabit one or more of the first three islands, and their endemic fauna represents 76% (26) of the total number of endemics (34) in the area (Meurgey & Poiron 2012). Furthermore, 13 species are single island endemics: *Protoneura capillaris*, *Neoneura maria*, *N. carnatica*, *Microneura caligata* and *Enallagma truncatum* from Cuba; *Protoneura sanguinipes*, *P. dunklei*, *Progomphus serenus*, *P. zephyrus*, *P. tennesse*, *Diceratobasis melanogaster* and *Phyllestes ethelae* from Hispaniola; and *D. macrogaster* from Jamaica (Westfall & May 2006).

Taxonomical lists and data on odonate species distribution are available for Cuba (Trapero-Quintana & Naranjo López, 2003; Trapero-Quintana & Torres Cambas, 2008) and Dominican Republic (Daigle, 1993a, 1996a; Flint, Bastardo & Péres-Gelabert, 2006), although some regions within these islands remain as yet little explored. Information on odonate fauna from Haiti and Jamaica is both less numerous and less recent; and although some records can be found in Needham, Westfall & May (2000) and Westfall & May (2006), within the last 20 years virtually nothing has been published about the odonate fauna from these countries. In contrast, much more attention has been given to the odonate fauna of the Lesser Antilles, despite being less diverse than that of the Greater Antilles (Meurgey & Picard, 2011; Meurgey & Poiron, 2012).

With the exception of *Brechmorhoga grenadensis*, an endemic to Grenada island (Lesser Antilles) with a doubtful taxonomical status (Garrison, von Ellenrieder, & Louton, 2006; Meurgey & Picard, 2011), all Antillean odonate species catalogued by the International Union for Conservation of Nature (IUCN) ([www.iucnredlist.org](http://www.iucnredlist.org)) as “endangered” (EN), “vulnerable” (VU) or “data deficient” (DD), are restricted to Cuba, Hispaniola and Jamaica (Table 1). These include the

Table 1. West Indian odonates included in the Red List of the IUCN under the category of endangered (EN), vulnerable (VU) and data deficient (DD).

Family	Species	IUCN category	Distribution
Coenagrionidae	<i>Diceratobasis macrogaster</i> <sup>s</sup>	DD	Jamaica
	<i>Diceratobasis melanogaster</i>	DD	Hispaniola
	<i>Enallagma truncatum</i>	VU	Cuba
Synlestidae	<i>Phyllestes ethelae</i> <sup>s</sup>	EN	Hispaniola
Protoneuridae	<i>Microneura caligata</i> <sup>s</sup>	EN	Cuba
	<i>Neoneura carnatica</i>	DD	Cuba
	<i>Neoneura maria</i> <sup>s</sup>	DD	Cuba
	<i>Protoneura capillaris</i> <sup>s</sup>	DD	Cuba
Megapodagrionidae	<i>Hypolestes clara</i> <sup>s</sup>	EN	Hispaniola, Jamaica
	<i>H. trinitatis</i> <sup>s</sup>	VU	Cuba, Hispaniola
Gomphidae	<i>Progomphus serenus</i>	DD	Dominican Republic
	<i>P. tennesse</i>	EN	Dominican Republic
	<i>P. zephyrus</i> <sup>s</sup>	EN	Dominican Republic
Libellulidae	<i>Brechmorhoga grenadensis</i>	DD	Grenada
	<i>Erythrodiplax bromeliicola</i>	DD	Cuba, Jamaica

(s): sampled during the surveys carried out in this study.

single-island endemic species cited above, with the exception of *Protoneura sanguinipes* and *P. dunklei*; plus *Hypolestes clara*, *H. trinitatis* and *Erythrodiplax bromeliicola*. The lack of information on the distribution and ecology of eight of these species has not allowed them to be classified as threatened, but as DD, although it is supposed that they are at risk (Table 1). An improvement in the understanding of their status could be gained by compiling data that have been collected but remain unpublished or dispersed throughout scientific literature. Here, we present records from a series of field surveys that we conducted in Dominican Republic, Jamaica and Cuba, and combine them with other published or unpublished records, to update the distribution and status of threatened and DD odonates from Greater Antilles.

## Materials and methods

### Field surveys

We collected odonates in 21 localities in Dominican Republic, Jamaica and Cuba, between 9 May and 16 August 2012 (Table 2). Adults were collected with entomological aerial nets, exuviae by hand and larvae from bromeliads. For every single capture, we used a GPS to record geographic coordinates and elevation above sea level (asl). Taxonomic identification of collected specimens was done following Alayo (1968), Meurgey & Picard (2011), Trapero-Quintana & Naranjo López (2004, 2009) and Westfall & May (2006).

### Records from scientific literature, museum collections and personal communications

We compiled records from scientific literature, museum collections, and personal communications from odonatologists in a database, using the software Biota 2.04 (<http://viceroy.eeb.uconn.edu/biota>). When not provided by the source of information, coordinates were assigned to each record with the help of the database of foreign geographic feature names of the US National Imagery and Mapping Agency (NIMA) (<http://earth-info.nga.mil/gns/html/index.html>), the geographic dictionary of Cuba (Comisión Nacional de Nombres Geográficos, 2000) and the Cuban 1:50,000 map from the Instituto de Geodesia y Cartografía. Records from Cuba

Table 2. List of localities sampled by the authors in Dominican Republic (DR), Jamaica (J) and Cuba (C) during May and June 2012.

