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SCIENTIFIC NOTE

First detection of mosquito *Uranotaenia sapphirina* (Diptera: Culicidae) in New Brunswick, Canada

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Abstract
Climate change and other anthropogenic stressors are reshaping Earth's biodiversity, motivating efforts to monitor changing faunal diversity. Canada is home to 80 documented species of mosquitoes, 38 of which are reported in New Brunswick. Using Centers for Disease Control and Prevention miniature CO_2 light traps, three adult mosquito collection surveys were performed to encompass 43 trapping sites across New Brunswick, Canada. Study one took place from 21 July 2022 to 9 September 2022, study two took place from 29 May 2023 to 24 October 2023, and study three took place from 15 May 2024 to 19 September 2024. Among the specimens collected, a total of 18 *Uranotaenia sapphirina* (Osten Sacken) (Diptera: Culicidae) were identified from five separate trapping sites. This species, previously documented only in Ontario, Quebec, and Manitoba, is considered rare in Canada and is known for its specialisation in feeding on annelids rather than vertebrates. Our detection of *Ur. sapphirina* in New Brunswick, where it has been absent in earlier surveys, suggests a recent range expansion, possibly driven by climate change. This observation highlights the need for ongoing surveillance to monitor the impacts of environmental changes on mosquito distribution.

Human activity is reshaping Earth's biodiversity, including through extinction (Cowie *et al.* 2022), invasions (Isitt *et al.* 2024), and range shifts in response to climate change (Rubenstein *et al.* 2023). Documenting this reshaping is a major challenge, in part because there are a multitude of species to be monitored and because many taxonomic groups are chronically understudied (Cowie *et al.* 2022). Within Insecta, the most diverse clade of animals, much biodiversity remains undiscovered or poorly documented. However, some taxa have received more careful attention because of their importance to human health or to economic activity, and these provide opportunities to detect biodiversity changes. In such groups, extinctions, local extirpations, invasions, or range expansions are more likely to be detected, and the resulting data provide a window on processes presumably affecting Earth's biota more widely. One such well-studied insect group is the family Culicidae, the mosquitoes.

The family Culicidae (Diptera) includes over 3500 species worldwide, 80 of which occur in Canada (Wood *et al.* 1979; Thielman and Hunter 2007). In New Brunswick, Canada, a mosquito survey performed in 2002–2003 (Webster *et al.* 2004) reported 38 species of mosquitoes belonging to seven genera: *Aedes* Meigen (including *Ochlerotatus* Lynch Arribalzaga), *Anopheles* Meigen,

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Coquillettidia Dyar, *Culex* Linnaeus, *Culiseta* Felt, *Psorophora* Robineau-Desvoidy, and *Wyeomyia* Theobald (Webster *et al.* 2004). To date, no published records document mosquitoes from the genus *Uranotaenia* Osten Sacken (Diptera: Culicidae) for New Brunswick. North America is home to three species of *Uranotaenia*: *Ur. anhydor* Dyar, *Ur. lowii* Theobald, and *Ur. sapphirina* (Osten Sacken); however, only *Ur. sapphirina* has been identified in Canada. Considered rare, it has been reported in Canada only in Manitoba, Ontario, and Quebec (Twinn 1949; Judd 1950; Wood *et al.* 1979; Stuart 2007). The North American distribution of *Ur. sapphirina* includes much of the eastern and midwestern United States of America, extending west to North Dakota and south into Mexico (Darsie and Ward 2005; Canto-Mis *et al.* 2021; Ortega-Morales *et al.* 2022; Fig. 1). Here, we report the first known observation of *Ur. sapphirina* in New Brunswick, Canada.

Three separate field surveys for adult mosquitoes were performed. Study one took place from 21 July 2022 to 9 September 2022 at 12 trapping locations across southern New Brunswick (Table 1). Study two took place from 29 May 2023 to 24 October 2023, and study three took place from 15 May 2024 to 19 September 2024, both latter using the same 31 trapping locations across New Brunswick each time (Table 1). For each site, a single Centers for Disease Control and Prevention miniature CO_2-baited light trap (John W. Hock Company, Gainesville, Florida, United States of America) was deployed for approximately 24 hours. Study one deployed traps at each site weekly, whereas studies two and three deployed traps weekly but rotated through locations such that each location was sampled on a triweekly basis. These traps use a combination of CO_2 (from dry ice) and light to attract the mosquitoes to the trap.

