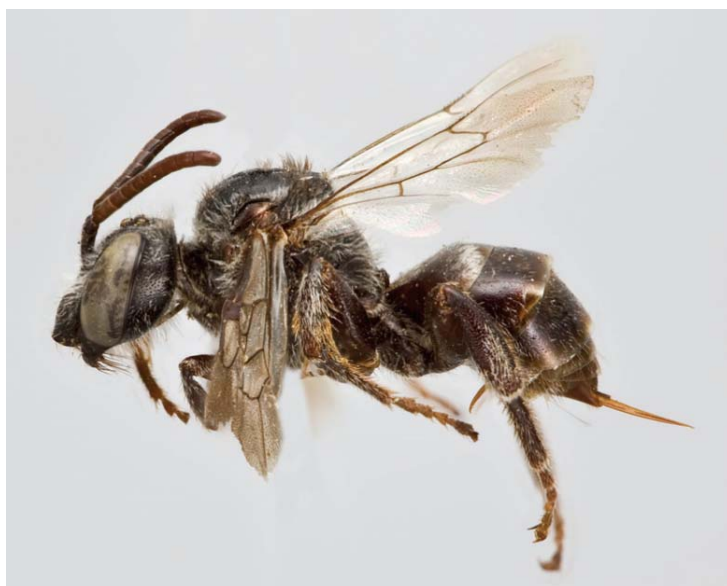


**COSEWIC**  
**Assessment and Status Report**

on the

**Macropis Cuckoo Bee**  
*Epeoloides pilosulus*

in Canada



**ENDANGERED**  
**2011**

**COSEWIC**  
Committee on the Status  
of Endangered Wildlife  
in Canada



**COSEPAC**  
Comité sur la situation  
des espèces en péril  
au Canada

COSEWIC status reports are working documents used in assigning the status of wildlife species suspected of being at risk. This report may be cited as follows:

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Production note:

COSEWIC would like to acknowledge Cory S. Sheffield for writing the status report on the *Macropis* Cuckoo Bee (*Epeoloides pilosulus*) in Canada, prepared under contract with Environment Canada. This report was overseen and edited by Laurence Packer, Co-chair of the COSEWIC Arthropods Specialist Subcommittee.

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## COSEWIC Assessment Summary

### Assessment Summary – May 2011

**Common name**

Macropis Cuckoo Bee

**Scientific name**

*Epeoloides pilosulus*

**Status**

Endangered

**Reason for designation**

This species is a habitat specialist, requiring both a suitable host (*Macropis* bees) and their host's foodplant. The foodplant requires moist habitat and the host bee requires sunny, sandy slopes for its nest site. Historically in Canada, this species was known from six sites across five provinces. Despite recent increases in bee surveying activity nationwide, it has been found in Canada only once in the past fifty years and has not been seen again at this locality or nearby despite recent extensive searches. With only one location and a predicted continuing decline in habitat area and quality, this species is at imminent risk of extinction.

**Occurrence**

Nova Scotia

**Status history**

Designated Endangered in May 2011.



**COSEWIC**  
**Executive Summary**

**Macropis Cuckoo Bee**  
*Epeoloides pilosulus*

**Wildlife species information**

The *Macropis* cuckoo bee, *Epeoloides pilosulus* (Cresson), is the only North American member of a genus that contains two species, the other being found in the Old World. *Epeoloides* is the only genus of the tribe Osirini (Apidae, Apinae) found in both the New and Old World, the remaining genera are otherwise restricted to the Neotropics. All Osirini are cleptoparasites (i.e., cuckoos), thought to have oil-collecting bees as hosts, many of them are rare. Cleptoparasitic bee females sneak into the nests of their hosts and lay eggs on the food provision collected by the host bee. The egg or larva of the host bee is killed by the cleptoparasite.

**Distribution**

Historically, *Epeoloides pilosulus* ranged throughout much of eastern and central North America. In Canada, *Epeoloides pilosulus* has been found originally from Quebec, but has since been reported from Ontario, Manitoba and Saskatchewan. In the past 40 years, it has only been collected in Canada at only one site in Nova Scotia and has not been found in more recent surveys there. In the United States, it was reported from Massachusetts south to Georgia and west to Montana. Recently it has been found only once in the U.S.

**Habitat**

*Epeoloides pilosulus* is found in habitats supporting both *Macropis* bees (Melittidae) and their food plant, Yellow Loosestrife (*Lysimachia*). Most species of *Lysimachia* known to be food hosts for *Macropis* bees in North America grow in swampy or moist habitats, and several are relatively common (and much more widely distributed than *Macropis*). Nest sites of *Macropis* (which serve as the “nesting sites” of *Epeoloides pilosulus*) are typically located within or adjacent to the host plant population, usually in sandy soil with sun exposure and vegetative undergrowth.

