An annotated checklist of clearwing moths (Lepidoptera: Sesiidae) in British Columbia and Yukon Territory

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ABSTRACT

The clearwing moths (Lepidoptera: Sesiidae) are infrequently documented wood-boring insects. Some species achieve pest status in managed ecosystems across North America, threatening agricultural and forestry sectors. The invasive apple clearwing moth, *Synanthedon myopaeformis* (Borkhausen), is one such pest species; its larvae damage domesticated apple (*Malus* spp.) (Rosaceae) trees in the southern reaches of British Columbia, Canada. Future management of this pest with classical biological control requires an understanding of 'non-target' sesiid distribution. To that end, we have produced an annotated checklist of species distribution and host-plant records in British Columbia and Yukon Territory, Canada. We report a total of 22 sesiid species in these two jurisdictions, based on more than 2000 records from entomological museums, online community science databases, and the primary literature. This annotated checklist will be used to inform the biological control programme of *S. myopaeformis* but will also be a valuable resource for understanding sesiid diversity in western Canada.

Keywords: biogeography, host-plant associations, biodiversity, iNaturalist, BugGuide

INTRODUCTION

Sesiidae is a family of primarily diurnal moths that mimic wasps and bees (Hymenoptera) (Eichlin and Duckworth 1988). More than 1500 valid species exist worldwide (Pühringer and Kallies 2004, 2022), at least 60 of which are found in Canada (Pohl *et al.* 2018, 2019). Larvae of most species bore into the limbs, trunks, stems, and roots of trees and herbaceous plants (Eichlin and Duckworth 1988; Taft *et al.* 1991). Pupation typically occurs within a larval cocoon located within a gallery in the host plant or in nearby soil (Duckworth and Eichlin 1978). Most sesiids are specialists on one or a few host species (Munroe 1979), although confirmed host records are limited to rearing experiments or an association between pupal exuviae and a host plant (Eichlin

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and Duckworth 1988). Several species can achieve pest status in managed agricultural or forest ecosystems (*e.g.*, Furniss and Carolin 1977; Cossentine *et al.* 1990; Bergh and Leskey 2003; Cossentine *et al.* 2013). Synthetic sex attractants have been imperative for monitoring these pests (Rocchini *et al.* 2003; Judd *et al.* 2015), but attractants have also become imperative for collecting non-pest sesiids (Eichlin and Duckworth 1988) and have improved our understanding of species boundaries and distribution (*e.g.*, Duckworth and Eichlin 1977; Bennett *et al.* 2001; Gorbunov 2018). Despite their vibrant colours, fascinating life histories, and threats to managed ecosystems, sesiids are infrequently found in collections, and their regional distributions remain relatively unknown.

Several authors have studied sesiid diversity and distribution in British Columbia (BC) and Yukon Territory (YT). When describing the genus *Albuna*, Edwards (1881) described *Albuna vancouverensis* and *Albuna torva* from specimens he had collected on Vancouver Island, BC. Beutenmüller (1901) later synonymised these species with *Albuna pyramidalis* (Walker) in his monograph and explicitly reported five sesiids in BC. Engelhardt (1946) reported 12 species in the province, two of which were also in YT. Eichlin and Duckworth (1988) produced the most recent treatment of the family in North America; they explicitly reported eight sesiids in BC. More recently, Pohl *et al.* (2015) reported 21 sesiid species from BC in the provincial checklist of Lepidoptera, which increased to 22 species in the Canadian and Alaskan checklist of Lepidoptera (Pohl *et al.* 2018). Pohl *et al.* (2018) reported six sesiids in YT. Although numerous, few of these publications report locality details below province or territory level, leaving gaps in our understanding of species distribution in both BC and YT.

The apple clearwing moth, *Synanthedon myopaeformis* (Borkhausen), is a European species now present in the southern commercial apple orchards of BC (Philip 2006; Judd *et al.* 2015). In Canada, larvae feed in the cambium layer of domestic apple trees, *Malus domestica* (Borkhausen), posing substantial risk to high-density apple orchards (Cossentine *et al.* 2013). Some control measures have had moderate success in BC (Cossentine *et al.* 2010; Aurelian *et al.* 2012; Judd and Eby 2014; Judd *et al.* 2015), but interest is growing in initiating a classical biological control programme for *S. myopaeformis* (Nelson *et al.,* unpublished data). This would permit the release of natural enemies of *S. myopaeformis* into BC to reduce its population density, thereby reducing impact to commercial apple production. An important step when initiating a biological control programme is ensuring that an introduced species will have minimal impact on native 'non-target' species (Wapshere 1974; van Driesche and Hoddle 2016). Despite more than a century of literature on North American sesiids, the distribution of native, 'non-target' species within BC remains relatively unknown, complicating potential biological control efforts for *S. myopaeformis*.

Here, we present the first checklist of Sesiidae in BC and YT, with intra-provincial distributions of each species. We also present host-plant records of each species and suggest areas where undocumented sesiid species may yet be discovered. We expect that this checklist will be a valuable resource for assessing sesiid biodiversity and development of a *S. myopaeformis* biological control programme.

MATERIALS AND METHODS

To develop our checklist, we collated records of Sesiidae from arthropod collections, digital collection databases, published literature, and online community science platforms. Classification and species concepts follow the taxonomic species treatments in Eichlin and Duckworth (1988) and Eichlin and Taft (1988), and we present species accounts in the same order as Pohl *et al.* (2018). Identified specimen vouchers are housed in the following collections: Summerland Research and Development Centre Collection, Summerland Research and Development Centre, Summerland, BC, Canada (ACBC); Academy of Natural Sciences, Drexel University, Philadelphia, Pennsylvania, USA (ANSP); Centre for Biodiversity Genomics, University of Guelph, Guelph, Ontario, Canada (BIOUG); Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Ontario, Canada (CNC); Mississippi Entomological Museum, Mississippi State University, Starkville, Mississippi, USA (MEM); Albert J. Cook Arthropod Research Collection, Michigan State University, East Lansing, Michigan, USA (MSUC); Pacific Forestry Centre Arthropod Reference Collection, Victoria, BC, Canada (PFCA); Royal British Columbia Museum, Victoria, BC, Canada (RBCM); Spencer Entomological Collection, University of BC, Vancouver, British Columbia, Canada (SEM); E.H. Strickland Entomological Museum, University of Alberta, Edmonton, Alberta, Canada (UASM); William F. Barr Entomological Museum, University of Idaho, Moscow, Idaho, USA (WFBM); Yale Peabody Museum, Yale University, New Haven, Connecticut, USA (YPM); and the personal collection of the first author (TDNC). Verified records from ANSP, BIOUG, BugGuide, iNaturalist, MEM, MSUC, UASM, WFMB, and YPM were obtained from the Global Biodiversity Information Facility digital database (Global Biodiversity Information Facility 2021, 2022). We also included photographic records from BugGuide and iNaturalist that were not part of the Global Biodiversity Information Facility digital object identifiers (BugGuide 2022; iNaturalist 2022). We vetted all photographic records using the dichotomous key and species accounts of Eichlin and Duckworth (1988) and Eichlin and Taft (1988), and we reported the number of vouchered specimens and photographic records for each species in its account.