Trap catches were kept frozen on dry ice until reaching the laboratory at either the University of New Brunswick (Fredericton, New Brunswick) or Acadia (Wolfville, Nova Scotia, Canada). At the lab, insects collected were transferred to Petri dishes and stored at –20 °C for study one and at –80 °C for studies two and three until they could be processed for identification. We identified insects using a stereomicroscope (Leica M60; Leica Microsystems, Wetzlar, Germany) and standard keys (Carpenter and LaCasse 1955; Wood *et al.* 1979; Thielman and Hunter 2007). Study one identification was performed at the genus level, except that we identified mosquitoes to species in the genera *Culex* (to assay West Nile virus prevalence in the potential vectors *Culex pipiens/restuans*; MacDonald and Heard 2023) and *Uranotaenia* (to confirm the identity of *Ur. sapphirina* for the present paper). Studies two and three were performed at the species level.

For study one, five female individuals of *Ur. sapphirina* were identified over the course of our collections. Two were identified from the 19 August 2022 New Maryland catch, and three were identified from the 9 September 2022 New Maryland catch. For study two, three individuals of *Ur. Sapphirina* from three separate locations were identified. The first individual (female) was collected on 20 September 2023 from one of the Fredericton sites, the second individual (male) was collected on 21 September 2023 from the Saint Martin's Parish site, and the last individual (female) was collected on 7 October 2023 from the Plumweseep site. In 2024, a total of 10 individuals of *Ur. sapphirina* were identified from two separate locations. On 12 September, two individuals (males) were collected from one of the Fredericton sites (the same site where it was collected in 2023). The second collection was a total of eight individuals (seven males, one female) from one of the sites in Woodstock. No *Ur. sapphirina* mosquitoes were identified at the remaining collection sites at any of the collection times.

Uranotaenia mosquitoes in North America are very distinctive, with short palps, a proboscis swollen at the tip, a short r2 wing cell, and – most obviously – iridescent bright-blue scales in patches on the head and thorax (Fig. 2). *Uranotaenia sapphirina* is easily distinguished from other North American *Uranotaenia* by the presence of a stripe of blue scales down the centre of the scutum and the lack of pale scales on the hind tarsi. Three specimens from study one have been deposited in the insect collection of the New Brunswick Museum, Saint John, New Brunswick, Canada. Voucher specimens from studies two and three will be deposited at the Canadian National Collection of Insects, Arachnids, and Nematodes in Ottawa, Ontario, Canada.

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Figure 1. Range map for *Uranotaenia sapphirina.* Shaded range is approximate and is drawn from the literature: Mexico, after Ortega-Morales *et al.* (2022); United States of America and Canada, after Darsie and Ward (2005). The dot is 2022 New Maryland, New Brunswick collection; the Xes are our 2023–2024 collections near Woodstock, Fredericton, St. Martin's, and Sussex, New Brunswick. The square is Stuart's (2007) record from Winnipeg, Manitoba; stars are selected research-grade observations from iNaturalist. The province of New Brunswick is enlarged, showing collection localities.

The Canadian distribution of *Ur. sapphirina* was previously recorded only as including southern Ontario, the southwestern part of Quebec, and more recently southern Manitoba (Twinn 1949; Judd 1950; Stuart 2007). The closest reported occurrences of *Ur. sapphirina* to our New Brunswick sites appear to be research-grade observations on iNaturalist from Berthierville in southwestern Quebec (500 km to the west; apdp 2024) and near Waterville in south–central Maine (250 km to the southwest; myawiles 2019). The Maine observation is itself 200 km from the next most northerly iNaturalist observation in central New Hampshire (Fig. 1).

Uranotaenia sapphirina is not known to bite humans or other vertebrates and is therefore not a public health concern for vector-borne illnesses. Instead, these mosquitoes are specialist feeders on annelids (Reeves *et al.* 2018). The small number of individuals caught in our survey and their absence from Webster *et al.*'s (2004) survey of an overlapping set of sites using the same trapping

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Table 1. Location, GPS coordinates, and total number of *Uranotaenia sapphirina* captured in New Brunswick, Canada. Traps 1–12 are from the 2022 survey and traps 13–32 are from the 2023 and 2024 surveys.