## Biology

*Epeoloides pilosulus* attacks nests of *Macropis* in North America, a genus which is dependent on its floral host, *Lysimachia*, for pollen and floral oil, though nectar from other plant species is also collected. *Epeoloides coecutiens* (Fabricius, 1775) from Europe is known to attack *Macropis* nests which it locates by the scent of nesting provisions (i.e., pollen and oil from *Lysimachia* flowers).

## Population sizes and trends

Until the recent captures of two male specimens of *Epeoloides pilosulus* in Nova Scotia (2002) and one female in Connecticut (2006), this species was thought to be possibly extinct as no specimens had been seen since the early 1960s and very few since the early 1940s. Despite the commonness and wide distribution of oil-producing *Lysimachia*, *E. pilosulus* is very rare.

## Threats and limiting factors

The main factors contributing to the tenuous existence of this species are primarily linked to loss or reduction of *Macropis* nesting sites. Both cleptoparasite and host bee are dependent on host plant populations of suitable size, and their distribution is thus restricted within the range of the food plant. As the oil-producing *Lysimachia* species normally used by North American *Macropis* usually grow in wet or swampy habitats, populations may be isolated from one another, preventing gene flow among both floral and bee populations. Under such conditions, local extirpation of both bee species is possible due to intrinsic factors linked to the haplodiploid reproductive system of bees, i.e., the production of sterile or inviable males instead of fertile females as population size declines, leading to fewer egg-laying females in the population which exacerbates the other impacts of small population size. Loss of large stands of *Lysimachia* through natural and anthropogenic causes with resulting increased distances between isolated patches are probably affecting *Macropis* populations, which in turn is probably the main factor contributing to the rarity of *Epeoloides pilosulus*.

## Special significance

This species is one of only two species of *Epeoloides* in the world, a disjunct taxon of the otherwise Neotropical tribe Osirini. This species is one of the rarest bees in North America; only three specimens have been collected since 1958 despite increased collecting effort in recent decades.

## **Existing protection, status, and ranks**

Although until recently thought to be possibly extinct, this species has not previously received any protection in Canada. After its rediscovery in Nova Scotia in 2002, *Epeoloides pilosulus* was recognized by the Xerces Society in its Red List for Pollinator Insects as critically imperiled (CI): “At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors”. It is listed G1 globally and N1 for Canada on NatureServe. However, no protection exists for this species.

## TECHNICAL SUMMARY

*Epeoloides pilosulus*  
Macropis Cuckoo Bee

Abeille-coucou de Macropis

Range of Occurrence in Canada: Nova Scotia

### Demographic Information

Generation time (average age of parents in the population)	1 yr
[Observed] percent [decrease] in total number of mature individuals over the last [10 years].	Data are too sparse for serious consideration other than that given for observed apparent disappearance from the one recent site
[Projected or suspected] percent [reduction or increase] in total number of mature individuals over the next [2 generations].	Unknown
[Observed] percent [reduction AND increase] in total number of mature individuals over any [10 years] period, over a time period including both the past and the future.	Data are too sparse for serious consideration other than that given for observed apparent disappearance from the one recent site
Are the causes of the decline clearly reversible?	Unknown
Are the causes of the decline understood?	Somewhat – loss of wetland habitat and increased pressure from invasive plants in wetlands.
Have the causes of the decline ceased?	No
[Suspected] trend in number of populations	Decline
Are there extreme fluctuations in number of mature individuals?	Unknown
Are there extreme fluctuations in number of populations?	Unknown

### Extent and Occupancy Information

Estimated extent of occurrence	< 1,000,000 km <sup>2</sup>
[Inferred] trend in extent of occurrence	Considerable decline seems certain over the past 60 years
Are there extreme fluctuations in extent of occurrence?	No
Index of area of occupancy (IAO) (Always report 2x2 grid value).	At most 4 km <sup>2</sup> known at present. Historical total 24 km <sup>2</sup> based on 2X2 grid
[Inferred] trend in area of occupancy	Considerable decline
Are there extreme fluctuations in area of occupancy?	No
Is the total population severely fragmented?	Yes, if the species still occurs in Canada
Number of current locations	One recent location may not remain, additional locations may be discovered pending further fieldwork
Trend in number of locations	Decline
Are there extreme fluctuations in number of locations?	No
Trend in [area and/or quality] of habitat	Decline in area and quality of wetlands.

