The Odonata of Quebec: Specimen data from seven collections

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Abstract

Background

The Odonata, dragonflies and damselflies, constitute one of the more charismatic and better-studied orders of insects. The approximately 6,000 extant species on Earth can be variously found on all continents, except Antarctica. A relatively stable taxonomy, a relative ease of species identification and an aquatic immature stage has made the Odonata a taxon of interest in documenting the symptoms of global environmental change, especially at higher latitudes. The Odonata fauna of the north-temperate Canadian province of Quebec includes 150 species, many of which are at the northern limits of their geographic distribution.

New information

Quebec hosts multiple entomological specimen depositories, including seven publicly-accessible research collections. One of these, the University of Montreal's Ouellet-Robert Entomological Collection, houses an exceptionally large collection of Odonata. An initial specimen data capture project for this collection gathered 31,595 Quebec Odonata...
occurrence records, but several Quebec species were missing and geographic coverage was biased towards the Montreal region. To complement this dataset, we undertook to digitise the Odonata records of six other public research collections. They are, in order of Quebec Odonata collection size, the Laval University Entomological Collection, McGill University’s Lyman Entomological Museum, the Insectarium of Montreal Research Collection, the Quebec Government's Insect Collection, Bishop's University's Insect Collection and the Laurentian Forestry Centre's René-Martineau Insectarium. Of the 40,447 total specimen occurrence records, 36,951 are identified to the species level, including 137 of the 150 species officially-recorded in Quebec and 2 non-nominotypical subspecies. We here summarise the data and highlight the strengths and weaknesses of the datasets. The complete dataset is available with this publication (Suppl. material 1), whereas the specimen data associated with each collection are available as Darwin Core archives at Canadensys.net and will be updated as appropriate.

Keywords
Anisoptera, Canada, damselfly, distribution, dragonfly, natural history collection, specimen digitisation, Zygoptera

Introduction
Dragonflies and damselflies (Insecta: Odonata) are large charismatic flying insects at the adult stage, aquatic naiads during their immature stages. Both adults and naiads are predatory, the former capturing their prey in flight, the latter using a distinctive extendable labial mask. Albeit generally less sensitive to water quality than mayflies, stoneflies and caddisflies (Ephemeroptera, Plecoptera and Trichoptera, respectively), Odonata naiads can be used as water quality indicators in some situations (Briers and Biggs 2003, Foote and Rice Hornung 2005, Osborn 2005). There are approximately 6,000 described species of Odonata (Dijkstra et al. 2013) and the conservation status of a large number of these is of concern (Gerlach et al. 2014, Clausnitzer and Jödicke 2004).

There are 150 species of Odonata recorded from the Canadian province of Quebec (151 listed by Savard (2019) minus the newly synonymised *Sympetrum janeae* Carle, 1993 (Paulson and Dunkle 2018, Pilgrim and Von Dohlen 2007)), representing 70% of the Canadian fauna (Cannings 2019) and one third of the species known from North America (Kalkman et al. 2007). Thanks to years of collection and study (Provancher 1871, Robert 1963, Pilon and Lagacé 1998, Hutchinson and Ménard 2014), the status of Quebec Odonata is relatively well-known (Cannings 2019). In places, there appears to be a replacement of specialist species by generalists (Piché and Hutchinson 2016), probably due to anthropogenic habitat change. In order to contribute to the Atlas of Quebec Odonata (Savard 2011), to promote the general knowledge of and future research on this group (e.g. Beatty et al. 2010, Grewe et al. 2012, Kalkman et al. 2018) and to facilitate the use of natural history museum data (e.g. Ball-Damerow et al. 2019, Lister 2011, Kharouba et al.
2018), we thought it important to digitise and make publicly accessible the specimen data in Quebec's public entomological collections.

The Odonata collections of Quebec

The Ouellet-Robert Entomological Collection at the University of Montreal has an exceptionally large holding of Odonata, so when the opportunity presented itself to digitise insect specimen data, this group was an obvious choice (Favret et al. 2019). Of the 33,122 Odonata specimen occurrence records in the Ouellet-Robert Collection, 31,595 (95%) are from the Canadian province of Quebec. However, of the 150 species of Odonata known from Quebec, the Ouellet-Robert Collection houses only 128 and their distribution records exhibit a "collection bias" (Ferro and Flick 2015) for the Montreal region (Fig. 1). Additionally, despite the large number of records, they are concentrated in a relatively small number of collection localities (222). In order to perform more rigorous distribution modelling and other computational analyses in the future, we sought to broaden the sampling, both geographically and taxonomically, by adding the specimen occurrence records from the other public research collections in Quebec. These include three other university collections and three governmental collections at the city, provincial and federal levels: McGill University's Lyman Museum, Bishop's and Laval Universities, the Insectarium of Montreal, the Government of Quebec and Natural Resources Canada's Laurentian Forestry Centre's Insectarium René Martineau (Table 1).

| Institution          | Collection                              | Location          | Canadensys DOI | No. occurrence records | No. species-level records | No. species | No. unique species | No. species-level collection localities |
|----------------------|-----------------------------------------|-------------------|----------------|------------------------|--------------------------|-------------|-------------------|---------------------------------------|
| University of Montreal | Ouellet-Robert Collection (QMOR)         | Montreal          | 10.5886/gwyt63fz | 31,595                 | 29,982                   | 128         | 3                 | 222                                   |
| Laval University     | Collection entomologique de l'Université Laval (ULQC) | Quebec City       | 10.5886/bxbpry  | 4,994                  | 4,993                    | 122         | 2                 | 296                                   |
| McGill University    | Lyman Entomological Museum (LEMQ)       | Sainte-Anne-de-Bellevue | 10.5886/g79vhp1e | 1,841                  | 270                      | 45          | 1                 | 39                                    |
| Insectarium of Montreal | (IMQC)                             | Montreal          | 10.5886/i6z1vo  | 922                    | 782                      | 110         | 1                 | 109                                   |