We employed an ecoprovince method to summarise sesiid distribution in BC. This method splits the province into 10 ecoprovinces (Fig. 1) based on similar topography, climatic conditions, and geological history (Demarchi 2011) and has been used for other provincial species checklists (*e.g.*, Scudder and Cannings 2007; Ratzlaff 2015; Gibson 2017; Bennett *et al.* 2021). Each ecoprovince can be considered a unique set of habitats (Gibson 2017). To account for the potential uncertainty in photographic identifications, we indicated when a species was known only from photographic records in a given ecoprovince (Table 1). In addition, we reported host-plant records from the primary literature, confirmed by rearing adult sesiids from host material. Records of all voucher specimen and photographic records are reported in Supplementary material, Table S1, available on figshare (DOI: 10.6084/m9.figshare.24549643).

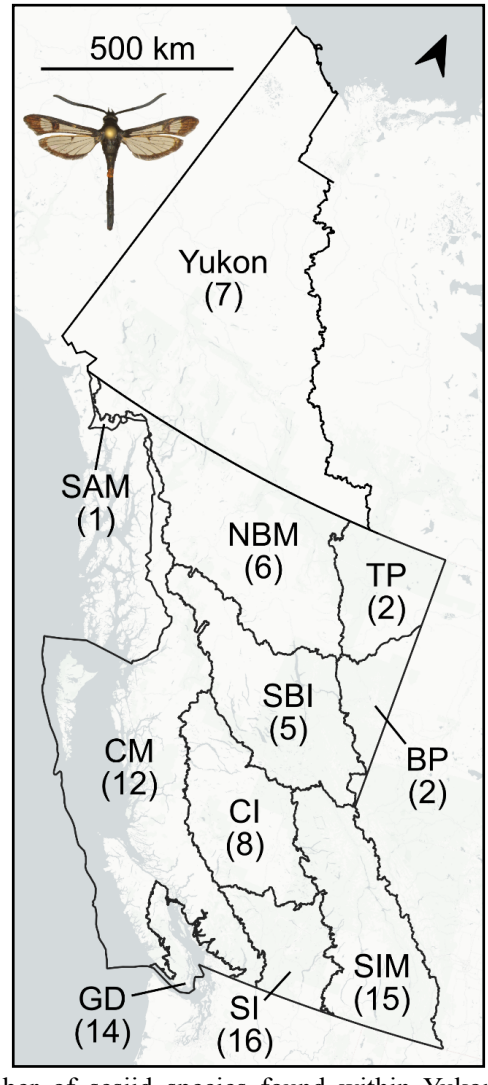

Figure 1. The number of sesiid species found within Yukon Territory and each ecoprovince of British Columbia. Abbreviations: SAM – Southern Alaska Mountains; CM – Coast and Mountains; GD – Georgia Depression; NBM – Northern Boreal Mountains; SBI – Southern Boreal Interior; CI – Central Interior; SI – Southern Interior; TP – Taiga Plains; BP – Boreal Plains; SIM – Southern Interior Mountains. Map prepared in QGIS, version 3.16.6, with base map from https://github.com/CartoDB/basemap-styles.

RESULTS AND DISCUSSION

We collated 2164 specimens and observations of Sesiidae in BC and YT, totalling 22 species. All 22 species were found in BC, and seven were found in YT (Table 1). These seven species are shared between the two regions. We found that several other species are unconfirmed but possible in BC or YT and discuss those following the species checklist.

Table 1. Sesiid species recorded in British Columbia and Yukon Territory, Canada. Ecoprovince map of British Columbia in Figure 1. 'v' indicates voucher specimen(s), 'p' indicates photographic records only (no voucher specimens), and 'lit' indicates literature records only (no voucher specimens). Ecoprovince abbreviations: SAM – Southern Alaska Mountains; CM – Coast and Mountains; GD – Georgia Depression; NBM – Northern Boreal Mountains; SBI – Southern Boreal Interior; CI – Central Interior; SI – Southern Interior; TP – Taiga Plains; BP – Boreal Plains; SIM – Southern Interior Mountains.

	Ecoprovinces of British Columbia										Yukon
Species	**SAM**	**CM**	**GD**	**NBM**	**SBI**	**CI**	**SI**	**TP**	**BP**	**SIM**	**-**
Pennisetiini											
Pennisetia marginatum		v	v	v			v			v	
Paranthrenini											
Paranthrene robiniae		v	v			v	v			v	v
Albuna pyramidalis	p	v	v	v	v	v	v	v	v	v	v
Sesiini											
Sesia tibiale		p	v	v			v			v	v
Sesia spartani					v					v	
Synanthedonini											
Synanthedon scitula			p								
Synanthedon tipuliformis		p	v			v	v			v	
Synanthedon bolteri								v			lit
Synanthedon canadensis					v						p
Synanthedon culiciformis		v	v	v	v	v	v			v	
Synanthedon helenis										lit	
Synanthedon saxifragae		v	v			p				p	v
Synanthedon albicornis		v	v				v		p	v	p
Synanthedon bibionipennis		v	v			v	v			v	
Synanthedon mellinipennis							v			v	
Synanthedon polygoni							v				
Synanthedon resplendens							v				
Synanthedon exitiosa		p	v	v		v	v			v	
Synanthedon novaroensis		v	v	v	v	v	v			v	
Synanthedon sequoiae		v	v				v			v	
Synanthedon myopaeformis			v				v				
Podosesia syringae							v				

Species checklist

Pennisetiini

Pennisetia marginatum (Harris, 1839), raspberry crown borer

BC records (Fig. 2): 50 vouchers, 46 photos.