Country	Locality	Coordinates	Date (in 2012)	Time	Elev. (m)
DR	Arroyo Bermejo, Hatillo, Distrito Nacional (Be)	N 18°36'29" W 70°6'54"	9 May	09:00–13:00	85
	Arroyo Capacito, Buena Vista, La Vega (Ca)	N 19°9'1" W 70°36'5"	10 May	09:00–10:00	540
	Alto de la Virgen, Jarabacoa, La Vega (Vi)	N 19°2'4" W 70°29'53"	10 May	13:50–14:30	1029
J	River Mammee, The Grove, Kingston (Mm)	N 18°1'48" W 76°44'2"	13 May	10:46–12:30	281
J	Wag Water river, Toms River, Castleton (Wa)	N 18°9'35" W 76°49'44"	14 May	13:20–15:30	171
	Reach Falls, Spring Valley, Manchioneal (Re)	N 18°1'53" W 76°18'38"	15 May	11:16–12:00	104
	Horse Savanna River, Holland Park (Ho)	N 17°59'26" W 76°15'11"	15 May	14:40–15:40	19
	Dry Harbour, Dunedin, St. Elisabeth (Dr)	N 18°6'15" W 77°46'15"	16 May	13:30–14:15	18
	Moneague, Middlesex, St. Ann (Mo)	N 18°14'51" W 77°3'22"	17 May	12:30–14:44	525
	Road to Corn Puss Gap, Bath (Co)	N 17°58'48" W 76°21'40"	18 May	12:00–13:57	347
C	Parque Guanayara, Topes de Collantes, Sancti Spiritus (Gu)	N 21°57'45" W 80°2'29"	21 May	10:00–12:15	376
	Río Turquino II (4 km upstream from the river estuary), Guamá, Santiago de Cuba (Ut)	N 19°57'41" W 76°45'10"	26 July	10:40–11:00	11
	Playa Girón, Ciénaga de Zapata, Matanzas (Gi)	N 22°3'56" W 81°1'54"	11 August	10:00–11:00	
	Boca de Guamá, Ciénaga de Zapata, Matanzas (Bo)	N 22°22'3" W 81°9'54"	12 August	12:00–13:00	
	Arroyo La Batata, Topes de Collantes (Ba)	N 21°54'24" W 80°2'14"	14 August	12:15–15:30	731
	Salto Vegas Grandes, Topes de Collantes (Vg)	N 21°54'51" W 80°0'9"	15 August	12:30–15:30	603
	La Represa, Topes de Collantes (Re)	N 21°54'27" W 80°1'20"	16 August	10:00–10:30	670

Abbreviations: Elev.: metres above sea level; Be: Arroyo Bermejo; Ca: Arroyo Capacito Vi: Alto de la Virgen; Mm: River Mammee; Wa: Wag Water River; Re: Reach Falls; Ho: Horse Savanna River; Dr: Dry Harbour; Mo: Moneague; Co: Road to Corn Puss Gap; Gu: Parque Guanayara Am: Alfredo Álvarez Mola; Ve: Arroyo Vegas Grandes; Ju: Arroyo El Junco; Mr: Los Morones; Ut: Río Turquino II; Gi: Playa Girón; Bo: Boca de Guamá; Ba: La Batata; Vg: Salto Vegas Grandes; Re: La Represa, Topes de Collantes.

were projected onto the map of Cuban protected areas (Centro Nacional de Áreas Protegidas, 2009) with DIVA-GIS 7.5 (<http://www.diva-gis.org/>). The layers with the boundaries of Cuba, Hispaniola and Jamaica were downloaded from <http://thematicmapping.org/downloads>.

The collections examined were those at the Instituto de Ecología y Sistemática (IES); Museo Felipe Poy (MFPUH), Universidad de La Habana and Museo Charles Ramsden (MCHR), Universidad de Oriente in Cuba; and the Institute of Jamaica (IJ). Other references to museum collections were extracted from the literature.

## Results

A total of 37 odonate species were sampled during the field surveys in 2012 (Table 3). *Microneura caligata*, *Phyllestes ethelae* and *Hypolestes clara* (all endangered); *H. trinitatis* (vulnerable); and *Diceratobasis macrogaster*, *Neoneura maria* and *Protoneura capillaris* (data deficient) deserve

Table 3. List of the odonate species sampled at 21 localities from Dominican Republic (DR), Jamaica (J) and Cuba (C) during May–August 2012.