Table 1. Summary of Quebec insect research collections and their Quebec Odonata holdings.
**Sampling methods**

**Study extent:** We targeted the Odonata held in seven public insect research collections of Quebec, but it should be noted that there are a number of other public teaching collections in the many universities and CÉGEPs (post-secondary, pre-university schools) in Quebec. In addition, the amateur entomologist community is organised and active in Quebec (Association des Entomologistes Amateurs du Québec 2020, Entomofaune du Québec

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### Table: Sampling methods

| Collection Location                                                                 | Number of Specimens |
|------------------------------------------------------------------------------------|---------------------|
| Government of Quebec Collection d’Insectes du Québec (CIQ)                         | 655                 |
| Bishop's University Bishop's University Insect Collection (BUIC)                    | 228                 |
| Laurentian Forestry Centre Insectarium René-Martineau (IRM)                        | 212                 |
| TOTAL                                                                             | 40,459              |

**Figure 1.**

Collection localities of the Ouellet-Robert Collection specimens.

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2020) and, given the popularity of Odonata collecting, a large amount of material, not catalogued here, is held in private collections.

**Sampling description:** Data capture followed two distinct protocols. Prior to 2012 (Method 1), the Ouellet-Robert Collection specimen label data were parsed and captured manually and verbatim into an Excel spreadsheet. No photographs were taken. After import into a custom FileMaker Pro (FileMaker, Inc., Santa Clara, California, USA) relational database, locality georeferencing was conducted with reference to a downloaded gazeteer, the Canadian Geographical Names Data Base at Natural Resources Canada. Both the verbatim locality description and the gazeteer's locality name were recorded in the FileMaker database.

For the other six collections, after 2012 (Method 2), the digitisation process largely followed that described by Nelson et al. (2012). Labels of pinned specimens were removed and placed alongside the specimen, a unique identifier label was added and the ensemble was photographed (Fig. 2). Glassine envelopes were photographed as found, with the occasional displacement of the specimens in cases where they obstructed the labels (Fig. 3). Unfortunately, we were inconsistent in our use of calibration scale. We found that the rate of photography was optimal with three workers, the first preparing the specimens, the second photographing them, the third replacing them. With this set-up, we photographed an average of 1.2 pinned specimens and 4.0 envelopes per minute. Photograph files were renamed, either manually or with a simple Perl script that added the collection code and sequential numbers, to correspond to each specimen's unique identifier, allowing for batch importation into a rapid-input FileMaker database.

**Figure 2.** Example of pinned specimen photograph with labels removed.
In order to accelerate data input, only three numbers and one date were captured manually: 1) The taxon, based on the most recent determination, was captured with a reference ID to a nomenclator built on several taxonomic checklists (Paulson and Dunkle 2018, Garrison and von Ellenrieder 2016). 2) The collection locality, with its geoposition coordinates, was recorded with another reference ID to the same gazeteer mentioned above. Finally, 3) the collection date and 4) the number of specimens represented by each museum object (e.g. several specimens in a single glassine envelope (Fig. 3)) were recorded. Taxonomic data were added during batch import of the photographs. The other three data fields were added by hourly undergraduate employees, referencing the photos and the gazeteer. Their average data capture rate of 106 museum objects per hour was speeded up when multiple specimens in a row had been collected at the same locality.

Figures for the efficiency of the Ouellet-Robert Collection data capture are unavailable (Method 1). However, based on previous experience (Favret and Dewalt 2002), we estimate that it proceeded at approximately 12 museum objects per hour. On the other hand, photographing the museum objects first and then choosing to capture only the most critical data assured a higher rate (Method 2). Including photography, file naming and import and data capture, but excluding time for set-up, we averaged 19 objects per person-hour for pinned specimens, 44 for glassine envelopes. Although some data were not captured in the database, for example, the collector and determiner, these are available on the photographs and can be incorporated into the database in the future, as resources allow, without having to re-access the actual physical specimen.

**Quality control:** The taxonomic nomenclature was referenced with the latest sources and is up-to-date. Additionally, most identifications were made by experts in Odonata taxonomy,
most notably Adrien Robert and Jean-Marie Perron at the University of Montreal and Laval University, respectively. However, we did not re-identify every specimen and some of the taxonomy has changed since the original identifications, especially those of Robert. Notably, 663 specimens were identified as *Enallagma cyathigerum* (Charpentier, 1840), a species now known to be absent from North America. What was labelled as *E. cyathigerum* may properly be attributed the name *Enallagma annexum* (Hagen, 1861) (Turgeon et al. 2005). Alternatively, some specimens may actually be *Enallagma vernale* Gloyd, 1943, as this latter species was once considered a subspecies of *E. cyathigerum* (Donnelly 1989).

Taxonomic determination is always subject to error and revision and users of the data should bear this in mind.

Likewise, the geographic latitude and longitude coordinates reference precise localities in Quebec. In most cases, we were able to pinpoint the historical collection locality to within a radius of approximately 10 km, that is, for most towns and lakes. Larger geographic regions, for example, the Montreal metropolis, were assigned an imprecision of 100 km radius. Locality names that did not occur in our geographic gazetteer but that were nonetheless clearly Quebec locations were assigned a geoposition in the geographic centre of the province. These geographic coordinates were assigned a high level of imprecision (i.e. 1,000 km radius) and therefore should be filtered out of any data analysis that requires more specific locality data. Some place names refer to more than one locality and this is especially true for Quebec lakes (for example, the Canadian Geographic Names Data Base contains 144 Quebec entries for "Lac Rond"). We were sometimes able to establish which one was the correct collection locality (much research was conducted at the University of Montreal Laurentian Biological Research Station’s Lac Rond), but otherwise we tried to be conservative by selecting a higher geographic level, most commonly the province itself. A certain number of geopositions can be refined in the future; these data will be updated and made available in the Canadensys.net datasets as time and resources allow. The geoposition coordinates were mapped with Simplmapp (Shorthouse 2010) to confirm that they all fell within the province of Quebec and to correct the two that did not.