YT records: None.

Host plant(s): This species is a larval borer of blackberry and raspberry (*Rubus* spp.) (Rosaceae) root crowns, buds, and shoots (Raine 1962; Eichlin and Duckworth 1988).

Paranthrenini

Paranthrene robiniae (Edwards, 1880), western poplar clearwing

BC records (Fig. 2): 47 vouchers, seven photos.

YT records (Fig. 2): three vouchers.

Host plant(s): This species is a larval borer of poplar (*Populus* spp.) (Salicaceae), willow (*Salix* spp.) (Salicaceae), and birch (*Betula* spp.) (Betulaceae) (Eichlin and Duckworth 1988). It can be a pest of ornamental tree varieties (Furniss and Carolin 1977; Eichlin and Duckworth 1988).

Albuna pyramidalis (Walker, 1856), fireweed clearwing

BC records (Fig. 2): 284 vouchers, 99 photos. Two additional vouchers are known from the Boreal Plains ecoprovince; one from Hudson's Hope (D. Holden, personal communication) and one from Pink Mountain (Pohl and Nelson, unpublished data).

YT records (Fig. 2): 109 vouchers, 59 photos.

Host plant(s): This species is a larval root borer of fireweed (*Chamaenerion* spp.) (Onagraceae) and evening primrose (*Oenothera biennis* (Linnaeus)) (Onagraceae) (Engelhardt 1946).

Sesiini

Sesia tibiale (Harris, 1839), American hornet moth

BC records (Fig. 2): 78 vouchers, 26 photos.

YT records (Fig. 2): two vouchers, five photos.

Host plant(s): This species is a larval root and bole borer of poplar (*Populus* spp.) and willow (*Salix* spp.) (Engelhardt 1946; Furniss and Carolin 1977).

Sesia spartani Eichlin and Taft, 1988, Spartans' clearwing

BC records (Fig. 2): 13 vouchers. First detected in BC by Bennett *et al.* (2000).

YT records: None.

Host plant(s): This species probably feeds on members of the Salicaceae, particularly trembling aspen (*Populus tremuloides* Micheaux). Eichlin and Taft (1988) report larval damage of *P. tremuloides* where *S. spartani* adults have been collected.

Synanthedonini

Synanthedon scitula (Harris, 1839), dogwood borer

BC records (Fig. 2): four photos. This species was first detected in the Pacific Northwest by Looney *et al.* (2012). We recovered four photographic records from the Metro Vancouver area.

YT records: None.

Host plant(s): This species is a larval root or bole borer in black cherry (*Prunus* spp.) (Rosaceae), apple, quince (*Cydonia oblonga* Miller) (Rosaceae), mountain ash (*Sorbus* spp.) (Rosaceae), hawthorn (*Crataegus* spp.) (Rosaceae), ninebark (*Physocarpus opulifolius* (Linnaeus) Maximowicz) (Rosaceae), dogwood (Cornaceae), chestnut (*Castanea* spp.) (Fagaceae), beech (*Fagus* spp.) (Fagaceae), oak (*Quercus* spp.) (Fagaceae), hazelnut (*Corylus* spp.) (Betulaceae), birch (Betulaceae), pecan, and hickory (*Carya* spp.) (Juglandaceae), bayberry (*Myrica pensylvanica* Loiseleur-Deslongchamps) (Myricaceae), wax myrtle (*M. cerifera* Linnaeus) (Myricaceae), pine (*Pinus* spp.) (Pinaceae), willow (*Salix* spp.), rattan vine (*Berchemia scandens* (J. Hill)) (Rhamnaceae), and wisteria (*Wisteria* spp.) (Fabaceae) (Engelhardt 1946; Eichlin and Duckworth 1988). It is associated with woody galls of cynipid wasps (Taft *et al.* 1991) or other abnormal growths on its host (Engelhardt 1946). It can be a pest of various trees and shrubs (Taft *et al.* 1991) and is of economic concern in domestic apple orchards in eastern North America (Bergh and Leskey 2003).

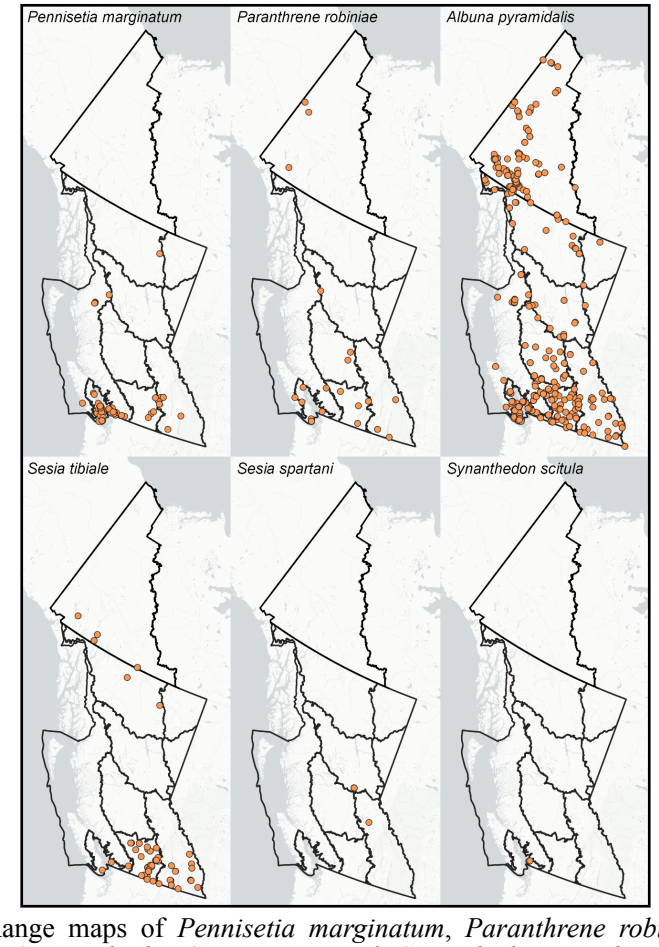

Figure 2. Range maps of *Pennisetia marginatum*, *Paranthrene robiniae*, *Albuna pyramidalis*, *Sesia tibiale*, *S. spartani*, and *Synanthedon scitula* within British Columbia and Yukon Territory. The ecoprovinces of BC (Fig. 1) and the territorial boundary of YT are outlined.