Family	Species	Locality																				
		DR			J							C										
		Be	Ma	Vi	Mm	Wa	Re	Ho	Dr	Mo	Co	Gu	Am	Ve	Ju	Mr	Ut	Gi	Bo	Ba	Vg	Re
Coenagrionidae	<i>Diceratobasis macrogaster</i>									x	x											
	<i>Enallagma civile</i>											x										
	<i>E. coecum</i>	x	x		x	x	x	x		x	x	x		x	x	x						
	<i>Ischnura capreolus</i>								x				x									
	<i>I. hastata</i>								x				x					x				
	<i>I. ramburii</i>								x				x					x				
	<i>Leptobasis vacillans</i>								x													
	<i>Telebasis dominicana</i>	x	x																			
Lestidae	<i>Lestes sp.</i>								x													
	<i>L. tenuatus</i>												x									
Synlestidae	<i>Phylolestes ethelae</i>			x																		
Protoneuridae	<i>Microneura caligata</i>														x	x			x	x		
	<i>Neoneura maria</i>															x						
	<i>Protoneura capillaris</i>														x		x					
	<i>P. sanguinipes</i>	x																				
	<i>P. viridis</i>	x						x	x													
Megapodagrionidae	<i>Hypolestes clara</i>				x	x	x	x														
	<i>H. trinitatis</i>	x	x												x		x					
Gomphidae	<i>Progomphus integer</i>							x							x							
	<i>P. zephyrus</i>	x																				

(Continued)

Table 3. Continued.

Family	Species	Locality																				
		DR			J							C										
		Be	Ma	Vi	Mm	Wa	Re	Ho	Dr	Mo	Co	Gu	Am	Ve	Ju	Mr	Ut	Gi	Bo	Ba	Vg	Re
Libellulidae	<i>Brachymesia herbida</i>												x									
	<i>Cannaphila insularis funerea</i>													x								
	<i>Crocothemis servilia</i>												x					x				
	<i>Dythemis rufinervis</i>	x	x		x									x								
	<i>Erythemis plebeja</i>												x									
	<i>E. vesiculosa</i>												x				x		x			
	<i>Erythrodiplax justiniana</i>												x						x			
	<i>E. umbrata</i>												x									
	<i>Macrothemis celeno</i>	x	x		x	x									x		x	x				
	<i>Miathyria marcella</i>												x									
	<i>Orthemis macrostigma</i>				x																	
	<i>Orthemis ferruginea</i>												x						x			
	<i>Pantala flavescens</i>												x									
	<i>Perithemis domitia</i>	x											x						x			
	<i>Scapanea frontalis</i>	x	x	x	x									x		x						
	<i>Tramea abdominalis</i>												x									
	<i>T. onusta</i>												x									

Abbreviations: Be: Arroyo Bermejo; Ca: Arroyo Capacito Vi: Alto de la Virgen; Mm: River Mammee; Wa: Wag Water River; Re: Reach Falls; Ho: Horse Savanna River; Dr: Dry Harbour; Mo: Moneague; Co: Road to Corn Puss Gap; Gu: Parque Guanayara Am: Alfredo Álvarez Mola; Ve: Arroyo Vegas Grandes; Ju: Arroyo El Junco; Mr: Los Morones; Ut: Río Turquino II; Gi: Playa Girón; Bo: Boca de Guamá; Ba: La Batata; Vg: Salto Vegas Grandes; Re: La Represa.

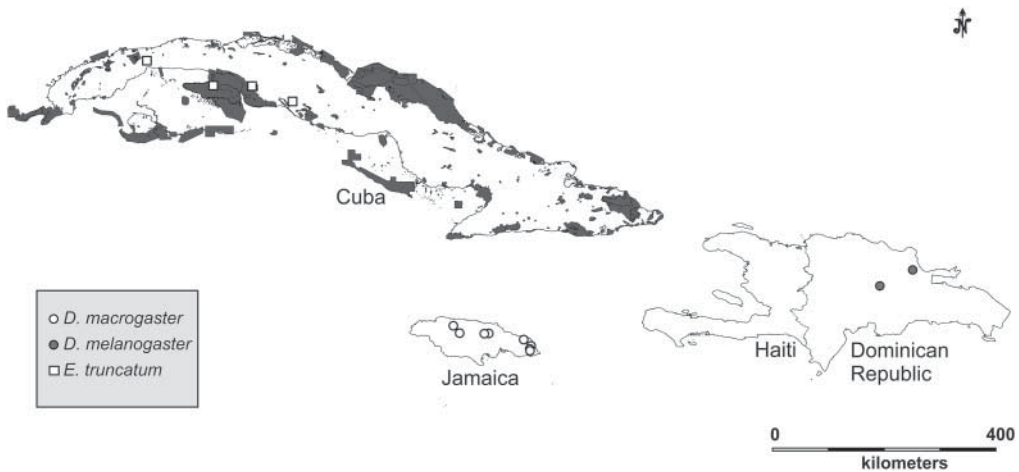


Figure 2. Distribution of *Diceratobasis macrogaster*, *D. melanogaster* and *Enallagma truncatum*. Cuban Protected Areas are shaded in grey. © 2014 Bjørn Sandvik. This content is licensed under a [Commons Attribution-Share Alike License 3.0](https://creativecommons.org/licenses/by-sa/4.0/).

special mention. Moreover, *Orthemis ferruginea* and *O. macrostigma* are confirmed for Cuba and Jamaica respectively, and *Lestes tenuatus* is reported for the first time from the province of Camagüey in Cuba. Below we provide detailed information on the distribution of the EN, VU and DD species from the Greater Antilles.

#### *Diceratobasis macrogaster* (Selys in Sagra, 1857)

This species, endemic to Jamaica, is reported from eight localities in five of 14 parishes of this country. We collected four larvae on leaf axils of *Tillandsia fasciculata* (Bromeliaceae) and 1 adult female at Moneague, near the location sampled by Westfall and Drummond in 1960 (Westfall, 1976) (Figure 2), and four females at the road to Corn Puss Gap, perching on plants on the bank of a stream and a forest road.