**Geographic coverage**

**Description:** The specimen records are from the province of Quebec, Canada, comprising an area of approximately 1.5 million square km.

**Coordinates:** 44.99° and 62.59° Latitude; -57.10° and -79.76° Longitude.

**Taxonomic coverage**

**Description:** The specimen data records are all of the insect order Odonata, including 137 of the 150 species officially recorded from Quebec. The following list includes all 150 species. The total number of specimen records in the seven collections is in parentheses following each taxon name.
### Taxa included:

| Rank      | Scientific Name                        | Common Name           |
|-----------|----------------------------------------|-----------------------|
| order     | Odonata (40,447)                       |                       |
| suborder  | Anisoptera (20,552)                    | Dragonflies           |
| family    | Aeshnidae Leach in Brewster, 1815 (4,339) | Darners              |
| genus     | *Aeshna* Fabricius, 1775 (3,690)       | Mosaic darners        |
| species   | *Aeshna canadensis* Walker, 1908 (752) | Canada darner         |
| species   | *Aeshna clepsydra* Say, 1839 (6)       | Mottled darner        |
| species   | *Aeshna constricta* Say, 1839 (119)    | Lance-tipped darner   |
| species   | *Aeshna eremita* Scudder, 1866 (990)   | Lake darner           |
| species   | *Aeshna interrupta* Walker, 1908 (583) | Variable darner       |
| subspecies| *Aeshna interrupta interna* Walker, 1908 (82) |                       |
| subspecies| *Aeshna interrupta interrupta* Walker, 1908 (46) |               |
| species   | *Aeshna juncea* (Linnaeus, 1758) (60)  | Sedge darner          |
| species   | *Aeshna septentrionalis* Burmeister, 1839 (3) | Azure darner         |
| species   | *Aeshna sitchensis* Hagen, 1861 (105)  | Zigzag darner         |
| species   | *Aeshna subarctica* Walker, 1908 (157) | Subarctic darner      |
| subspecies| *Aeshna subarctica subarctica* Walker, 1908 (16) |               |
| species   | *Aeshna tuberculifera* Walker, 1908 (83) | Black-tipped darner   |
| species   | *Aeshna umbrosa* Walker, 1908 (772)    | Shadow darner         |
| subspecies| *Aeshna umbrosa umbrosa* Walker, 1908 (29) |               |
| species   | *Aeshna verticalis* Hagen, 1861 (27)   | Green-striped darner  |
| genus     | *Anax* Leach, 1815 (95)                | Green darners         |
| species   | *Anax junius* (Drury, 1770) (95)       | Common green darner   |
| species   | *Anax longipes* Hagen, 1861 (0)        | Comet darner          |
| genus     | *Basiaeschna* Selys, 1883 (262)        | Springtime darner     |
| species   | *Basiaeschna janata* (Say, 1839) (261) | Springtime darner     |
| genus     | *Boyeria* McLachlan, 1895 (151)        | Spotted darners       |
| species   | *Boyeria grafiana* Williamson, 1907 (26) | Ocellated darner      |
| species   | *Boyeria vinosa* (Say, 1839) (121)     | Fawn darner           |
| genus     | *Epiaeschna* Hagen, 1877 (23)          | Swamp darner          |
| species     | genus                          | family     | Count | Description                      |
|-------------|--------------------------------|------------|-------|----------------------------------|
| *Epiaeschna heros* (Fabricius, 1798) (23) | *Gomphaeschna* Selys, 1871 (15) | *Cordulegastridae* Hagen, 1877 (661) | Swamp darning | Pygmy darners                      |
| *Gomphaeschna furcillata* (Say, 1839) (15) | *Nasiaeschna* Selys in Förster, 1900 (0) | *Cordulegastridae* Hagen, 1877 (661) | Harlequin darning | Cyrano darning                      |
| *Nasiaeschna pentacantha* (Rambur, 1842) (0) | *Rhionaeschna* Förster, 1909 (0) | *Cordulegastridae* Hagen, 1877 (661) | Harlequin darning | Neotropical darners                  |
| *Rhionaeschna mutata* (Hagen, 1861) (0) | *Cordulegaster* Leach, 1815 (631) | *Cordulegaster* diastatops (Selys, 1854) (314) | Delta-spotted spiketail | Spiketails                           |
| *Cordulegaster maculata* Selys, 1854 (289) | *Cordulegaster* Leach, 1815 (631) | *Cordulegaster obliqua* (Say, 1839) (22) | Twin-spotted spiketail | Arrowhead spiketail                  |
| *Cordulegaster obliqua* (Say, 1839) (22) | *Cordulegaster* Leach, 1815 (631) | *Corduliidae* Selys, 1850 (4,194) | Emeralds | Emeralds                           |
| *Cordulida* Leach, 1815 (1,229) | *Dorocordulia* Needham, 1901 (193) | *Cordulida* Leach, 1815 (1,229) | American emerald | American emerald                     |
| *Cordulia shurtleffi* Scudder, 1866 (1,211) | *Epitheca* Burmeister, 1839 (1,232) | *Epitheca* canis (McLachlan, 1886) (503) | Racket-tailed emerald | Baskettails                          |
| *Epitheca canis* (McLachlan, 1886) (503) | *Epitheca* Burmeister, 1839 (1,232) | *Epitheca cynosura* (Say, 1839) (285) | Racket-tailed emerald | Baskettails                          |
| *Epitheca princeps* Hagen, 1861 (95) | *Epitheca* Burmeister, 1839 (1,232) | *Epitheca princeps* Hagen, 1861 (95) | Beavertail baskettail | Beavertail baskettail                |
| *Epitheca spinigera* (Selys, 1871) (339) | *Somatochlora* Selys, 1871 (20) | *Somatochlora* uhleri (Selys, 1871) (349) | Spiny baskettail | Spiny baskettail                     |
| *Somatochlora uhleri* (Selys, 1871) (349) | *Somatochlora* Selys, 1871 (20) | *Somatochlora* uhleri (Selys, 1871) (349) | Uhler's sundragon | Uhler's sundragon                    |
| *Somatochlora abicincta* (Burmeister, 1839) (232) | *Neurocordulia* Selys, 1871 (1,082) | *Neurocordulia* abicincta (Burmeister, 1839) (232) | Ringed emerald | Ringed emerald                      |
| *Somatochlora brevicincta* Robert, 1954 (10) | *Neurocordulia* Selys, 1871 (1,082) | *Neurocordulia* brevicincta Robert, 1954 (10) | Quebec emerald | Quebec emerald                      |
| *Somatochlora cingulata* (Selys, 1871) (191) | *Neurocordulia* Selys, 1871 (1,082) | *Somatochlora cingulata* (Selys, 1871) (191) | Lake emerald | Lake emerald                         |
| species                          | genus                          | family               |
|----------------------------------|---------------------------------|----------------------|
| Somatochlora elongata (Scudder, 1866) (184) |                               |                      |
| Somatochlora filosa (Hagen, 1861) (1) | Somatochlora forcipata (Scudder, 1866) (29) |                      |
| Somatochlora franklini (Selys, 1878) (27) | Somatochlora incurvata Walker, 1918 (2) |                      |
| Somatochlora kennedyi Walker, 1918 (57) | Somatochlora linearis (Hagen, 1861) (0) |                      |
| Somatochlora minor Calvert, 1898 (147) | Somatochlora septentrionalis (Hagen, 1861) (10) |                      |
| Somatochlora tenebrosa (Say, 1839) (9) | Somatochlora walshii (Scudder, 1866) (65) |                      |
| Somatochlora whitehousei Walker, 1925 (1) | Somatochlora williamsoni Walker, 1907 (104) |                      |
| Williamsonia fletcheri Williamson, 1923 (3) | Dromogomphus Selys, 1854 (112) |                      |
| Arigomphus cornutus (Tough, 1900) (21) | Arigomphus furcifer (Hagen, 1878) (21) |                      |
| Dromogomphus spinosus (Selys, 1854) (112) | Gomphurus fraternus (Say, 1839) (24) |                      |
| Gomphurus vastus (Walsh, 1862) (84) | Gomphurus ventricosus (Walsh, 1863) (4) |                      |
| Hagenius Selys, 1854 (49) | Hagenius brevistylus Selys, 1854 (49) |                      |
| Hylogomphus Needham, Westfall & May, 2000 (122) | Hylogomphus adelphus (Selys, 1858) (122) |                      |
| Lanthus Needham, 1897 (45) | Lanthus parvulus (Selys, 1834) (44) |                      |