Synanthedon tipuliformis (Clerck, 1759), currant clearwing

This species was likely an accidental introduction to North America from the Palearctic (Beutenmüller 1901; Eichlin and Duckworth 1988).

BC records (Fig. 3): 59 vouchers, 10 photos. We could not confirm Foxlee's (1945) record from Nelson.

YT records: None.

Host plant(s): This species is a larval borer of currants and gooseberries (*Ribes* spp.) (Grossulariaceae), and blackberries (*Rubus* spp.) (Engelhardt 1946; Taft *et al.* 1991).

Synanthedon bolteri (Edwards, 1883), northern willow clearwing

This species is uncommon (Taft *et al.* 1991).

BC records (Fig. 3): two vouchers near the YT border along the Liard highway.

YT records (Fig. 3): We found no YT records of this species with our methods, but Engelhardt (1946) reported one voucher from Dawson. Pohl *et al.* (2018) report that it is present in the territory.

Host plant(s): This species is a larval borer of low-growing willow (*Salix* spp.) and is associated with damage by beetles (Coleoptera) and fungi (Engelhardt 1946).

Synanthedon canadensis Duckworth and Eichlin, 1973, Canadian clearwing

BC records (Fig. 3): 25 vouchers. This species was first detected in BC by Bennett *et al.* (2001). We recovered records from Prince George.

YT records (Fig. 3): one photo.

Host plant(s): This species may feed on lodgepole pine (*Pinus contorta* Doug.) (Pinaceae), but we found conflicting evidence and cannot confirm its host-plant use. Bennett *et al.* (2001) suggest it does not feed on Pinaceae in Prince George; however, Scudder and Cannings (2007) report that it feeds on the seeds of *P. contorta*. Label data on specimens in the Pacific Forestry Centre Arthropod Reference Collection suggest the species feeds on *P. contorta* seeds.

Synanthedon culiciformis (Linnaeus, 1758), large red-belted clearwing

Holarctic species (Engelhardt 1946).

BC records (Fig. 3): 241 vouchers, six photos.

YT records: None.

Host plant(s): This species is a larval borer of alders (*Alnus* spp.) and ornamental birch (*Betula* spp.) (Betulaceae) in North America (Engelhardt 1946; Eichlin and Duckworth 1988).

Synanthedon helenis (Engelhardt, 1946), Helenis clearwing

BC records (Fig. 3): We found no BC records of this species with our methods; however, Engelhardt (1946) reported one voucher from Fernie. Pohl *et al.* (2018) report that it is present in the province.

YT records: None.

Host plant(s): This species may be a larval borer of Asteraceae (Engelhardt 1946).

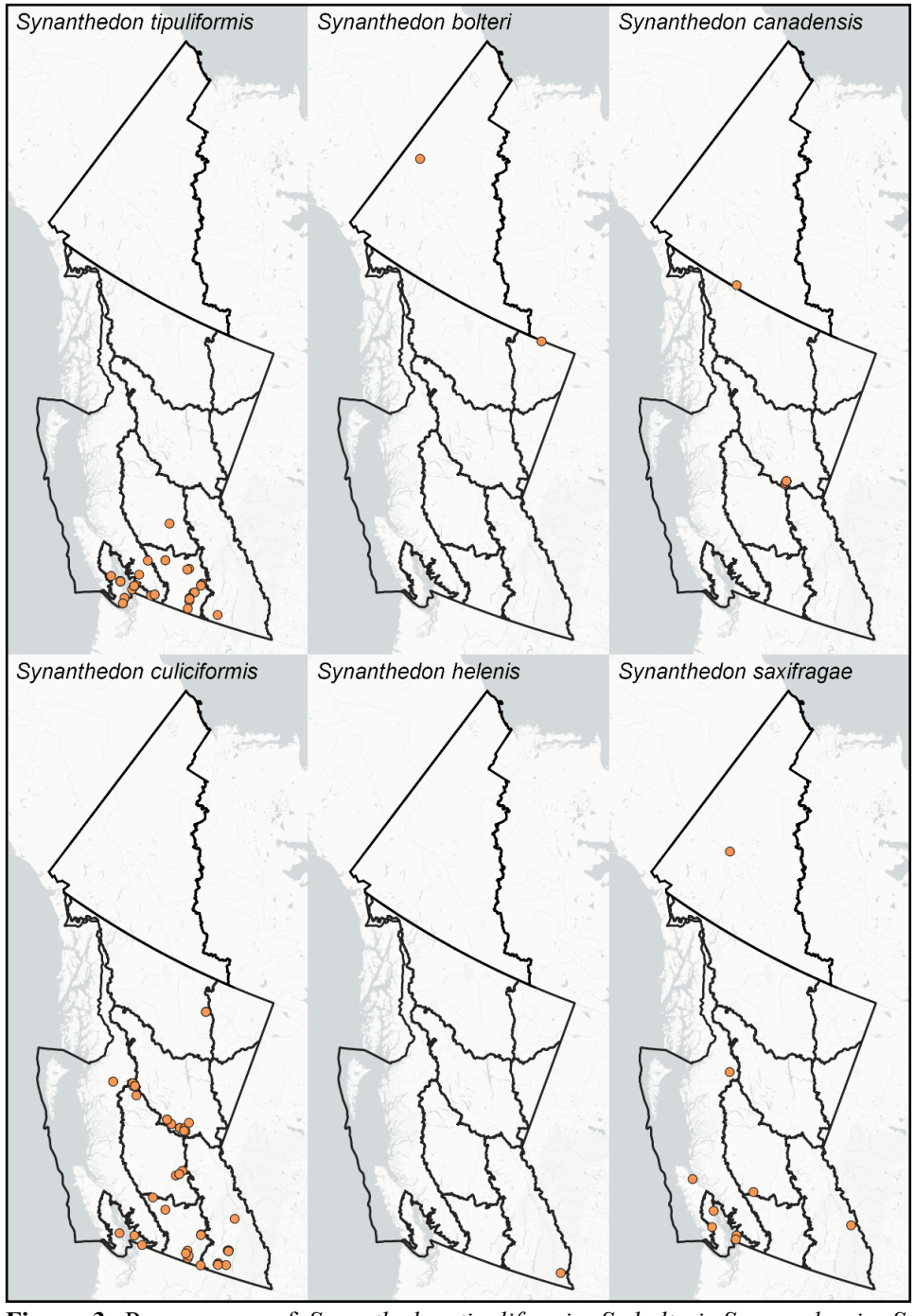

Figure 3. Range maps of *Synanthedon tipuliformis*, *S. bolteri*, *S. canadensis*, *S. culiciformis*, *S. helenis*, and *S. saxifragae* within British Columbia and Yukon Territory. The ecoprovinces of BC (Fig. 1) and the territorial boundary of YT are outlined.