#### *D. melanogaster* (Garrison, 1986)

We did not collect this Dominican endemic species, but two records of localities extracted from the literature are compiled in the Supplemental material and shown in Figure 2. These records correspond to the provinces of La Vega and María Trinidad Sánchez; however, Daigle (1993a) also reports *D. melanogaster* from Monseñor Nouel province.

#### *Enallagma truncatum* (Gundlach, 1888)

This endemic to Cuba has been recorded four times, including the first described specimens collected in Zarabanda, south-west Cuba. The last record is from 1970 at La Turbera, Artemisa province, in south-western Cuba. *E. truncatum* is restricted to few localities in the south of the provinces Cienfuegos, Matanzas and Artemisa. The localities of Zarabanda and Maniadero are within the Reserve of the Biosphere Ciénaga de Zapata (Figure 2).

#### *Phyllestes ethelae* (Christiensen, 1947)

This species is endemic to Hispaniola; however the last record from Haiti was in 1960 (Westfall, 1976). We compiled five records from the Dominican Republic including one of a teneral male collected by us in a stream near Alto de la Virgen in La Vega Province (Figure 3; see also

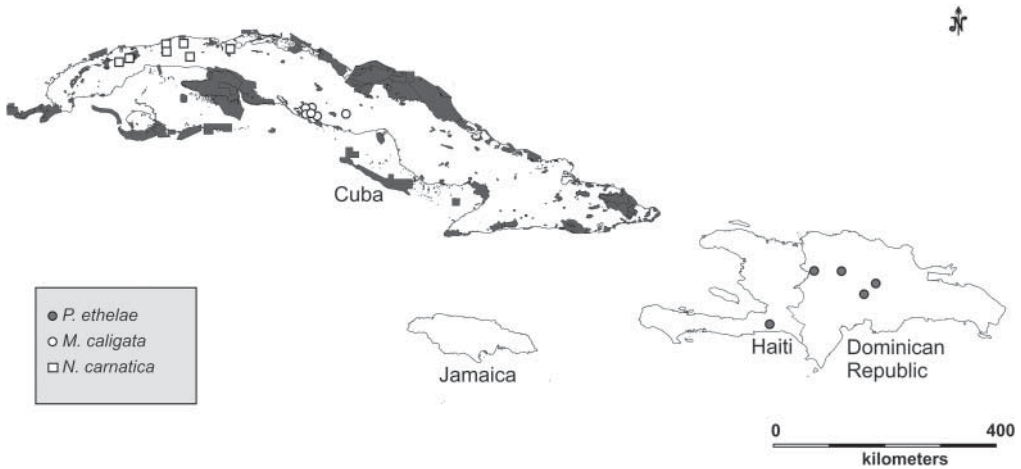


Figure 3. Distribution of *Phylolestes ethelae*, *Microneura caligata* and *Neoneura carnatica*. Cuban Protected Areas are shaded in grey. © 2014 Bjørn Sandvik. This content is licensed under a [Commons Attribution-Share Alike License 3.0](https://creativecommons.org/licenses/by-sa/4.0/).

Supplemental material). Our records are distributed through the provinces of La Vega, Elías Piña and Santiago; however, Flint et al. (2006) reported it also from Monseñor Nouel province.

***Microneura caligata*** (Hagen in Selys, 1886)

*M. caligata* is a Cuban endemic species restricted to the Guamuhaya Mountains, central Cuba. This species went unreported from 1973 to 2012 (Supplemental material), when it was observed in the Banao mountains, north-east of Topes de Collantes (Ramos & Rodríguez, 2012).

We spotted seven ovipositing pairs, five males and five females (one of them teneral) in Arroyo Vegas Grandes, the same stream where Westfall sampled it in 1959 (Westfall, 1964); six males and six females in Arroyo La Batata, and two ovipositing pairs in Salto Vegas Grandes (Figure 3; Supplemental material). All of these sites are included in the protected area Topes de Collantes. In addition, one teneral female was observed in Arroyo El Junco, a new locality, c.10 km north of Topes de Collantes. Ramos & Rodríguez (2012) recorded *M. caligata* from a stream located c.60 km east of Topes de Collantes, but in the same mountains.

***Neoneura carnatica*** (Selys, 1886)

This is an endemic species from Cuba that has been recorded from eight localities in western areas of the main island: Pinar del Río, Artemisa, La Habana and Matanzas provinces. Although we did not collect this species, we provide a new record for Guanabo, La Habana: one male collected in 1983 and deposited at MFPUH. It was reported for the last time in 1994 from Soroa and Candelaria, Artemisa (Flint, 1996). Three of these eight localities are in protected areas (Figure 3).

***N. maria*** (Scudder, 1866)

This is the only Cuban endemic species that is also found in Isla de la Juventud, the second largest island of the Cuban archipelago, located south-west of the main island (Figure 4; Supplemental material). We collected this species at Los Morones, Santiago de Cuba and Arroyo El Junco, Sancti Spíritus (Table 3). It is recorded from 21 localities, including 11 new records. Nine of the 21 localities are in protected areas.