genus **Williamsonia** Davis, 1913 (3) - Boghaunters

family **Gomphidae** Rambur, 1842 (2,266) - Clubtails

species **Arigomphus** Needham, 1897 (42) - Pond clubtails

species **Dromogomphus** Selys, 1854 (112) - Black-shouldered spinyleg

species **Gomphurus** Selys, 1854 (49) - Dragonhunter

species **Hylogomphus** Needham, Westfall & May, 2000 (122) - Bantam clubtails

species **Lanthus** Needham, 1897 (45) - Bantam clubtails

species **Somatochlora** elongata (Scudder, 1866) (184) - Ski-tipped emerald

species **Somatochlora** filosa (Hagen, 1861) (1) - Fine-lined emerald

species **Somatochlora** forcipata (Scudder, 1866) (29) - Forcipate emerald

species **Somatochlora** franklini (Selys, 1878) (27) - Delicate emerald

species **Somatochlora** incurvata Walker, 1918 (2) - Incurvate emerald

species **Somatochlora** kennedyi Walker, 1918 (57) - Kennedy's emerald

species **Somatochlora** linearis (Hagen, 1861) (0) - Mocha emerald

species **Somatochlora** minor Calvert, 1898 (147) - Ocellated emerald

species **Somatochlora** septentrionalis (Hagen, 1861) (10) - Muskeg emerald

species **Somatochlora** tenebrosa (Say, 1839) (9) - Clamp-tipped emerald

species **Somatochlora** walshii (Scudder, 1866) (65) - Brush-tipped emerald

species **Somatochlora** whitehousei Walker, 1925 (1) - Whitehouse's emerald

species **Somatochlora** williamsoni Walker, 1907 (104) - Williamson's emerald

species **Williamsonia** fletcheri Williamson, 1923 (3) - Ebony boghaunter

family **Gomphidae** Rambur, 1842 (2,266) - Clubtails

species **Arigomphus** cornutus (Tough, 1900) (21) - Horned clubtail

species **Arigomphus** furcifer (Hagen, 1878) (21) - Lilypad clubtail

species **Dromogomphus** Selys, 1854 (112) - Spinylegs

species **Dromogomphus** spinosus (Selys, 1854) (112) - Black-shouldered spinyleg