### Number of Mature Individuals (in each population)

Population	N Mature Individuals
Middleton, NS	Unknown, possibly extirpated
Total	Unknown

**Quantitative Analysis**

Probability of extinction in the wild is at least [20% within 20 years or 5 generations, or 10% within 100 years].	Not performed
--	---------------

**Threats (actual or imminent, to populations or habitats)**

<p>Loss of wetland habitat due to draining.</p> <p>Loss of quality of wetland habitat for the bee due to competition between invasive plants and the floral host upon which it ultimately depends.</p> <p>Haplodiploids with single locus complementary sex determination produce increasing proportions of male diploids at smaller populations such that they enter the extinction vortex more readily than other organisms.</p>
--

**Rescue Effect (immigration from outside Canada)**

Status of outside population(s)? Recently found Connecticut, until which time it had been considered extirpated from the U.S.	
Is immigration known or possible?	No, and it is unlikely
Would immigrants be adapted to survive in Canada?	Yes
Is there sufficient habitat for immigrants in Canada?	Probably
Is rescue from outside populations likely?	No

**Current Status**

COSEWIC: Endangered (May 2011)
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**Recommended Status and Reasons for Designation**

<b>Recommended Status:</b> Endangered	<b>Alpha-numeric code:</b> B2ab(iii)
<p><b>Reason for Designation:</b> This species is a habitat specialist, requiring both a suitable host (<i>Macropis</i> bees) and their host's foodplant. The foodplant requires moist habitat and the host bee requires sunny, sandy slopes for its nest site. Historically in Canada, this species was known from six sites across five provinces. Despite recent increases in bee surveying activity nationwide, it has been found in Canada only once in the past fifty years and has not been seen again at this locality or nearby despite recent extensive searches. With only one location and a predicted continuing decline in habitat area and quality, this species is at imminent risk of extinction.</p>	

**Applicability of Criteria**

<p><b>Criterion A:</b> Decline seems to have occurred at the one recently known site, but A criteria are considered unsuitable due to lack of detailed information.</p>
<p><b>Criterion B:</b> Meets Endangered B2ab(iii) as the IAO (4km<sup>2</sup>) is below the threshold, the species has been found at only one location in the past 10 years, has always existed in fragmented populations and there is a continuing decline in suitable wetland habitat for the flowering plant species upon which the host cuckoo bee ultimately depends due to development, invasive species and reduction in wetland area.</p>
<p><b>Criterion C:</b> Insufficient data.</p>
<p><b>Criterion D:</b> Meets Threatened D2 as the species has an IAO of less than 20km<sup>2</sup>, and has been found at only one location in the past 10 years. The species is likely prone to human activities and stochastic events, and is thus capable of becoming endangered in a very short time period.</p>
<p><b>Criterion E (Quantitative Analysis):</b> Not performed.</p>





### COSEWIC HISTORY

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was created in 1977 as a result of a recommendation at the Federal-Provincial Wildlife Conference held in 1976. It arose from the need for a single, official, scientifically sound, national listing of wildlife species at risk. In 1978, COSEWIC designated its first species and produced its first list of Canadian species at risk. Species designated at meetings of the full committee are added to the list. On June 5, 2003, the *Species at Risk Act* (SARA) was proclaimed. SARA establishes COSEWIC as an advisory body ensuring that species will continue to be assessed under a rigorous and independent scientific process.

### COSEWIC MANDATE

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) assesses the national status of wild species, subspecies, varieties, or other designatable units that are considered to be at risk in Canada. Designations are made on native species for the following taxonomic groups: mammals, birds, reptiles, amphibians, fishes, arthropods, molluscs, vascular plants, mosses, and lichens.

### COSEWIC MEMBERSHIP

COSEWIC comprises members from each provincial and territorial government wildlife agency, four federal entities (Canadian Wildlife Service, Parks Canada Agency, Department of Fisheries and Oceans, and the Federal Biodiversity Information Partnership, chaired by the Canadian Museum of Nature), three non-government science members and the co-chairs of the species specialist subcommittees and the Aboriginal Traditional Knowledge subcommittee. The Committee meets to consider status reports on candidate species.