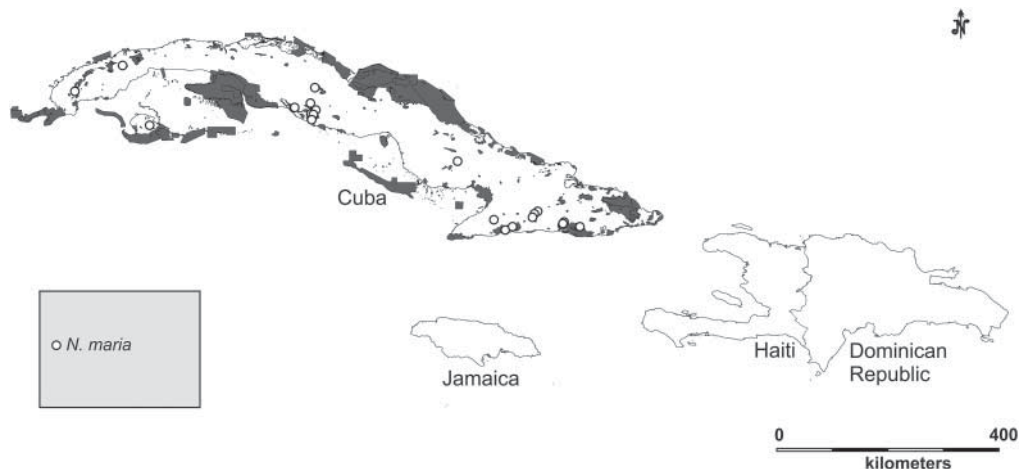


Figure 4. Distribution of *Neoneura maria*. Cuban Protected Areas are shaded in grey. © 2014 Bjørn Sandvik. This content is licensed under a [Commons Attribution-Share Alike License 3.0](https://creativecommons.org/licenses/by-sa/3.0/).

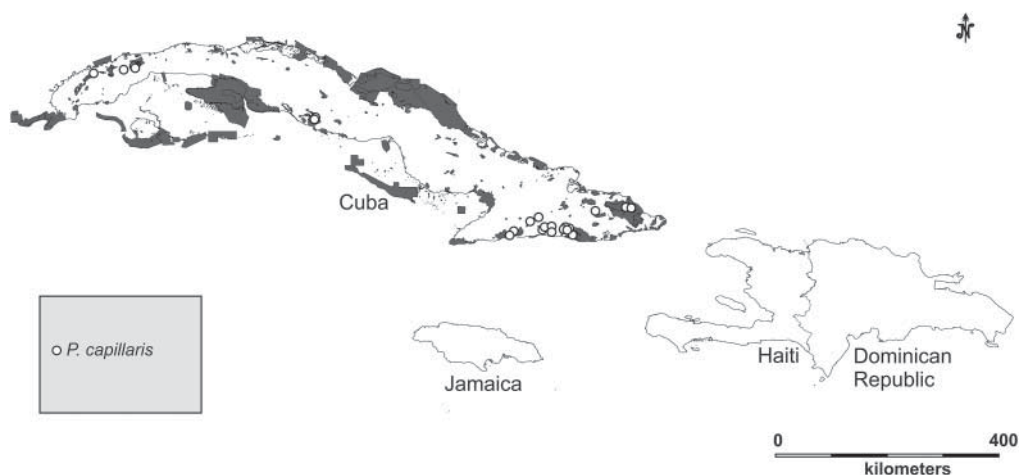


Figure 5. Distribution of *Protoneura capillaris*. Cuban Protected Areas are shaded in grey. © 2014 Bjørn Sandvik. This content is licensed under a [Commons Attribution-Share Alike License 3.0](https://creativecommons.org/licenses/by-sa/3.0/).

### *Protoneura capillaris* (Rambur, 1842)

This species is endemic to Cuba and it is present in 22 localities distributed throughout eight provinces (Figure 5; Supplemental material). All records are from areas at 200–800 m asl. We collected this species at Arroyo Vegas Grandes, Sancti Spíritus; and Los Morones. Of the 22 localities, nine are new records and 12 are in protected areas.

### *Hypolestes clara* (Calvert, 1891)

This species is widely distributed in Jamaica in 16 localities and five parishes (Figure 6). Calvert (1893) mentioned the locality of Bath for two paratypes of *H. clara*, but for the other specimens used in the species description he only stated that they were collected in Kingston or Jamaica. We collected *H. clara* from five localities in Jamaica (Table 3), all of them new records, with the exception of Bath (Supplemental file).