Trap	Location	GPS coordinates	# *Uranotaenia sapphirina*
1	Fredericton	45.956049, 66.663517	0
2	New Maryland	45.832243, 66.740072	5
3	Saint Stephen	45.17266, –67.162238	0
4	St. Andrews	45.074726, –67.037834	0
5	Saint John	45.295939, –66.056524	0
6	Saint John	45.231462, –66.12265	0
7	Sackville	45.906262, –64.369129	0
8	Moncton	46.087534, –64.816263	0
9	Moncton	46.125692, –64.832135	0
10	Salisbury	46.02067, –65.041655	0
11	Alma	45.602314, –64.94852	0
12	Hopewell Cape	45.816447, –64.577589	0
13	Woodstock	46.15672, –67.5791	0
14	Woodstock	46.18269, –67.5677	0
15	Woodstock	46.1256, –67.59262	8
16	Woodstock	46.18339, –67.53655	0
17	Bathurst	47.67246, –65.68949	0
18	Bathurst	47.63786, –65.60902	0
19	Bathurst	47.60959, –65.63371	0
20	Plumweseep	45.75339, –65.4938	1
21	Edmundston	47.35043, –68.21244	0
22	Edmundston	47.36556, –68.31968	0
23	Edmundston	47.42659, –68.40138	0
24	Edmundston	47.4412, –68.3954	0
25	Edmundston	47.39258, –68.329813	0
26	Lower Newcastle	47.09423, –65.35998	0
27	Miramichi	47.0293, –65.45777	0
28	Miramichi	46.97095, –65.5489	0
29	Cambellton	47.98554, –66.6942	0
30	Cambellton	47.98614, –66.7283	0
31	Fisher Lakes	45.29606, –66.059566	0
32	Saint Martins Parish	45.40669, –65.592826	1
33	Saint John	45.32198, –65.930555	0
34	Saint John	45.26504, –66.0877	0
35	Moncton	46.08495, –64.818778	0
36	Moncton	46.08522, –64.819096	0

(*Continued*)

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Table 1. (*Continued*)

Trap	Location	GPS coordinates	# *Uranotaenia sapphirina*
37	Moncton	46.12386, −64.851044	0
38	Moncton	46.20884, −64.993433	0
39	Mactaquac	45.95433, −66.88715	0
40	Fredericton	45.95657, −66.66362	3
41	Fredericton	45.95794, −66.64372	0
42	Nashwaaksis	45.97681, −66.6602	0
43	Fredericton	45.98862, −66.65371	0

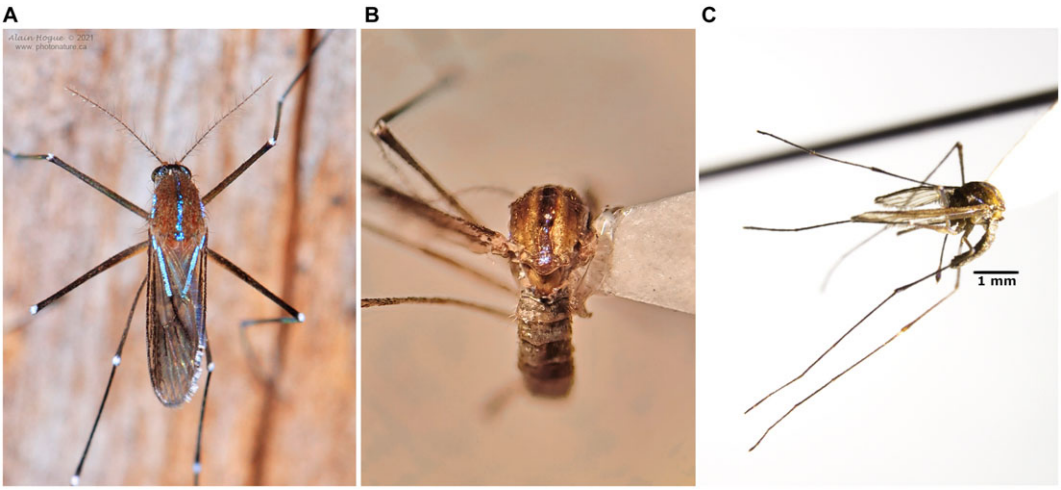

Figure 2. *Uranotaenia sapphirina*: **A,** live specimen, observed by Alain Hogue at Châteuaguay, Quebec, Canada (alainhogue 2021; photograph used with permission); **B,** dried specimen from 2023 New Brunswick collections, dorsal view showing blue scales; and **C,** dried specimen from 2023 New Brunswick collections, lateral view. Images B and C have been cropped and focus-stacked, and brightness and contrast have been adjusted. Visibility of blue scales depends strongly on angle and intensity of incident light.

methods suggest that these mosquitoes are a recent arrival to New Brunswick. Although we do not have direct evidence for the cause of this range expansion, it could be related to changing climate, which involves warming in most regions, including Atlantic Canada. Indeed, other mosquito species, including medically relevant ones, are undergoing similar range shifts (Ludwig *et al.* 2019). Continued monitoring of mosquitoes using the kind of standardised survey techniques we deployed in the present study is likely to document further changes in local faunas. Only with repeated monitoring of well-documented insect groups can we hope to understand the rate and drivers of future biodiversity change.

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Competing interests. The authors declare that they have no competing interests.

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