### DEFINITIONS (2011)

Wildlife Species	A species, subspecies, variety, or geographically or genetically distinct population of animal, plant or other organism, other than a bacterium or virus, that is wild by nature and is either native to Canada or has extended its range into Canada without human intervention and has been present in Canada for at least 50 years.
Extinct (X)	A wildlife species that no longer exists.
Extirpated (XT)	A wildlife species no longer existing in the wild in Canada, but occurring elsewhere.
Endangered (E)	A wildlife species facing imminent extirpation or extinction.
Threatened (T)	A wildlife species likely to become endangered if limiting factors are not reversed.
Special Concern (SC)*	A wildlife species that may become a threatened or an endangered species because of a combination of biological characteristics and identified threats.
Not at Risk (NAR)**	A wildlife species that has been evaluated and found to be not at risk of extinction given the current circumstances.
Data Deficient (DD)***	A category that applies when the available information is insufficient (a) to resolve a species' eligibility for assessment or (b) to permit an assessment of the species' risk of extinction.

\* Formerly described as "Vulnerable" from 1990 to 1999, or "Rare" prior to 1990.

\*\* Formerly described as "Not In Any Category", or "No Designation Required."

\*\*\* Formerly described as "Indeterminate" from 1994 to 1999 or "ISIBD" (insufficient scientific information on which to base a designation) prior to 1994. Definition of the (DD) category revised in 2006.



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The Canadian Wildlife Service, Environment Canada, provides full administrative and financial support to the COSEWIC Secretariat.

# **COSEWIC Status Report**

on the

## **Macropis Cuckoo Bee** *Epeoloides pilosulus*

**in Canada**

2011

## TABLE OF CONTENTS

WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE.....	4
Name and classification.....	4
Morphological description.....	4
Genetic description.....	6
Designatable units.....	6
DISTRIBUTION.....	6
Global range.....	6
Canadian range.....	7
HABITAT.....	8
Habitat requirements.....	8
Habitat trends.....	10
Habitat protection/ownership.....	11
BIOLOGY.....	11
Life cycle and reproduction.....	12
Herbivory/predation.....	12
Physiology.....	12
Dispersal/migration.....	13
Interspecific interactions.....	13
Adaptability.....	13
POPULATION SIZES AND TRENDS.....	13
Search effort.....	13
Abundance.....	15
Fluctuations and trends.....	15
Rescue effect.....	15
THREATS AND LIMITING FACTORS.....	15
SPECIAL SIGNIFICANCE OF THE SPECIES.....	19
Protection, status, and ranks.....	20
ACKNOWLEDGEMENTS AND AUTHORITIES CONTACTED.....	20
INFORMATION SOURCES.....	20
BIOGRAPHICAL SUMMARY OF REPORT WRITER.....	24
COLLECTIONS EXAMINED.....	25

### List of Figures

Figure 1. Female (left) and male (right) <i>Epeoloides pilosulus</i> (Apidae).....	5
Figure 2. The approximate distribution of North American <i>Macropis</i> (Mellitidae) (light shaded area) and its cleptoparasite, <i>Epeoloides pilosulus</i> (Apidae) (dark shaded area). Black dots indicate known sites of collections within Canada (see Table 1). Compiled from data in Sheffield <i>et al.</i> (2004), Ascher (2005), Wagner and Ascher (2008), and Discover Life ( <a href="http://www.discoverlife.org">www.discoverlife.org</a> ) (note that the maps for the species on this website show provincial centroids not actual localities; this is their protocol until such a time as the detailed data can be entered).....	7
Figure 3 Female <i>Macropis nuda</i> (Melittidae) foraging on <i>Lysimachia terrestris</i> in Middleton, Nova Scotia.....	9

- Figure 4. Examples of habitats where native Canadian *Lysimachia* can be found. Small populations of *Lysimachia terrestris* in roadside ditches in A) Kings Co., and B) Yarmouth Co., Nova Scotia; C) *L. ciliata* growing next to a river in Guelph, Ontario; D) a large stand of *L. terrestris* at the edge of a lowbush blueberry field in Hants Co., Nova Scotia. .... 17
- Figure 5. Reproduction in *Lysimachia terrestris* (Myrsinaceae). A. Flowering, B. Sexual reproduction resulting in seed capsule production, C. Asexual reproduction via bulbil production; this mode of asexual reproduction is only known for this species among the genus *Lysimachia*..... 17
- Figure 6. Introduced *Lysimachia* growing A) in an urban park flower bed in Guelph, Ontario, and B) at roadside in a rural setting in Digby Co., Nova Scotia..... 18

### List of Tables

- Table 1. List of localities where *Epeoloides pilosulus* (Apidae) has been collected in Canada. See Sheffield *et al.* (2004). .... 8
- Table 2. Geographic distribution of *Macropis* species in North America. From Michez and Patiny 2005; Ascher *et al.* 2007. .... 8
- Table 3. North American species of *Lysimachia*, showing their status, oil production, and distribution. .... 10

## WILDLIFE SPECIES DESCRIPTION AND SIGNIFICANCE

### Name and classification

First described as *Nomada pilosulus* from New York in 1878, this species was clearly recognized by Cresson as a cleptoparasite, even from the single male specimen he examined (Cresson 1878). Synonyms are *Nomia compacta* Provancher 1888, *Viereckella ceanothina* Swenk and *V. obscura* Swenk.