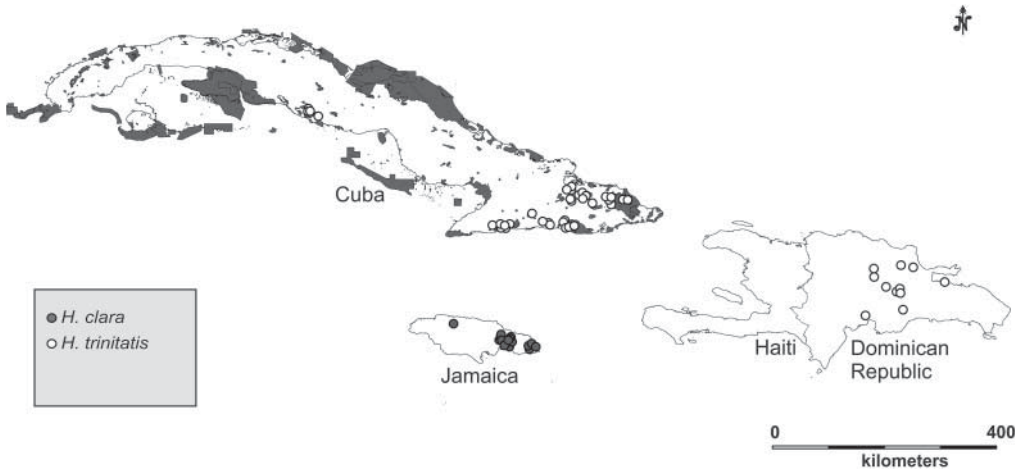


Figure 6. Distribution of *Hypolestes clara* and *H. trinitatis*. Cuban Protected Areas are shaded in grey. © 2014 Bjørn Sandvik. This content is licensed under a [Commons Attribution-Share Alike License 3.0](https://creativecommons.org/licenses/by-sa/3.0/).

### *H. trinitatis* (Gundlach, 1888)

This species, restricted to Cuba and Hispaniola, was collected by us in four localities in Cuba and two in the Dominican Republic (Table 3). There are 37 records from Cuba, located in the eastern (Sierra Maestra and Montañas de Nipe-Sagua-Baracoa) and central (Montañas de Gumuhaya) mountains (Figure 6), and 19 of them are published here for the first time (Supplemental material). Twenty-two of the localities from Cuba are inside protected areas (Figure 6).

We compiled 12 records in eight provinces of Dominican Republic, one of them unpublished (Figure 6, Supplemental file). In addition to these, the species is reported for the provinces of Barahona, San Cristóbal, Samaná and Puerto Plata (Daigle, 1993a; Flint et al., 2006) without other details that could lead us to determinate coordinates for these localities.

### *Progomphus serenus* (Hagen in Selys, 1878)

This endemic from Hispaniola is the most abundant of its genus in this island (Flint et al., 2006). However, we did not collect it and have coordinates only for three localities in three provinces (Figure 7; Supplemental material). Flint et al. (2006) recorded it for the provinces of La Vega, San Cristóbal, Santiago and Distrito Nacional. Needham (1941) mentioned one male deposited at Museum of Comparative Zoology at Cambridge, USA and collected four larvae in 1940 in the Dominican Republic sites, namely Arroyo Hondo, Río Ámina, Río Inoa and Bajo Millo. We were unable to determine coordinates for these sites following the given descriptions.

### *P. tenneseni* (Daigle 1996)

The only locality known for this species is the type locality at Río Guasara, La Vega province, Dominican Republic (Figure 7; Supplemental material).

### *P. zephyrus* (Needham, 1941)

This species is endemic to the Dominican Republic (Figure 7). We collected one male of *P. zephyrus* at Arroyo Bermejo, Santo Domingo province and recorded five localities, none of them new (Supplemental material).

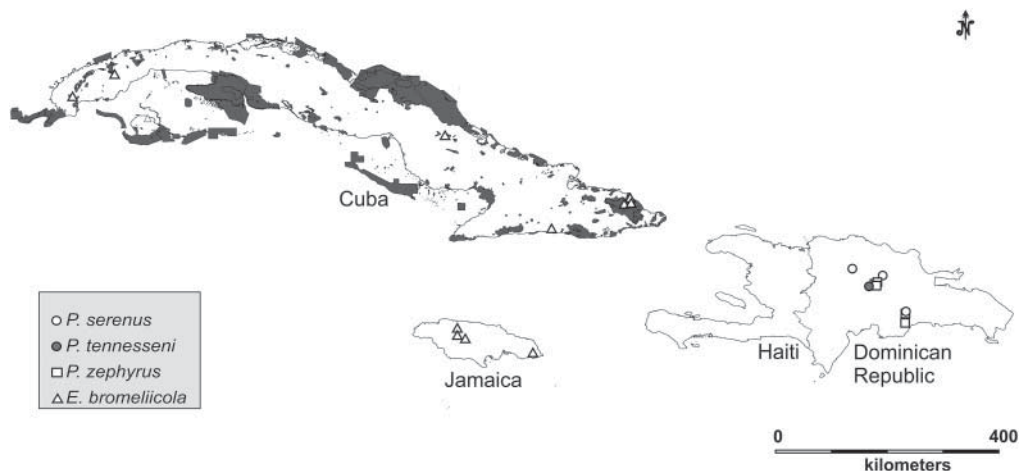


Figure 7. Distribution of *Progomphus serenus*, *P. tennesseus*, *P. zephyrus* and *E. bromeliicola*. Cuban Protected Areas are shaded in grey. © 2014 Bjørn Sandvik. This content is licensed under a [Commons Attribution-Share Alike License 3.0](https://creativecommons.org/licenses/by-sa/3.0/).

