

Note

Sphex ichneumoneus and *Sphex pensylvanicus* (Hymenoptera: Sphecidae) in Atlantic Canada: evidence of recent range expansion into the region

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Lewis, J.H. 2020. *Sphex ichneumoneus* and *Sphex pensylvanicus* (Hymenoptera: Sphecidae) in Atlantic Canada: evidence of recent range expansion into the region. Canadian Field-Naturalist 134(1): 52–55. <https://doi.org/10.22621/cfn.v134i1.2413>

Abstract

The detection of range shifts is an important part of tracking species' responses to climate warming and anthropogenic disturbance. Here, arguments in support of such change-induced expansion of the thread-waisted wasps, *Sphex pensylvanicus* and *Sphex ichneumoneus* (Hymenoptera: Sphecidae), into Atlantic Canada are made on the basis of collections in southwestern New Brunswick. Despite their large size, bold colouration, and active presence on wildflowers in open areas, no previous records for either species exist from Atlantic Canada. Increases in mean annual temperature, as well as increases in the abundance, regional diversity, and uniformity in the ranges of katydids (Tettigoniidae), the preferred nest provision for both *Sphex* species, may be promoting northward colonization by *Sphex* wasps.

Key words: Range expansion; *Sphex*; climate change; anthropogenic disturbance; Hymenoptera; Sphecidae; wasp; thread-waisted wasp; climate warming; geographic range

Climate change and anthropogenic disturbance are significantly altering the ranges of insects on a global scale (Parmesan *et al.* 1999; Hickling *et al.* 2005; Schowalter 2012). Although studies of the northeastern North American fauna have identified range shifts in charismatic taxa such as Lepidoptera and Odonata (Rodenhouse *et al.* 2009; Catling 2016; McAlpine *et al.* 2017), disease vectors (Rochlin *et al.* 2016), pollinators (mostly bees and, to a lesser extent, flies; Deans *et al.* 2007; Harrison *et al.* 2019), and other economically important groups (Dukes *et al.* 2009), reports of climate change or anthropogenic driven shifts in the distributional ranges of wasps are generally lacking (Sánchez-Bayo and Wyckhuys 2019). The principal reason for the shortage of wasp-based studies is almost certainly the scarcity of accessible taxonomic resources for many taxa; indeed, wasps are one of the least-known groups taxonomically and are possibly also the most diverse animal group on the planet (Forbes *et al.* 2018).

The relative ignorance of wasps in many regions is problematic for biodiversity conservation, as Hymenoptera appear to be experiencing some of the

greatest declines among the terrestrial orders of insects (Sánchez-Bayo and Wyckhuys 2019). Particularly for highly host-specific parasitoid wasps, changes in climatic patterns can be devastating when the phenological synchrony of wasp and host(s) is compromised (Stireman *et al.* 2005; Hance *et al.* 2007; Kharouba *et al.* 2018). In addition, changes in the species composition and diversity of local wasp communities can occur over relatively short periods. Using morphology and DNA barcoding, Fernandez-Triana *et al.* (2011) found that the community structure of parasitoid wasps in northern Manitoba has changed significantly over the last 70 years and is likely linked to climate warming.

Here, the apparent recent range expansion of the thread-waisted wasps (Hymenoptera: Sphecidae), *Sphex ichneumoneus* (Linnaeus, 1758) and *Sphex pensylvanicus* Linnaeus, 1763, into Atlantic Canada is reported for the first time on the basis of specimens recently collected in southwestern New Brunswick. All specimens were collected by aerial net or by hand during general insect surveys and are deposited in the New Brunswick Museum insect collection.

A contribution towards the cost of this publication has been provided by the Thomas Manning Memorial Fund of the Ottawa Field-Naturalists' Club.

The Sphecidae are a charismatic group of largely solitary wasps that dig burrows (most Sphecinae and Ammophilinae) or build clay nests (Sceliphrinae), which they provision with insect prey (Matthews 1991; Finnermore and Michener 1993). Both *S. ichneumoneus* and *S. pensylvanicus* have been previously recorded in Quebec and Ontario (Buck 2003) and across much of the United States (Bohart and Menke 1963). Detailed studies on the behaviour of northern populations of *S. ichneumoneus* have revealed that adults live approximately six weeks, are active from mid-July to mid-September, are most active at temperatures above 26°C and inactive at temperatures below 18°C, nest in open areas with relatively little ground cover and in clay or sandy soil, and, as nectarivores, build their nests in the vicinity of wildflowers (Brockman 1976, 1979; Brockman and Dawkins 1979). *Sphex pensylvanicus* has similar seasonality, temperature preferences, and habitat preferences (Frisch 1938; Rau 1944; Kurczewski 1997).

Both species are large (19–28 mm), strikingly patterned, and often active on wildflowers in open, semi-forested areas; if present, they would likely not go undetected. Despite this, there are no specimens of either species from Atlantic Canada in the insect collections of the New Brunswick Museum (NBM), Nova Scotia Museum (NSM), University of Guelph (DEBU), Royal Alberta Museum (RAM), or in the Canadian National Collection of Insects, Arachnids and Nematodes (CNC), and no published records for Atlantic Canada prior to those reported here. Although not conclusive evidence, this is notable and suggests that a fairly recent range expansion of *Sphex* into the region may have occurred.