Ducke described *Epeoloides nearcticus* in 1909, a species he felt was congeneric with the European (then monotypic) genus *Epeoloides* Giraud; the type species is *Epeoloides coecutiens* (Fabricius, 1775; originally described in the genus *Apis*). Thus he (Ducke 1909) was the first to assign a North American species to the genus *Epeoloides* (see Krombein *et al.* 1979). Mitchell (1962) and Krombein *et al.* (1979) subsequently placed *E. nearcticus* and the other proposed names into synonymy with *Epeoloides pilosulus* (Cresson), excluding *Epeoloides obscura* (Swenk), which was treated as a valid species by Krombein *et al.* (1979) and Roig-Alsina (1989). However, Michener (2000, 2007) and Sheffield *et al.* (2004) concluded *E. obscura* was also synonymous with *E. pilosulus*. *Epeoloides pilosulus* thus is the only species of the cleptoparasitic tribe Osirini (Apidae: Apinae) present in the United States and Canada, and one of only two species of the genus worldwide (Michener 2007).

The complete classification is as follows:

Kingdom: Animalia  
Phylum: Arthropoda  
Class: Insecta  
Order: Hymenoptera  
Superfamily: Apoidea  
Family: Apidae  
Subfamily: Apinae  
Tribe: Osirini  
Genus: *Epeoloides* Giraud  
Species: *Epeoloides pilosulus* (Cresson, 1878)

The English name chosen for this species is the *Macropis* Cuckoo Bee. The French name is abeille-coucou de *Macropis*. “*Macropis*” refers to the genus name of the melittid bees which are the hosts of *Epeoloides*.

### Morphological description

*Epeoloides pilosulus* is a very distinctive species. It is a moderate-sized (7.5 – 10 mm long) cleptoparasitic bee with a smooth, black, shining integument (Figure 1). *Epeoloides pilosulus* differs from other cleptoparasitic bees by the short but densely plumose, erect pubescence (Cresson 1878; Linsley and Michener 1939; Mitchell 1962), the absence of the red and/or yellow integument markings characteristic of the common

genus *Nomada* (Nomadinae), and in lacking the bands and/or dense patches of short, appressed hair (which superficially resemble integument markings) typical of the epeoline genera *Epeolus* and *Triepeolus* (also Nomadinae) and some other cleptoparasitic Apidae. *Epeoloides pilosulus* possesses apical tergal bands of erect, densely plumose, white hairs (Cresson 1878) which are lacking in Nomadinae, and has the second submarginal cell much smaller than the first or third (see Sheffield *et al.* 2004). In addition, the apex of the marginal cell is separated from the wing margin (illustrated in Michener *et al.* 1994; Sheffield *et al.* 2004). Male *E. pilosulus* have large eyes which are strongly convergent above, and a uniquely shaped pygidial plate on the 7<sup>th</sup> abdominal tergum (Linsley and Michener 1939; see Sheffield *et al.* 2004). *Epeoloides pilosulus* females can readily be recognized as cleptoparasitic Apidae as they lack specialized pollen-collecting hairs (i.e., scopae). However, unlike most nomadine females, *Epeoloides* females lack a well-defined pseudopygidial area on the 5<sup>th</sup> metasomal tergum. Linsley and Michener (1939), Mitchell (1962), and Sheffield *et al.* (2004) provide illustrations of various structures, and the latter also provided a habitus drawing. Immature stages of *E. pilosulus* have never been observed, though those of the European species recently received attention (Straka and Bogusch 2007).



Figure 1. Female (left) and male (right) *Epeoloides pilosulus* (Apidae).

*Epeoloides pilosulus*, the only member of the genus in the New World and the only member of the tribe Osirini in America north of Mexico, is a distinct species and can be easily identified using keys in Mitchell (1962; eastern North America), Stephen *et al.* (1969; western North America); Michener *et al.* (1994; North and Central America), Michener (2000, 2007; global) and Packer *et al.* (2007; eastern Canada).