Synanthedon saxifragae (Edwards, 1881), confusing clearwing

Collected at high elevation or high latitude (Engelhardt 1946).

BC records (Fig. 3): six vouchers, two photos.

YT records (Fig. 3): one voucher.

Host plant(s): Unknown (Eichlin and Duckworth 1988). Despite its name, this species does not feed on saxifrage (Saxifragaceae) (Engelhardt 1946).

Synanthedon albicornis (Edwards, 1881), western willow clearwing

BC records (Fig. 4): 33 vouchers, eight photos.

YT records (Fig. 4): one photo. We recovered one iNaturalist (2022) observation 75 km east of Watson Lake, identified by F. Pühringer (iNaturalist (2022) observation 14675206), but identification by other community members has differed. Pohl *et al.* (2018) report that *S. albicornis* is present in the territory.

Host plant(s): This species is a larval root or limb borer of willow (*Salix* spp.) (Engelhardt 1946; Eichlin and Duckworth 1988). It is often associated with damage by beetle larvae (Engelhardt 1946).

Synanthedon bibionipennis (Boisduval, 1869), strawberry crown borer

BC records (Fig. 4): 67 vouchers, 31 photos.

YT records: None.

Host plant(s): This species is a larval root borer of the Rosaceae spp. strawberry (*Fragaria* spp.), cinquefoil (*Potentilla* spp.), rose (*Rosa* spp.), raspberry, blackberry, and boysenberry (*Rubus* spp.) (Engelhardt 1946; Eichlin and Duckworth 1988). It has long been a pest of cultivated strawberry (Engelhardt 1946).

Synanthedon mellinipennis (Boisduval, 1836), ceanothus borer

BC records (Fig. 4): five vouchers, one photo.

YT records: None.

Host plant(s): This species is a larval bole borer of California lilac (*Ceanothus* spp.) (Rhamnaceae) (Williams 1909; Engelhardt 1946).

Synanthedon polygoni (Edwards, 1881), buckwheat borer

BC records (Fig. 4): four vouchers, 10 photos.

YT records: None.

Host plant(s): This species is a larval root borer of buckwheat (*Eriogonum* spp. and *Polygonum* spp.) (Polygonaceae) (Williams 1909; Engelhardt 1946) and prickly phlox (*Linanthus pungens* (Torrey) Porter and Johnson) (Polemoniaceae) (Duckworth and Eichlin 1978).

Synanthedon resplendens (Edwards, 1881), sycamore borer

BC records (Fig. 4): two vouchers.

YT records: None.

Host plant(s): This species is a larval bole borer of sycamore (*Acer pseudoplanatus* Linnaeus) (Sapindaceae) and oak (*Quercus* spp.) (Engelhardt 1946; Furniss and Carolin 1977; Eichlin and Duckworth 1988). It is sometimes found on avocado (*Persea americana* Miller) (Lauraceae) (Ryan 1928).