In addition, the *Sphex* species mentioned here are katydid specialists and provision their nests primarily with various members of the Tettigoniidae (Bohart and Menke 1963; Brockman 1985). Based on published reports, the orthopteran species used by *S. pensylvanicus* and *S. ichneumoneus* appear to differ somewhat: the former preys on larger katydids such as Fork-tailed Bush Katydid (*Scudderia furcata* Brunner, 1878; Rau 1944), Northern Bush Katydid (*Scudderia septentrionalis* (Serville 1839); Kurczewski 1997), and Greater Angle-wing Katydid (*Microcentrum rhombifolium* (Saussure, 1859); Frisch 1938); the latter preys on a wider variety of orthopterans (Brockman 1985) including various *Scudderia* spp., *Neoconocephalus* spp., *Conocephalus* spp., *Orchelimum* spp., and, to a somewhat lesser extent, Black-horned Tree Cricket (*Oecanthus nigricornis* F. Walker, 1869). As both *Sphex* species show an obvious preference for katydids as nest provisions, any increases in the abundance, regional diversity, or uniformity in the ranges

of katydids should promote further colonization by these wasps.

All members of the Tettigoniidae known to occur in Maritime Canada prefer open areas, such as old field habitat, forest clearings and trails, and roadside margins (Vickery and Kevan 1985). Given that forestry, agriculture, and industry have transformed Atlantic Canada into a much patchier, heterogeneous landscape over the last five centuries (Loo *et al.* 2010), an increase in abundance and geographic uniformity of katydids in the region during this period seems likely. There is also evidence of recent expansion of some orthopteran species used by *Sphex* in the region (McAlpine and Ogden 2012; Klymko *et al.* 2018; Lewis and McAlpine 2018), such as native Sword-bearing Conehead Katydid (*Neoconocephalus ensiger* (Harris, 1841)), *S. septentrionalis*, *O. nigricornis*, and the European introduction Roesel's Shield-backed Katydid (*Metroptera roeselii* (Hagenbach, 1822)). As climate warming continues, further increases in the abundance and range of orthopterans in the region can be expected (Scudder and Vickery 2010).

Many climate warming studies have used historical data to examine changes in the phenology of insects, particularly in northern regions. Climate warming in northern areas will allow some species to be active for longer periods (Levy *et al.* 2016). Altermatt (2009) found that, even since 1980, the warmer climate has allowed some European butterflies and moths to increase the number of generations completed within a season. This may, however, be harmful for species that produce an additional generation but encounter a lack of available host plants (Altermatt 2009) or those that fail to enter diapause on time (Buckley *et al.* 2017). As the northern populations of *S. ichneumoneus* (and presumably also *S. pensylvanicus*) are univoltine (Brockman 1985), any increase in temperature will likely be beneficial and may allow these wasps to be active longer each day and later in the season when their preferred katydid nest provisions are mature and most active.

Voucher specimens

Sphex ichneumoneus (Linnaeus, 1758)—CANADA, NEW BRUNSWICK: Saint John County: Black Beach, end of Lighthouse Road, 7.5 km southwest of Lorneville, 45.144285°N, 66.236958°W, 15 September 2017, J.H. Lewis, one dead male taken from spider web on *Solidago* sp. in coastal old field habitat (NBM-068251), orthopterans *Oecanthus nigricornis*, Slender Meadow Katydid (*Conocephalus fasciatus* (De Geer, 1773)), and Broad-winged Bush Katydid (*Scudderia pistillata* Brunner, 1878) also collected.

Sphex pensylvanicus Linnaeus, 1763—CANADA, NEW BRUNSWICK: Kings County: along Nerepis River, near intersection of Brittain Road and McKenzie Road, 45.390972°N, 66.285265°W, 15 August 2015,

J.H. Lewis, along Silver Maple (*Acer saccharinum* L.) dominated floodplain forest in wildflower rich clearing, two males taken from Queen-of-the-Meadow (*Filipendula ulmaria* (L.) Maximowicz) (NBM-052358; NBM-052382), orthopterans *Conocephalus fasciatus* and *Scudderia pistillata* also collected; Charlotte County: along Highway 1, between Oak Bay and St. Stephen, 45.219586°N, 67.232816°W, 25 September 2017, J.H. Lewis, two females taken along wildflower rich trail near highway (NBM-068247), orthopterans *Scudderia septentrionalis* and *Oecanthus nigricornis* also collected.

Acknowledgements

I thank Dr. Stephen Clayden (New Brunswick Museum) for confirming the identities of wildflowers referenced in the collection notes. Dr. Andrew Bennett (Canadian National Collection of Insects, Arachnids and Nematodes), Dr. Steven Paiero (University of Guelph), Katherine Ogden (Nova Scotia Museum), and Dr. Matthias Buck (Royal Alberta Museum) confirmed the lack of *Sphex* wasp specimens from Atlantic Canada in their respective collections. I also thank Dr. Robert Anderson (Canadian Museum of Nature) and Dr. Donald McAlpine (New Brunswick Museum) for their critical reviews of the manuscript.

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Received 2 December 2019

Accepted 22 April 2020