## Genetic description

Given the wide historical range of this species and the patchiness of its distribution, genetic differentiation among populations is possible; however, appropriate studies have not been performed. As only three specimens of *Epeoloides pilosulus* have been collected since the 1960s, no population genetic studies are feasible. However, a small DNA sequence (<600 base pairs) of the mitochondrial gene *Col* (i.e., the DNA barcode) for a single specimen of *E. pilosulus* was analyzed by Sheffield *et al.* (2009).

## Designatable units

There is no evidence to suggest that the species occurs as more than one designatable unit.

## DISTRIBUTION

### Global range

The distribution of *Epeoloides pilosulus* in North America, as expected, falls within the range of its host (Figure 2) which in turn follows the distribution of oil-producing species of *Lysimachia* (Myrsinaceae), which show their greatest diversity in the Appalachian region of the southeastern United States (Ray 1956). These plants have a variety of common names including Swamp Candle, Yellow Flag and Yellow Loosestrife.

The type locality of *Epeoloides pilosulus* is “New York”, and the species is known historically throughout much of eastern and central North America (Figure 2). Mitchell (1962) and Krombein *et al.* (1979) recorded *Epeoloides pilosulus* from Quebec, Michigan and the New England states, south to Georgia, and west to Wisconsin, North Dakota and Nebraska. Ascher (2005) provided the most recent collection dates for several localities in the United States, including Massachusetts (Needham: 1921-1927), Connecticut (South Meriden: 1911), Wisconsin (Dane County: 1910), Michigan (Paw Paw Lake: 1906), Ohio, New York (Springlake, Cayuga Co.: 1918, Tuxedo: 1928, Yaphank: 1930, Yonkers: 1935), Virginia, North Carolina, Georgia, North Dakota (Fargo: 1913), and Nebraska. Additional records are from Montana (International Peace Garden, Turtle Mountain: 1958), Illinois (Savannah: 1917), New Jersey (Plainfield: 1927), Pennsylvania, Maryland, West Virginia, and Virginia. *Epeoloides pilosulus* has also been collected near major cities, including New York City (e.g., Flatbush in Brooklyn, Kings County, New York, in 1894 and 1896; Palisades, New Jersey in 1918 and 1920), Washington, D.C. (Plummers Island, Maryland, 1905-1917), and Boston (Needham: 1921-1927) (Ascher 2005). Ascher (2005) made note of the fact that most of the collection events post-1935 are from southern Canada (Nova Scotia, western Ontario to Saskatchewan) and Montana, and indicated that Canada may be the last stronghold for this species. More recently, Wagner and Ascher (2008) found a single

female specimen in Connecticut.

### Canadian range

Originally known only from Quebec (Cap Rouge) in Canada (Hurd 1979), Sheffield *et al.* (2004) published additional Canadian records from Ontario (One Sided [=Oneside] Lake: 1960), Manitoba (Aweme: 1916), and Saskatchewan (Wallwort: 1942, Wood Mountain: 1955), documenting a distribution much further west in Canada than previously reported (Figure 2; Table 1). In 2002, two specimens were collected in Middleton, Kings County, Nova Scotia (Sheffield *et al.* 2004), thus expanding the known Canadian, and North American, distribution eastward (Figure 2).



Figure 2. The approximate distribution of North American *Macropis* (Mellitidae) (light shaded area) and its cleptoparasite, *Epeoloides pilosulus* (Apidae) (dark shaded area). Black dots indicate known sites of collections within Canada (see Table 1). Compiled from data in Sheffield *et al.* (2004), Ascher (2005), Wagner and Ascher (2008), and Discover Life ([www.discoverlife.org](http://www.discoverlife.org)) (note that the maps for the species on this website show provincial centroids not actual localities; this is their protocol until such a time as the detailed data can be entered).



**Table 1. List of localities where *Epeoloides pilosulus* (Apidae) has been collected in Canada. See Sheffield *et al.* (2004).**

Location	Province (# specimens)
Middleton	Nova Scotia (2)
Cap Rouge	Quebec (1)
Oneside Lake [=Onesided Lake]	Ontario (1)
Aweme	Manitoba (1)
Walwort	Saskatchewan (3)
Wood Mountain	Saskatchewan (1)

## HABITAT

### Habitat requirements

*Epeoloides pilosulus* is a cleptoparasite of bees of the genus *Macropis*. *Macropis* females are entirely dependent on *Lysimachia* (Malyshev 1929; Popov 1958; Vogel 1976, 1986; Michez and Patiny 2005; Figure 4). There are four species of *Macropis* (Table 2) and 19 species of *Lysimachia* in North America within the range of *Macropis*; four of which are adventive (Table 3). However, as noted by Popov (1958), the global distribution of *Lysimachia* is much more widespread than either *Macropis* or *Epeoloides*.