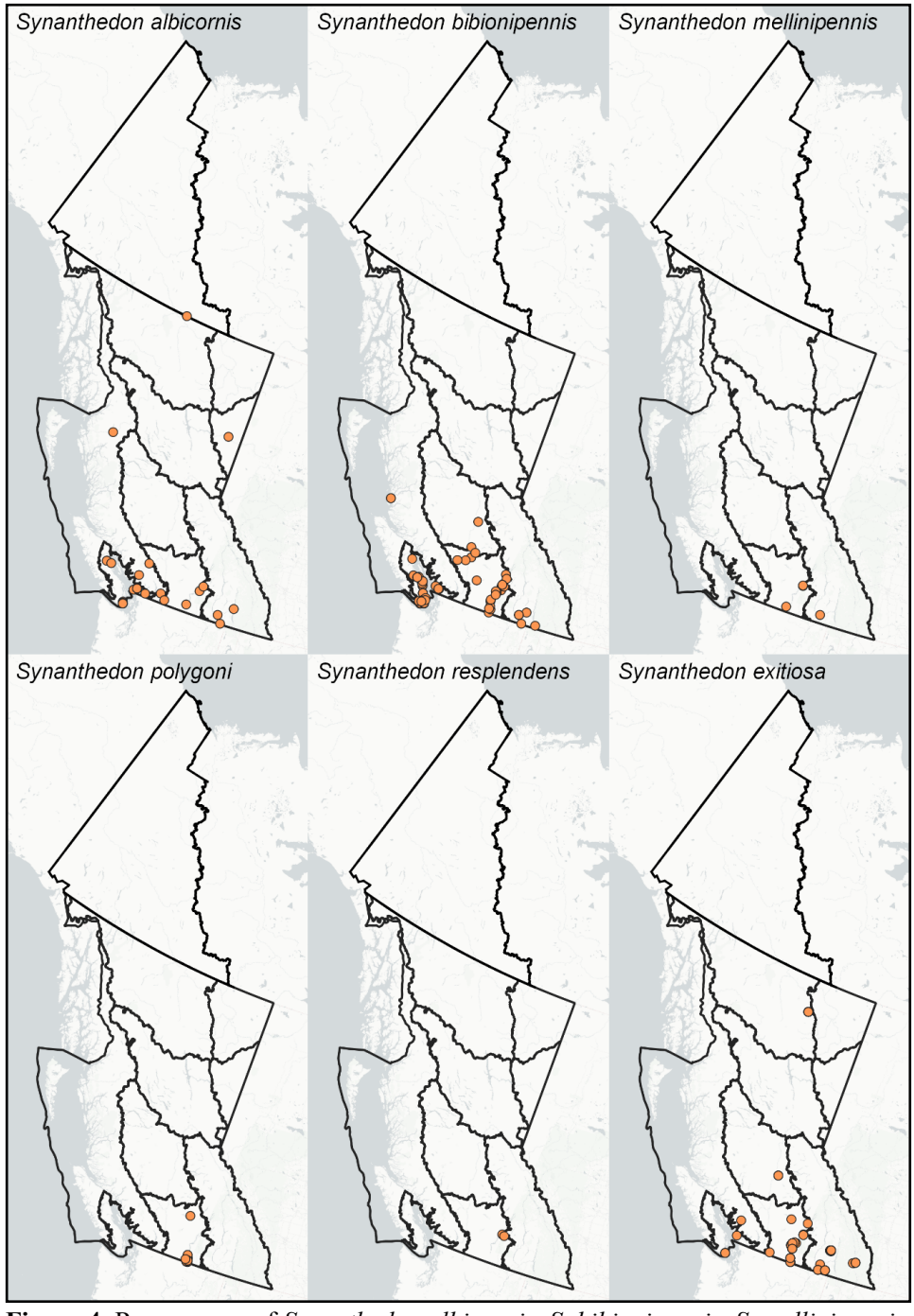

Figure 4. Range maps of *Synanthedon albicornis*, *S. bibionipennis*, *S. mellinipennis*, *S. polygoni*, *S. resplendens*, and *S. exitiosa* within British Columbia and Yukon Territory. The ecoprovinces of BC (Fig. 1) and the territorial boundary of YT are outlined.

Synanthedon exitiosa (Say, 1823), peachtree borer

Before Engelhardt (1946), this species was called *Sanninoidea opalescens* (Edwards, 1881) west of the Rocky Mountains and *Synanthedon exitiosa* in eastern Canada and parts of the USA (Lyne 1911, 1913). However, *S. exitiosa* was the species found in BC's Okanagan Valley (Lyne 1913; Brittain 1914), believed to be an introduction from importation of contaminated root stocks (Lyne 1911). Engelhardt (1946) resolved this taxonomic confusion when he synonymised *S. opalescens* with *S. exitiosa*, but the origins of *S. exitiosa* in the Okanagan remain unclear.

BC records (Fig. 4): 171 vouchers, three photos.

YT records: None.

Host plant(s): This species is a larval root and bole borer of *Prunus* spp., including peach (*P. persica* Batsch), almond (*P. amygdalus* Batsch), apricot (*P. armeniaca* Linnaeus), sour cherry (*P. cerasus*), European plum (*P. domestica* Linnaeus), hortulan plum (*P. hortulana* Bailey), nectarine (*P. persica* var. *nectarina* Maximowicz), Japanese flowering cherry (*P. serrulata* Lindley), and chokecherry (*P. virginiana* Linnaeus) (Eichlin and Duckworth 1988). Its most common host is peach (Russell and Stanley 1969), on which it is a serious pest (Taft *et al.* 1991). It probably feeds on other members of Rosaceae (Eichlin and Duckworth 1988).

Synanthedon novaroensis (Edwards, 1881), Douglas-fir pitch moth

BC records (Fig. 5): 489 vouchers, 13 photos.

YT records: None.

Host plant(s): This species is a larval bole borer of spruce (*Picea* spp.) (Pinaceae), pine (*Pinus* spp.) and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco) (Pinaceae) (Engelhardt 1946; Furniss and Carolin 1977). It can be a pest on these conifers (Furniss and Carolin 1977).

Synanthedon sequoiae (Edwards, 1881), sequoia pitch moth

BC records (Fig. 5): 52 vouchers, five photos.

YT records: None.

Host plant(s): This species is a larval bole borer of pine (*Pinus* spp.), spruce (*Picea* spp.), and Douglas-fir (*Pseudotsuga menziesii* (Mirb.) Franco), and it can be a pest on each (Furniss and Carolin 1977). Despite its name, it does not appear to feed on *Sequoia* spp. (Cupressaceae) (Engelhardt 1946; Furniss and Carolin 1977; Eichlin and Duckworth 1988).

Synanthedon myopaeformis (Borkhausen, 1789), apple clearwing moth or red-belted clearwing moth

BC records (Fig. 5): eight vouchers, 21 photos. This species was introduced to North America from Europe, first detected in Cawston, BC in 2005 (Philip 2006; Cossentine *et al.* 2013), but a museum specimen collected in Oliver, BC in 2003 has recently been identified (Nelson *et al.*, unpublished data); GenBank accession OL711867). There are literature records from the Fraser Valley and Armstrong (Cossentine *et al.* 2013).

YT records: None.

Host plant(s): This species is a larval borer of domesticated apple in BC (*Malus domestica* Borkhausen) (Cossentine *et al.* 2013). In Europe, it reportedly

feeds on pear (*Pyrus* spp.) (Rosaceae) (Baggiolini and Antonin 1976), mountain ash (*Sorbus* spp.), hawthorn (*Crataegus* spp.), sea-buckthorn *(Hippophae rhamnoides* Linnaeus) (Elaeagnaceae), and *Prunus* spp. (Špatenka *et al.* 1999).