species **Gomphurus** Selys, 1854 (49) - Dragonhunter

species **Gomphurus** fraternus (Say, 1839) (24) - Midland clubtail

species **Gomphurus** vastus (Walsh, 1862) (84) - Cobra clubtail

species **Gomphurus** ventricosus (Walsh, 1863) (4) - Skillet clubtail

species **Hagenius** Selys, 1854 (49) - Dragonhunter

species **Hagenius** brevistylus Selys, 1854 (49) - Dragonhunter

species **Hylogomphus** Needham, Westfall & May, 2000 (122) - Bantam clubtails

species **Hylogomphus** adelphus (Selys, 1858) (122) - Mustached clubtail

species **Lanthus** Needham, 1897 (45) - Bantam clubtails

species **Lanthus** parvulus (Selys, 1834) (44) - Northern pygmy clubtail
| genus | Ophiogomphus Selys, 1854 (324) | Snaketails |
|-------|-----------------------------|------------|
| species | Ophiogomphus anomalus Harvey, 1898 (6) | Extra-striped snaketail |
| species | Ophiogomphus aspersus Morse, 1895 (52) | Brook snaketail |
| species | Ophiogomphus carolus Needham, 1897 (40) | Riffle snaketail |
| species | Ophiogomphus colubrinus Selys, 1854 (147) | Boreal snaketail |
| species | Ophiogomphus mainensis Packard, 1863 (32) | Maine snaketail |
| species | Ophiogomphus ripinsulensis (Walsh, 1862) (36) | Rusty snaketail |
| genus | Phanogomphus Carle, 1986 (1,156) | American clubtails |
| species | Phanogomphus borealis (Needham, 1901) (95) | Beaverpond clubtail |
| species | Phanogomphus descriptus (Banks, 1896) (62) | Harpoon clubtail |
| species | Phanogomphus exilis (Selys, 1854) (572) | Lancet clubtail |
| species | Phanogomphus lividus (Selys, 1854) (2) | Ashy clubtail |
| species | Phanogomphus spicatus (Hagen in Selys, 1854) (425) | Dusky clubtail |
| genus | Progomphus Selys, 1854 (0) | Sanddragons |
| species | Progomphus obscurus (Rambur, 1842) (0) | Common sanddragon |
| genus | Stylogomphus Fraser, 1922 (58) | Least clubtails |
| species | Stylogomphus albistylus (Hagen in Selys, 1878) (58) | Eastern least clubtail |
| genus | Stylurus Needham, 1897 (185) | Hanging clubtails |
| species | Stylurus amnicola (Walsh, 1862) (10) | Riverine clubtail |
| species | Stylurus notatus (Rambur, 1842) (96) | Elusive clubtail |
| species | Stylurus scudderii (Selys, 1873) (55) | Zebra clubtail |
| species | Stylurus spiniceps (Walsh, 1862) (24) | Arrow clubtail |
| family | Libellulidae Leach in Brewster, 1815 (8,781) | Skimmers |
| genus | Celithemis Hagen, 1861 (14) | Small pennants |
| species | Celithemis elisa (Hagen, 1861) (11) | Calico pennant |
| species | Celithemis eponina (Drury, 1773) (3) | Halloween pennant |
| genus | Erythemis Hagen, 1861 (17) | Pondhawks |
| species | Erythemis simplicicollis (Say, 1839) (17) | Eastern pondhawk |
| genus | Erythrodiplax Brauer, 1868 (2) | Dragonlets |
| species | Erythrodiplax berenice (Drury, 1770) (2) | Seaside dragonlet |
| genus | Ladona Needham, 1899 (812) | Corporals |
| Species | Common Name                                      | Authors and Year |
|---------|--------------------------------------------------|------------------|
| *Ladona julia* (Uhler, 1857) | Chalk-fronted corporal | |
| *Leucorrhinia* Brittinger, 1850 (3,239) | Whitefaces | |
| *Leucorrhinia frigida* Hagen, 1890 (83) | Frosted whiteface | |
| *Leucorrhinia glacialis* Hagen, 1890 (1,147) | Crimson-ring whiteface | |
| *Leucorrhinia hudsonica* (Selys, 1850) (935) | Hudsonian whiteface | |
| *Leucorrhinia intacta* Hagen, 1861 (213) | Dot-tailed whiteface | |
| *Leucorrhinia patricia* Walker, 1940 (26) | Canada whiteface | |
| *Leucorrhinia proxima* Calvert, 1890 (822) | Belted whiteface | |
| *Libellula* Linnaeus, 1758 (613) | King skimmers | |
| *Libellula incesta* Hagen, 1861 (16) | Slaty skimmer | |
| *Libellula luctuosa* Burmeister, 1839 (51) | Widow skimmer | |
| *Libellula pulchella* Drury, 1773 (127) | Twelve-spotted skimmer | |
| *Libellula quadrimaculata* Linnaeus, 1758 (411) | Four-spotted skimmer | |
| *Libellula semifasciata* Burmeister, 1839 (0) | Painted skimmer | |
| *Nannothemis* Brauer, 1868 (339) | Elfin skimmer | |
| *Nannothemis bella* (Uhler, 1857) (339) | Elfin skimmer | |
| *Pachydiplax* Brauer, 1868 (6) | Blue dasher | |
| *Pachydiplax longipennis* (Burmeister, 1839) (6) | Blue dasher | |
| *Pantala* Hagen, 1861 (31) | Rainpool gliders | |
| *Pantala flavescens* (Fabricius, 1789) (26) | Wandering glider | |
| *Pantala hymenaeas* (Say, 1839) (5) | Spot-winged glider | |
| *Perithemis* Hagen, 1861 (0) | Amberwings | |
| *Perithemis tenera* (Say, 1839) (0) | Eastern amberwing | |
| *Plathemis* Hagen, 1861 (258) | Whitetails | |
| *Plathemis lydia* (Drury, 1770) (258) | Common whitetail | |
| *Sympetrum* Newman, 1833 (2,967) | Meadowhawks | |
| *Sympetrum corruptum* (Hagen, 1861) (0) | Variegated meadowhawk | |
| *Sympetrum costiferum* (Hagen, 1861) (298) | Saffron-winged meadowhawk | |
| *Sympetrum danae* (Sulzer, 1776) (325) | Black meadowhawk | |
| *Sympetrum internum* Montgomery, 1943 (297) | Cherry-faced meadowhawk | |
| *Sympetrum obtrusum* Hagen, 1867 (1,428) | White-faced meadowhawk | |
| species               | Sympetrum rubicundulum (Say, 1839) (28) | Ruby meadowhawk |
|-----------------------|-----------------------------------------|-----------------|
| species               | Sympetrum semicinctum (Say, 1839) (93) | Band-winged meadowhawk |
| species               | Sympetrum vicinum (Hagen, 1861) (471)  | Autumn meadowhawk |
| genus                 | Tramea Hagen, 1861 (1)                 | Saddlebags      |
| species               | Tramea lacerata Hagen, 1861 (1)       | Black saddlebags |
| family                | Macromiidae Needham, 1903 (311)       | Cruisers        |
| genus                 | Didymops Rambur, 1842 (230)           | Brown cruisers  |
| species               | Didymops transversa (Say, 1839) (230) | Stream cruiser  |
| genus                 | Macromia Rambur, 1842 (81)            | River cruisers  |
| species               | Macromia illinoiensis Walsh, 1862 (80)| Swift river cruiser |
| suborder              | Zygoptera (17,815)                    | Damselflies     |
| family                | Calopterygidae Selys, 1850 (1,588)    | Broad-winged damsels |
| genus                 | Calopteryx Leach, 1815 (1,483)        | Jewelwings      |
| species               | Calopteryx aequabilis Say, 1839 (363) | River jewelwing |
| species               | Calopteryx amata Hagen, 1889 (308)    | Superb jewelwing |
| species               | Calopteryx maculata (Beauvois, 1805) (750) | Ebony jewelwing |
| genus                 | Hetaerina Hagen in Selys, 1853 (31)   | Rubyspots       |
| species               | Hetaerina americana (Fabricius, 1798) (10) | American rubyspot |
| family                | Coenagrionidae Kirby, 1890 (11,583)   | Pond damsels   |