**Table 2. Geographic distribution of *Macropis* species in North America. From Michez and Patiny 2005; Ascher *et al.* 2007.**

Species	North American Distribution
<i>M. ciliata</i> Patton	CAN: QC; USA: CT, GA, IL, MA, MD, ME, NC, NJ, NY, PA, RI, VA, WI
<i>M. nuda</i> (Provancher)	CAN: NS, NB, QC, ON, MB, SK; USA: CO, MA, ME, IA, ID, IL, MD, MI, MT, ND, NJ, NY, PA, SD, UT, WI, WY
<i>M. patellata</i> Patton	USA: CT, IA, IL, MD, MO, NC, NY, NE, VA, VT
<i>M. steironematis</i> Robertson, 1891	USA: DC, IA, IL, GA, KS, MN, MO, NC, NE, VA, WA



Figure 3 Female *Macropis nuda* (Melittidae) foraging on *Lysimachia terrestris* in Middleton, Nova Scotia.

Most species of *Lysimachia* grow in moist areas such as swamps, roadside ditches, and riparian zones (Figure 4). Rozen and Jacobson (1980) and Cane *et al.* (1983) described the nesting locations of *Macropis nuda* (Provancher) in eastern North America, indicating preference for sunny areas in sandy, well drained soil, often amongst the floral hosts themselves. *Macropis* bees are univoltine and solitary, but often nest in small aggregations on sloping banks. Nests are typically shallow (ca 6.5 cm), with the entrances usually partially concealed by vegetation (Rozen and Jacobson 1980). Nesting tunnels are 3 mm to 3.5 mm in diameter, containing 2-4 linearly arranged brood cells (Rozen and Jacobson 1980), which are lined with oils obtained from the floral host (Cane *et al.* 1983). Malyshev (1929) provided a detailed account of the nesting biology of two European species.

**Table 3. North American species of *Lysimachia*, showing their status, oil production, and distribution. Compiled from information in Britton and Brown (1913), Fernald (1950), Ray (1956), Scoggan (1979), Coffey and Jones (1980), Simpson *et al.* (1983).**

Species	Status	Oil	North American Distribution
<i>asperulaefolia</i>	Native	Yes	<b>USA:</b> GA, SC, NC
<i>fraseri</i>	Native	Yes	<b>USA:</b> AL, NC
<i>loomisii</i>	Native	Yes	<b>USA:</b> GA, SC, NC
<i>nummularia</i>	Adventive (Europe)	Yes	<b>CAN:</b> NS, NB, PE, NF, QC, ON, BC; <b>USA:</b> New England, NJ, VA, IL, MI, GA, MO, KS
<i>punctata</i>	Adventive (Eurasia)	Yes	<b>CAN:</b> NS, NB, PE, NF, QC, ON, AB, BC; <b>USA:</b> New England, NJ, PA, IL, NY
<i>quadrifolia</i>	Native	Yes	<b>CAN:</b> NS, NB, PE, QC, ON; <b>USA:</b> MN, TN, GA, WI
<i>terrestris</i>	Native	Yes	<b>CAN:</b> ON, QC, NS, NB, PE, NF, Lab, QC, ON, MB, introduced into BC; <b>USA:</b> GA, AR, KY, IA
<i>vulgaris</i>	Adventive (Eurasia)	Yes	<b>CAN:</b> NS, NB, PE, QC, ON; <b>USA:</b> ME, NY, PA, IL, OH
<i>x commixta</i>	Native	Yes	<b>CAN:</b> NS, NB, PE, QC, ON
<i>x product</i>	Native	Yes	<b>CAN:</b> QC, ON; <b>USA:</b> New England, ME, MI, SC
<i>thysiflora</i>	Native	No	<b>CAN:</b> circumboreal; NS, NB, PE, QC, ON, MB, SK, AB, BC, NT, YT; <b>USA:</b> AK, NY, PA, MO, NE, MT, CA, NJ, New England, WV, IA, IL, MO, CO, CA
<i>clethroides</i>	Adventive (China)	No	<b>CAN:</b> QC
<i>ciliata</i>	Native	Yes	<b>CAN:</b> NS-BC; <b>USA:</b> GA, AL, KS, NM, AZ, FL, TX, CO
<i>graminea</i>	Native	Yes	<b>USA:</b> northeastern AL
<i>hybrida</i>	Native	Yes	<b>CAN:</b> southwest QC, ON; <b>USA:</b> New England, ND, FL, MS, TX
<i>lanceolata</i>	Native	Yes	<b>CAN</b> ON (continental); <b>USA</b> ME to ND, south to FL, LA, AZ, PA, MI, WI
<i>quadriflora</i>	Native	Yes	<b>CAN:</b> ON, MB; <b>USA:</b> VA, NY, KY, Iowa, WV, IL, MO
<i>radicans</i>	Native	Yes	<b>USA:</b> Mississippi Valley; VA, WV, AR, TX, MO
<i>tonsa</i>	Native	Yes	<b>USA:</b> southeast; KY, VA, TN, AL, GA, AR