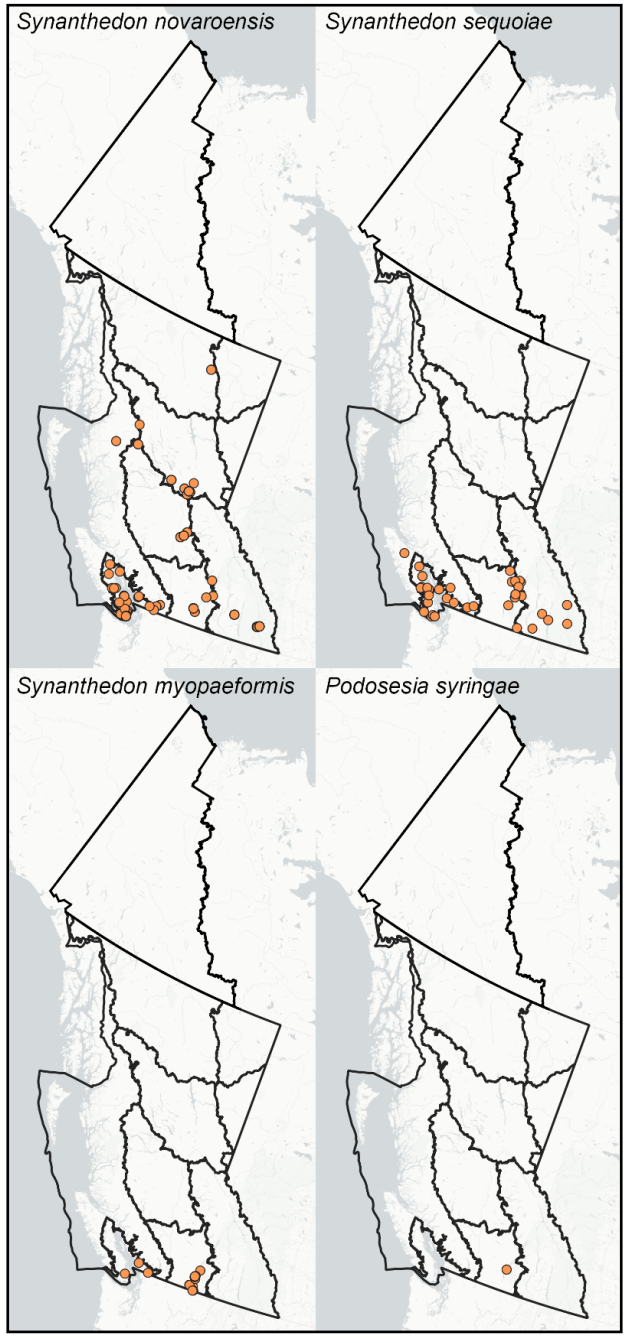

Figure 5. Range maps of *Synanthedon novaroensis*, *S. sequoiae*, *S. myopaeformis*, and *Podosesia syringae* within British Columbia and Yukon Territory. The ecoprovinces of BC (Fig. 1) and the territorial boundary of YT are outlined.

Podosesia syringae (Harris, 1839), ash borer moth

BC records (Fig. 5): two vouchers. This species was first detected in Westbank and Armstrong by Aurelian *et al.* (2008).

YT records: None.

Host plant(s): This species is a larval bole borer of the Oleaceae spp. ash (*Fraxinus* spp.), lilac (*Syringa* spp.) (Oleaceae) (Soloman 1975; Furniss and Carolin 1977), fringetree (*Chionanthus virginicus* Linnaeus), privet (*Ligustrum* spp.) (Engelhardt 1946), and olive (*Olea europaea* Linnaeus) (Eichlin and Duckworth 1988). It can be a pest in ash plantations (Furniss and Carolin 1977), as well as in lilac and privet (Taft *et al.* 1991).

Unconfirmed species

Most of the species in this checklist are placed within Synanthedonini, the most species-rich tribe of sesiids in North America (Eichlin and Duckworth 1988). Cognato *et al*. (2023) suggested that members of this tribe have undergone a recent, rapid speciation event resulting in close phylogenetic relationships among the evolutionary lineages, and they recommended that the generic relationships be reconsidered due to lack of monophyly. Furthermore, Lait and Hebert (2018) found that *S. exitiosa* and a few congeners had greater variation than expected at the barcoding fragment of the cytochrome *c* oxidase 1 gene. They found that haplotypic clusters of *S. exitiosa* correspond to collection locations across the USA and Ontario, Canada, suggesting that the species contains several evolutionary lineages. We conclude that the systematic position and validity of sesiid species known in BC and YT requires evaluation, particularly within the Synanthedonini, and that this checklist will serve as a foundation for such studies.

Several additional species may be present in BC or YT, but our methods did not recover any records. *Zenodoxus sidalceae* (Engelhardt, 1946) is known from both Alberta and Washington state (Pohl *et al.* 2018) but is unconfirmed to date in BC (Eichlin and Duckworth 1988; Pohl *et al.* 2018). It is likely to be found in southern reaches of the province. *Paranthrene tabaniformis* (Rottemburg, 1775) ranges across southern Canada into Alaska (Eichlin and Duckworth 1988) and is known from Alberta (Pohl *et al.* 2018). Scudder and Cannings (2007) report its presence in BC, but we could not confirm those records. *Synanthedon chrysidipennis* (Boisduval, 1869) was reported in BC by Engelhardt (1946) and Eichlin and Duckworth (1988), but the records have not been confirmed (Pohl *et al*. 2018). Beutenmüller (1901) and Eichlin and Duckworth (1988) reported *Carmenta giliae* (Edwards, 1881) from BC because the holotype specimen is incorrectly labelled as 'Ft. Calgary, N.W. British Columbia', which is in Alberta (Pohl *et al.* 2018). This species may occur in southeastern BC (Pohl *et al.* 2018). *Carmenta verecunda* (Edwards, 1881) may occur in BC; it is within the range reported by Eichlin and Duckworth (1988) and is known from Alberta (Pohl *et al.* 2018). *Penstemonia clarkei* (Engelhardt, 1946) was reported in BC by Powell and Opler (2009) but is not confirmed (Pohl *et al.* 2018). Recently, two sesiid observations from Vancouver Island were identified as *Penstemonia* (iNaturalist (2022) observations 129098312 and 133031614).

Synanthedon fatifera Hodges, 1962 may be present in BC. It is not known from BC or YT (Pohl *et al.* 2018), but we recovered two Barcode of Life Data (BOLD) Systems records from Prince George from July 1986, each identified

using cytochrome *c* oxidase 1 (Ratnasingham and Hebert 2007). These two records were previously labelled *S. fatifera* on the Global Biodiversity Information Facility database (2021), but their species-level identities have been revoked (Global Biodiversity Information Facility 2022; BOLD Systems records CNCLA3015-13 and CNCLA3016-13). Furthermore, two iNaturalist observations from BC have recently been identified by F. Pühringer (iNaturalist (2022) observations 54703184 and 89994144), but identification by other community members has differed. In northern North America, this species is only known from the east side of the Rocky Mountains (Pohl *et al.* 2018). We consider it unconfirmed but likely in BC.

Albuna fraxini (Edwards, 1881) may be present in the Northern Boreal Mountains ecoprovince of British Columbia. We recovered one specimen in the CNC from Summit Lake (CNC record CNCLEP00214731), collected using a pheromone trap on 28 August 1986. The specimen is worn but appears to be *A. fraxini* (J.-F. Landry, personal communication). This species is known only from Ontario and Quebec in northern North America (Pohl *et al.* 2018), and it is only known to fly until mid-August (Eichlin and Duckworth 1988). We cannot confirm that *A. fraxini* is present in BC due to the uncertainty of this specimen, but we consider it possible.