### *Erythrodiplax bromeliicola* (Westfall & May, 2000)

This species is known from Cuba and Jamaica, where it breeds in bromeliads (Figure 7; Supplemental material). In Cuba, larvae have been found in the axils of *Guzmania monostachia* at La Melba (Trapero-Quintana & Novelo-Gutierrez, 2012), *Tillandsia fasciculata* at Hoyo de Bonet, and *Hohenbergia penduliflora* at Los Portales (O. Bello, pers. comm., 2013). The species has been recorded at nine localities in Cuba, five of which are in protected areas, and two are new records (Figure 7). The records of this species from Jamaica are from the 1960s, and all data were extracted from the literature. *E. bromeliicola* has been recorded at five localities in three parishes on this island.

## Discussion

We have compiled and georeferenced locality records of all Greater Antillean odonates species classified as EN, VU or DD. This is the most comprehensive attempt to gather this kind of information on the Antillean odonates listed by the IUCN. Previously, records of these species had been included separately in checklists from each country (e.g. Daigle, 1993a; Flint et al., 2006 for Dominican Republic; and Flint, 1996; Trapero-Quintana & Naranjo-López, 2003 for Cuba), but in some cases coordinates had not been provided (e.g. Daigle, 1993a; Trapero-Quintana & Naranjo-López, 2003). Also, for the first time, the distribution of these odonates in relation to protected areas is analysed for Cuba.

Below, we discuss the distribution, status and threats of those species classified as EN, VU and DD in the Greater Antilles.

## *Diceratobasis*

*D. macrogaster* is endemic to Jamaica, where it is known from fewer than 10 localities. This island has a surface area of 10,991 km<sup>2</sup>, with 33% retaining natural forest and a high deforestation rate in the last two decades (FAO, 2010). Forest clearing, especially where relative humidity favours

storage of water in bromeliads, is a significant threat to this species. These arguments support a change of its status from DD to VU B1ab(iii).

*D. melanogaster* has been reported only from the Dominican Republic but it could be in the western part of Hispaniola, although the severe deforestation of Haiti is a matter of concern for its survival there. The most recent faunistic study of the odonates from the Dominican Republic gave a new record of this species (Flint et al., 2006); however, its occurrence range is limited. If we consider that the forest area in Hispaniola is 27,620 km<sup>2</sup> (FAO, 2010) and only those forests with high relative humidity are suitable for harbouring phytotelmata, then we could speculate that the occurrence range of *D. melanogaster* could be no more than 20,000 km<sup>2</sup>, and thus the category VU B1ab(iii) would be applicable to this species.

### ***Enallagma truncatum***

The records of this species for Santiago de Cuba and Baracoa, eastern Cuba (Trapero-Quintana & Naranjo-López, 2003) led us to think that its distribution was wider and was taken as an indicator of how poorly Cuban fauna have been surveyed (Paulson & von Ellenrieder, 2006). However, we re-examined these specimens, deposited at MCHR, and concluded that the record was due to a wrong identification, and the presence of this species is confirmed only at some localities in south-west Cuba. We thus agree with the category of VU assigned to this species by the IUCN.

### ***Phyllestes ethelae***

The depletion of forested areas in Haiti (FAO, 2010) is of great concern for the conservation of *P. ethelae*. There is a great chance that populations of this species from this country, where it was recorded for the last time in 1960 (Westfall, 1976), are extinct or severely threatened. In the Dominican Republic, although more surveyed, its occurrence is also rare. We confirm the category of VU given to this species by the IUCN.

### ***Microneura caligata***

This is the most threatened odonate in Cuba. The only records of this species away from the Guamuhaya mountains (central Cuba), at plains areas, were provided by Gundlach in the nineteenth century (as cited in Alayo, 1968), who collected it in Valle de Trinidad and Júcaro. However, it is unlikely that populations can be found at these localities nowadays, because most of the plains areas in Cuba were deforested in the first half of the twentieth century and transformed to sugar cane plantations or pasturelands. The distribution of this species as well as the threat to its habitat support *M. caligata* in the category of EN.

### ***Neoneura carnatica, N. maria and Protoneura capillaris***

We suggest that these species, currently classified as DD, should be changed to VU, in light of their geographic range, number of locations and the potential threats to which their habitat is subjected. All of these species inhabit forests and, although the role that vegetation plays in their life cycle is as yet poorly understood (as it is for most Neotropical odonates; Paulson, 2006), deforestation and subsequent habitat fragmentation is a major concern for their conservation.

Cuban forest areas, estimated to represent c.90% of the island's surface in 1492, fell to their lowest value in the 1950s, when they represented 14% (Pérez et al., 2011). According to the Global Forest Resource Assessment (FAO, 2010) and State of the World's Forests (FAO, 2012), this is the only country in the Antilles with a constant increase of forest area from 1990 to 2010. Nevertheless,

an increase in forest area should not be interpreted as an increase in the extent of Odonata habitat, as reforestation plans usually do not take into account forest structure and composition, issues that affect odonate assemblages (Rith-Najarian, 1998; Sahlén, 1999). Unfortunately, FAO reports do not distinguish between tree plantations (frequently of exotic species) and real forest recovery, which is a great source of confusion when discussing forest trends and their impact on biodiversity (Cordero-Rivera 2011).

*N. carnatica* has been reported in eight localities from western Cuba and four of them (Güines, Calabazar, Marianao and Guanacaro) have probably been affected by deforestation caused by urbanization and agriculture. This species is underrepresented in the Cuban Protected Area National System, since only 37.5% of its known populations are in protected areas.