| genus                 | Amphiagrion Selys, 1876 (97)          | Red damsels    |
| species               | Amphiagrion saucium (Burmeister, 1839) (97) | Eastern red damsel |
| genus                 | Argia Rambur, 1842 (365)              | Dancers         |
| species               | Argia apicalis (Say, 1839) (0)        | Blue-fronted dancer |
| species               | Argia fumipennis (Burmeister, 1839) (109) | Variable dancer |
| subspecies            | Argia fumipennis violacea (Hagen, 1861) (109) | Powdered dancer |
| species               | Argia moesta (Hagen, 1861) (250)      | Powdered dancer |
| genus                 | Chromagrion Needham, 1903 (404)       | Aurora damsel  |
| species               | Chromagrion conditum (Hagen in Selys, 1876) (404) | Aurora damsel |
| genus                 | Coenagrion Kirby, 1890 (1,010)        | Eurasian bluets |
| species               | Coenagrion interrogatum (Hagen in Selys, 1876) (591) | Subarctic bluet |
| species               | Coenagrion resolutum (Hagen in Selys, 1876) (419) | Taiga bluet |
| Genus          | Species                          | Description                  |
|---------------|----------------------------------|------------------------------|
| Enallagma     | Enallagma Charpentier, 1840       | American bluets              |
|               | (6,873)                           |                              |
|               | Enallagma anna Williamson, 1900   | River bluet                  |
|               | (0)                              |                              |
|               | Enallagma annexum Hagen, 1861     | Northern bluet               |
|               | (632)                            |                              |
|               | Enallagma antennatum Say, 1839   | Rainbow bluet                |
|               | (131)                            |                              |
|               | Enallagma aspersum Hagen, 1861   | Azure bluet                  |
|               | (387)                            |                              |
|               | Enallagma boreale Selys, 1875    | Boreal bluet                 |
|               | (2,744)                          |                              |
|               | Enallagma carunculatum Morse, 1895| Tule bluet                   |
|               | (190)                            |                              |
|               | Enallagma civile Hagen, 1861     | Familiar bluet               |
|               | (29)                             |                              |
|               | Enallagma clausum Morse, 1895    | Alkali bluet                 |
|               | (18)                             |                              |
|               | Enallagma ebrium Hagen, 1861     | Marsh bluet                  |
|               | (747)                            |                              |
|               | Enallagma exsulans Hagen, 1861   | Stream bluet                 |
|               | (142)                            |                              |
|               | Enallagma geminatum Kellicott, 1895| Skimming bluet             |
|               | (30)                             |                              |
|               | Enallagma hageni Walsh, 1863     | Hagen's bluet                |
|               | (1,361)                          |                              |
|               | Enallagma signatum Hagen, 1861   | Orange bluet                 |
|               | (101)                            |                              |
|               | Enallagma traviatum Selys, 1876  | Slender bluet                |
|               | (0)                              |                              |
|               | Enallagma vernale Gloyd, 1943    | Vernal bluet                 |
|               | (221)                            |                              |
|               | Enallagma vesperum Calvert, 1919 | Vesper bluet                 |
|               | (89)                             |                              |
| Ischnura      | Ischnura Charpentier, 1840       | Forktails                    |
|               | (1,289)                          |                              |
|               | Ischnura hastata Say, 1839       | Citrine forktail             |
|               | (0)                              |                              |
|               | Ischnura posita Hagen, 1861      | Fragile forktail             |
|               | (8)                              |                              |
|               | Ischnura verticalis Say, 1839    | Eastern forktail             |
|               | (1,277)                          |                              |
| Nehalennia    | Nehalennia Selys, 1850           |_sprites                     |
|               | (1,455)                          |                              |
|               | Nehalennia gracilis Morse, 1895  | Sphagnum sprite              |
|               | (583)                            |                              |
|               | Nehalennia irene Hagen, 1861     | Sedge sprite                 |
|               | (866)                            |                              |
| Lestidae      | Lestes Calvert, 1901             | Spreadwings                  |
|               | (4,644)                          |                              |
| Lestes        | Lestes Leach, 1815               | Pond spreadwings             |
|               | (4,472)                          |                              |
|               | Lestes congener Hagen, 1861      | Spotted spreadwing           |
|               | (695)                            |                              |
|               | Lestes disjunctus Selys, 1862    | Northern spreadwing          |
|               | (2,187)                          |                              |
|               | Lestes dryas Kirby, 1890         | Emerald spreadwing           |
|               | (376)                            |                              |
|               | Lestes eurinus Say, 1839         | Amber-winged spreadwing      |
|               | (470)                            |                              |
|               | Lestes forcipatus Rambur, 1842   | Sweetflag spreadwing         |
|               | (256)                            |                              |
species | *Lestes inaequalis* Walsh, 1862 (22) | Elegant spreadwing
species | *Lestes rectangularis* Say, 1839 (133) | Slender spreadwing
species | *Lestes unguiculatus* Hagen, 1861 (298) | Lyre-tipped spreadwing
species | *Lestes vigilax* Hagen in Selys, 1862 (15) | Swamp spreadwing