Synanthedon arctica (Beutenmüller, 1900) may be present in Yukon Territory iNaturalist (2022) observation 14675206, which has most recently been identified as *S. albicornis* (see its species account), had previously been identified as *S. arctica* by the community. This species is known from Alaska and Alberta (Pohl *et al*. 2018) and southwestern Northwest Territories (BOLD systems record CNNHC224-14). We cannot confirm the presence of this species in YT but consider it possible.

Distribution and abundance of records

For the first time, we have documented sesiid distribution below province level in BC and territory level in YT (Table 1; Figs. 2–5). In BC, the Georgia Depression, southeastern Coast and Mountains, Southern Interior, and Southern Interior Mountains ecoprovinces have received greater sampling effort than other ecoprovinces, together constituting more than 65% of provincial records (total BC records = 1974). The more northerly ecoprovinces and the coastal islands, including northwestern Vancouver Island, have considerably fewer records. In YT, more than 75% of records are from south of 63° N, almost all of which are between Kluane Lake and Teslin (total YT records = 189).

Several distributional trends are evident among the sesiid species in BC and YT. Most species are found throughout the Pacific Northwest or across North America; these include *P. marginatum*, *P. robiniae*, *A. pyramidalis*, *S. tibiale*, *S. spartani*, *S. tipuliformis*, *S. bolteri*, *S. culiciformis*, *S. saxifragae*, *S. albicornis*, *S. bibionipennis*, *S. mellinipennis*, *S. polygoni*, *S. resplendens*, *S. exitiosa*, *S. novaroensis*, *S. sequoiae*, and *P. syringae* (Engelhardt 1946; Eichlin and Duckworth 1988; Eichlin and Taft 1988). Notably, we recovered more than 550 records of *A. pyramidalis*; it is found in every ecoprovince in BC and throughout YT. Several authors have speculated that its widespread host plant, fireweed, drives this abundance (Engelhardt 1946; Eichlin and Duckworth 1988) because the plant quickly establishes and persists in disturbed habitats such as roadsides (Broderick 1990). Two introduced species, *S. scitula* and *S. myopaeformis*, have

much more restricted ranges in BC. *Synanthedon mellinipennis*, *S. resplendens*, and *S. polygoni* are found only in the valleys of the Southern Interior and Southern Interior Mountains ecoprovinces. *Sesia tibiale* is found in YT and the southern latitudes of BC but not in between, possibly due to poor habitat suitability but more likely due to low sampling effort in the area. Two species, *S. canadensis* and *S. helenis*, are so infrequently recorded that little can be said regarding their distribution. We recommend pheromone trap surveys to better understand the range of these species in particular.

Host-plant associations

It can be difficult to determine host-plant associations without rearing sesiid larvae to adult stage (Eichlin and Duckworth 1988); however, some trends are apparent in the data reported here. Most species develop on hosts within a single plant family (Table 2; see species checklist section for references), although *S. scitula* is a notable exception; it feeds on members of at least 10 families. Plant species in the Rosaceae, Salicaceae, and Pinaceae families are the most common hosts of sesiids in BC and YT (Table 2).

Apple clearwing moth biological control

Creating this checklist is the first step towards initiating a biological control programme for the apple clearwing moth, *S. myopaeformis*. This species feeds on domestic apple trees in both the Southern Interior and Georgia Depression (Table 1; Cossentine *et al.* 2013), two ecoprovinces that contain high sesiid species richness (16 and 14 species, respectively). We hypothesise that candidate biological control agents are more likely to parasitise species found in similar niches, *i.e.*, *P. marginatum*, *S. scitula*, *S. tipuliformis*, *S. bibionipennis*, and *S. exitiosa*, the five other species that feed on commercially grown members of Rosaceae in BC (Tables 1 and 2). *Synanthedon scitula* may not be established in BC; it is known from only four records in Vancouver (Supplementary material, Table S1) and, as such, may not require further work. The remaining congeners of *S. myopaeformis* (*S. tipuliformis*, *S. bibionipennis*, and *S. exitiosa*) should be prioritised in non-target testing. In particular, *S. exitiosa* feeds on other commercial orchard trees of Rosaceae (Eichlin and Duckworth 1988), making it a likely host for candidate biological control agents.

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Table 2. Host records of sesiid species found in British Columbia and Yukon Territory, Canada. 'v' indicates voucher specimen reared from host plant, and 'P' indicates possible host record. Species without host information are omitted.

Species	Rosaceae	Salicaceae	Betulaceae	Onagraceae	Cornaceae	Fagaceae	Juglandaceae	Myricaceae	Pinaceae	Rhamnaceae	Fabaceae	Grossulariaceae	Asteraceae	Polygonaceae	Polemoniaceae	Sapindaceae	Lauraceae	Oleaceae
Pennisetiini																		
Pennisetia marginatum	v																	
Paranthrenini																		
Paranthrene robiniae		v	v															
Albuna pyramidalis				v														
Sesiini																		
Sesia tibiale		v																
Sesia spartani		P																
Synanthedonini																		
Synanthedon scitula	v	v	v		v	v	v	v	v	v	v							
Synanthedon tipuliformis	v											v						
Synanthedon bolteri		v																
Synanthedon canadensis									P									
Synanthedon culiciformis			v															
Synanthedon helenis													P					
Synanthedon albicornis		v																

Species	Rosaceae	Salicaceae	Betulaceae	Onagraceae	Cornaceae	Fagaceae	Juglandaceae	Myricaceae	Pinaceae	Rhamnaceae	Fabaceae	Grossulariaceae	Asteraceae	Polygonaceae	Polemoniaceae	Sapindaceae	Lauraceae	Oleaceae
Synanthedon bibionipennis	v																	
Synanthedon mellinipennis										v								
Synanthedon polygoni														v	v			
Synanthedon resplendens						v										v	v	
Synanthedon exitiosa	v																	
Synanthedon novaroensis									v									
Synanthedon sequoiae									v									
Synanthedon myopaeformis	v																	
Podosesia syringae																		v

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