*P. capillaris* has been recorded in 20 localities, a number higher than the threshold established by the IUCN for the category VU B1ab(iii), which is 10 ([www.iucnredlist.org](http://www.iucnredlist.org)). Nevertheless these records are concentrated around four geographically isolated massifs: 12 from Sierra Maestra, south-eastern Cuba; three from Nipe-Sagua-Baracoa, north-eastern Cuba; two from Guamuhaia, central Cuba; and four from Guaniguanico, western Cuba. The same is true for *N. maria*, with nine records from Sierra Maestra, six from Guamuhaia, and two from Guaniguanico. *N. maria* seems to be more tolerant to deforestation and a better disperser than *P. capillaris* since it has been also reported from Isla de la Juventud, the second largest island in the Cuban archipelago; as well as Río Sevilla at Camagüey and Santa Clara, sites affected by sugar cane plantation and urbanization respectively. However, its presence in areas relatively deforested could be an exception, and thus it is more prudent to be conservative about the capacity of this species to tolerate forest clearing.

### *Hypolestes*

*H. clara* has been recorded from Hispaniola and Jamaica, although its presence at the former is doubtful. The only record of *H. clara* in Hispaniola is from one male collected by M. J. Westfall probably near Furcy, Haiti. This specimen is in the Florida State Collection of Arthropods with its penis separated and there is uncertainty whether the penis was switched or the specimen mislabelled (Dunkle, 1991).

Reyes & Alvarez (2001) listed the odonates deposited at the IES collection and reported *H. trinitatis* from Soroa and Río Taco-Taco, western Cuba; however this is very probably a mistake because we did not find this specimen in that collection, nor has the species been recorded in this locality by other authors. Therefore, we confirm that this species is restricted to Cuba in the central and eastern mountains of the island as stated by Trapero-Quintana & Naranjo-López (2003).

The only record of this species from Haiti was by Calvert (1893) who described *Ortholestes abbotti*, later synonymized with *H. trinitatis* (Calvert, 1919) from one male. If this species is actually in Haiti, its populations would be severely threatened by deforestation. We have treated all the records from Dominican Republic as *Hypolestes trinitatis* following the traditional classification used by other authors (e.g. Daigle, 1993a; Flint et al., 2006), however the taxonomy of this genus needs to be reviewed in order to clarify whether specimens from Dominican Republic belong to *H. trinitatis*, *H. clara* or an undescribed taxon (Dunkle, 1991).

Although we found *H. clara* in five localities, and compiled records of another 10, most populations are confined to a relative small area in the Blue Mountains, at the eastern end of Jamaica near human settlements where logging of the riparian forest and household use of water could represent a threat. Therefore, we consider that this species should remain in the category EN. Regarding *H. trinitatis*, we agree with the category of VU, since although there are more than 10 records for this species, they are concentrated in Sierra Maestra, Nipe-Sagua-Baracoa and Guamuhaia.

### ***Progomphus***

*P. serenus* is supposed to be a common lowland species (Daigle, 1996b) in the Dominican Republic, although more surveys are needed to confirm this. In addition, its presence in Haiti must also be confirmed before making a judgement about its status, since the only record available is old. The ranges of *P. tennesse* and *P. zephyrus*, according to the reports compiled by us, support the designation of EN and VU respectively.

### ***Erythrodiplax bromeliicola***

Records of this species in Cuba, except those from western areas of the island, are relatively recent, which could mean that knowledge of its distribution is limited by the few surveys that have been conducted. Thus, a conclusion about its conservation status is not possible until more surveys are conducted.

**Note added in press:** After comprehensive morphological and genetical analyses of *Hypolestes* specimens from Cuba, Hispaniola and Jamaica, we have concluded that the specimens from Paraiso Caño Hondo, Río Jivales (19.0843 N -69.4159 W); Arroyo Bermejo (18.60803 N -70.1150 W) and Arroyo Capacito (19.15031 N -70.60150 W) in the Dominican Republic are different from *Hypolestes trinitatis* and *H. clara* and belong to a third species of *Hypolestes* (Torres-Cambas et al., submitted). Therefore all citations included in this paper as *H. trinitatis* from these localities refer to a different taxon. The citations of *H. trinitatis* from Hispaniola need to be reviewed in the future, as they could also belong to a different taxon.

### **Acknowledgements**

Financial support was received from a project funded by Spanish Ministry of Science and Innovation (CGL2010-11959-E), a project “Ciencia y Conciencia” funded by Universidad de Oriente, Cuba (project code 9617), and a WDA Conservation and Research Grant to YTC. Y. L. Rodríguez, R. I. Aguirre, Y. Roldán, J. Soria, A. Van’t Hof, R. Gea Couto, E. Aragón and the family Cambas-Armendariz were of valuable help during the collecting trips in Cuba. J. Daigle kindly identified the specimens of *Orthemis* and Jim Johnson provided one record of *Hypolestes trinitatis*. Orestes Bello shared unpublished records of *Erythrodiplax bromeliicola* in Cuba.

### **Funding**

This work was supported by Spanish Ministry of Science and Innovation [CGL2010-11959-E], Universidad de Oriente, Cuba [9617] and Worldwide Dragonfly Association.

### **Supplemental data**

Supplemental data for this article can be accessed in the online version [<http://dx.doi.org/10.1080/13887890.2014.928241>].

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