**Temporal coverage**

**Data range:** 1875-6-08 - 2015-6-24.

**Usage rights**

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**Data resources**

**Data package title:** Quebec Odonata specimen data

**Number of data sets:** 1

**Data set name:** Quebec Odonata specimen data

**Character set:** UTF-8

**Data format:** Darwin Core

**Description:** The dataset contains the specimen-level metadata for Quebec Odonata as captured from seven publicly-accessible entomological collections in Quebec (Suppl. material 1). Future updates will be available from each collection at [Canadensys.net](http://canadensys.net).

| Column label    | Column description                                                                 |
|-----------------|------------------------------------------------------------------------------------|
| occurrenceID    | The globally unique identifier for the record.                                    |
| type            | The nature or genre of the resource, i.e. "PhysicalObject".                       |
| modified        | The most recent date on which the resource was changed.                            |
| language        | The language of the resource, i.e. English and/or French, "en|fr".                    |
| licence         | The legal document giving official permission to do something with the resource.  |
|                 | i.e. "http://creativecommons.org/publicdomain/zero/1.0/legalcode".                 |
| rightsHolder    | The organisation owning or managing rights over the resource, e.g. "Université de Montréal". |
| Term                  | Description                                                                 |
|-----------------------|-----------------------------------------------------------------------------|
| bibliographicCitation | A bibliographic reference for the resource as a statement indicating how this record should be cited (attributed) when used, e.g. "QMOR1" |
| collectionID          | An LSID for the collection or dataset from which the record was derived, e.g. "urn:lsid:biocol.org:col:34164". |
| datasetID             | The DOI for the original Canadensys source of the data, e.g. "10.5886/qwvt63fz". |
| institutionCode       | The name of the institution having custody of the object(s) or information referred to in the record, e.g. "Université de Montréal". |
| collectionCode        | The coden identifying the collection or dataset from which the record was derived, e.g. "QMOR". |
| datasetName           | The name identifying the dataset from which the record was derived, e.g. "Ouellet-Robert Entomological Collection". |
| basisOfRecord         | The specific nature of the data record, i.e. "PreservedSpecimen". |
| catalogNumber         | An identifier for the record within the dataset or collection, e.g. "QMOR1.001", where "QMOR1" refers to the museum object (e.g. the vial or envelope) and ".001" refers to one or several specimens contained in that museum object. |
| recordedBy            | The primary collector or collectors of the specimen(s), e.g. "Robert, Adrien". |
| individualCount       | The number of individuals represented in the data record.                   |
| sex                   | The sex of the biological individual(s) represented by the specimens, i.e. "Male" or "Female". |
| lifeStage             | The age class or life stage of the biological individual(s), i.e. "Adult", "Immature", "Exuvium" or "Egg". |
| preparations          | The preparation and preservation method for the specimens, i.e. "Envelope", "Pin", "Vial" or "Pill box". |
| otherCatalogNumbers   | An identifier for the museum object within the dataset or collection, e.g. "QMOR1". See catalogNumber. |
| eventDate             | The date or interval during which the collection event occurred, e.g. "2012-01-05". |
| startDayOfYear        | The first possible day of the year that the collection event occurred, i.e. between 1 and 365. |
| endDayOfYear          | The last possible day of the year that the collection event occurred, i.e. between 1 and 365. |
| year                  | The four-digit year in which the collection event occurred, according to the Common Era Calendar, i.e. between 1875 and 2015. |
| month                 | The ordinal month in which the collection event occurred, i.e. between 1 and 12. |
| day                   | The integer day of the month on which the collection event occurred, i.e. between 1 and 31. |
| continent             | The name of the continent on which the collection occurred, i.e. "North America". |
| **country** | The name of the country in which the collection occurred, i.e. "Canada". |
| **stateProvince** | The name of the next smaller administrative region than country (state, province, canton, department, region etc.) in which the collection occurred, i.e. "Quebec". |
| **locality** | The specific description of the place. This term may contain information modified from the original to correct perceived errors or standardise the description, e.g. "Saint-Hippolyte, Station de Biologie des Laurentides de l'Université de Montréal, Route de la station". |
| **decimalLatitude** | The geographic latitude in decimal degrees of the geographic centre of a Location. Positive values are north of the Equator, negative values are south of it. |
| **decimalLongitude** | The geographic longitude in decimal degrees of the geographic centre of a Location. Positive values are east of the Greenwich Meridian, negative values are west of it. |
| **coordinateUncertaintyInMetres** | The horizontal distance in metres from the given decimalLatitude and decimalLongitude describing the smallest circle containing the whole of the Location. |
| **georeferenceSources** | A list (concatenated and separated) of maps, gazetteers or other resources used to georeference the Location, i.e. "Canadian Geographic Names Data Base", "Google Maps", "Google Earth". |
| **identifiedBy** | The primary determiner or determiners of the specimen(s), e.g. "Robert, Adrien". |
| **dateIdentified** | The date (year) on which the specimen was determined, e.g. "1972". |
| **scientificName** | The full scientific name, as given by the determiner, with authorship and date information if known, e.g. "Gomphus descriptus Banks, 1896". |
| **acceptedNameUsage** | The full name, with authorship and date information if known, of the currently valid name of the taxon, e.g. "Phanogomphus descriptus (Banks, 1896)". |
| **kingdom** | The full scientific name of the kingdom in which the taxon is classified, i.e. "Metazoa". |
| **phylum** | The full scientific name of the phylum or division in which the taxon is classified, i.e. "Arthropoda". |
| **class** | The full scientific name of the class in which the taxon is classified, i.e. "Insecta". |
| **order** | The full scientific name of the order in which the taxon is classified, i.e. "Odonata". |
| **family** | The full scientific name of the family in which the taxon is classified, e.g. "Aeshnidae". |
| **genus** | The full scientific name of the genus in which the taxon is classified, e.g. "Aeshna". |
| **specificEpithet** | The name of the species epithet of the scientificName, e.g. "interrupta". |
| **infraspecificEpithet** | The name of the subspecific epithet of the scientificName, e.g. "interna". |
taxonRank | The taxonomic rank of the most specific name in the scientificName, i.e. "Family", "Genus", "Species" or "Subspecies".
---|---
scientificNameAuthorship | The authorship information for the scientificName formatted according to the conventions of the applicable nomenclaturalCode, e.g. "Walker, 1908".
nomenclaturalCode | The code of nomenclature that governs the scientificName, i.e. "ICZN", the International Code of Zoological Nomenclature.

**Additional information**

Although the Ouellet-Robert Collection accounted for 81% of all the species-level occurrence records (Fig. 4, Table 1), these specimens were collected in a relatively small number of localities, averaging only 45% of all unique localities per species (Figs 1, 5). Adding the other six collections dramatically increased the geographic coverage, especially the University of Laval Collection with as many localities as the Ouellet-Robert Collection (Table 1), including a nice series of specimens from Anticosti Island in the Gulf of Saint Lawrence (Fig. 6). The Insectarium of Montreal and Quebec Insect Collection both have broad geographic sampling (Figs 7, 8), whereas that of the other three collections is narrower, concentrated near Montreal, Sherbrooke and Quebec City (Fig. 9).

![Figure 4](doi)

Number of specimen occurrence and unique locality records per species for 137 Quebec Odonata species found in all seven collections (black and grey lines) and 128 species found in the Ouellet-Robert Collection (blue and red lines). The dashed line indicates the conservative 25-record threshold calculated by van Proosdij et al. (2015) for developing species distribution models.
Figure 5. Proportion of unique localities per species provided by Ouellet-Robert Collection specimens versus material provided by all other collections. The first three species are those present at the Ouellet-Robert Collection, but absent elsewhere and the last nine are those present elsewhere, but absent from the Ouellet-Robert Collection.

Figure 6. Collection localities of the Laval University specimens.
Figure 7. Collection localities of the Insectarium of Montreal specimens.

Figure 8. Collection localities of the Quebec Insect Collection specimens.
Adding the other collections also increased the taxonomic coverage. Whereas specimens of three species are held only at the Ouellet-Robert Collection, nine species, absent from this collection, are held elsewhere (Fig. 5), including four held only in a single other collection (Table 1). In all, seven species are present in a single collection each, whereas only seven are present in all seven collections (Table 2). The temporal coverage also broadened considerably with the addition of the other six collections. Whereas overall sampling is dominated by the Ouellet-Robert Collection, mostly thanks to the efforts of its long-time curator, Adrien Robert (Robert 1963), there is almost no material from the mid-1970s onwards (Fig. 10). It is the Laval University Collection that provides the vast majority of the material collected during the 1970s and then especially from the 1990s to 2010. This latter collection is in especially nice curatorial condition thanks to the work of Jean-Marie Perron.
Table 2.
Number of Quebec Odonata species deposited in no collection (absent from all collections), a single collection, two to six collections or all seven collections.

| Number of collections | Number of species |
|-----------------------|-------------------|
| No collections        | 13                |
| 1 collection          | 7                 |
| 2 collections         | 21                |
| 3 collections         | 30                |
| 4 collections         | 28                |
| 5 collections         | 19                |
| 6 collections         | 25                |
| All 7 collections     | 7                 |
| TOTAL                 | 150               |

Figure 10.
Number of species-level occurrence records from the four largest collections collected in each five-year interval.
The volume of material in the combined dataset should be useful for future modelling and other distribution-related analyses. More than half of the species are represented by over 100 specimens in the combined dataset (Fig. 4). If we restrict future work to only those species for which we have the conservative estimate of 25 unique records suggested by van Proosdij et al. (2015), 25 species at the Ouellet-Robert Collection and 57 across all collections are suitable for distribution modelling (Fig. 4). Using this admittedly somewhat arbitrary metric, the additional 19% of material gained by digitising the Odonata in the six other collections represents a two-fold improvement.

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Supplementary material

Suppl. material 1: Quebec Odonata specimen data doi

Authors: Favret C, Boucher S, Cloutier C, Cloutier L, Emond MC, Harper PP, Moisan-De Serres J, Larrivée M, Pelletier G, Perron JM, Piché C, Savage J, Wagner G, Wheeler T

Data type: occurrences

Brief description: Specimen metadata as of 16-12-2019, in Darwin Core format, for the Quebec Odonata specimens deposited in seven publicly-accessible research collections in Quebec, Canada.

Download file (24.96 MB)