## Habitat trends

Because of the ultimate dependence of this species upon the floral host of its bee host, the trends in its populations are intimately linked with those of *Lysimachia*. Although none of the Canadian species of *Lysimachia* are listed as at risk, some populations have undergone substantial decline. *Lysimachia quadrifolia* is rare in New Brunswick and Quebec and is the only native species found on dry ground. Its populations have been drastically reduced due to the loss of savannah and sand barrens which are now probably less than 1% of their historical area and which continue to decline (Catling 2009, pers. comm. 2010). All of the other species (*L. terrestris*, *L. thysiflora*, *L. ciliata*, and *L. quadriflora*) are wetland plants, and wetlands cover 80% of their historical extent in southern Ontario and the remainder have been thought to be declining by more than 5% per year (Snell 1989). In addition to the direct destruction of wetlands there is the threat of invasive alien plants such as *Phragmites australis* subsp.

*australis* (Poaceae) that eliminate native flora (Catling 2009 pers. comm. 2010). In Nova Scotia there has been extensive development in the Annapolis valley over the past few decades and many wetlands have been converted to urban areas or cranberry operations. Habitat has and is definitely declining over at least half of the historical Canadian range of this bee.

### **Habitat protection/ownership**

Only two specimens of *Epeoloides pilosulus* have been collected in the last 45 years in Canada, both from a single location in Middleton, Nova Scotia (Sheffield *et al.* 2004). At that time, the site of collection was a privately owned property. Currently no protection status has been given to this property. The established populations of *Lysimachia terrestris* and *Macropis nuda* still remain intact as of 2008 (Sheffield, unpublished observation), though the *Macropis* population appears small.

## **BIOLOGY**

*Epeoloides pilosulus* is an obligate cleptoparasite of melittid bees of the genus *Macropis*. This relationship (discussed in Sheffield *et al.* 2004) is generally accepted based on the well known associations between the abundant European species, *E. coecutiens*, and its two confirmed *Macropis* hosts, *M. europaea* Warncke and *M. fulvipes* (Fabricius) (Pekkarinen *et al.* 2003; Bogusch 2003, 2005; Celary 2004). However, the relationship of *E. pilosulus* to *Macropis* bees in North America is supported by frequent historical (see Ascher 2005) and recent (Sheffield *et al.* 2004; Wagner and Ascher 2008) co-occurrence of host and cleptoparasite in and near patches of *Lysimachia* spp. Given its historic distribution, *E. pilosulus* can be inferred to parasitize multiple *Macropis* species and its host range quite possibly includes all four North American species (see Michez and Patiny 2005). *Macropis nuda* is almost certainly a host of *E. pilosulus*, as this is the only *Macropis* known from much of the Canadian range of *Epeoloides*, including Nova Scotia (Sheffield *et al.* 2004). Other North American species of *Macropis* likely served as hosts in the U.S. and western Canada, as *E. pilosulus* is recorded south to Georgia where *Macropis ciliata* Patton and *M. steironematis* Robertson, but not *M. nuda*, occur (Ascher 2005). *Epeoloides pilosulus* has also been collected together with *Macropis patellata* Patton at Plummer's Island, Maryland, and elsewhere (Ascher 2005).

The known flight season of *E. pilosulus* is June and July (Mitchell 1962); Sheffield *et al.* (2004) and Wagner and Ascher (2008) have captures from July, all corresponding with peak nesting activity of *Macropis* and peak bloom of its host plant. The European congener flies from June to August (Pekkarinen *et al.* 2003). *Epeoloides pilosulus* visits a variety of plants for nectar (Mitchell 1962, listed four floral records), but ultimately depends upon populations of *Lysimachia*, because the *Macropis* hosts of *Epeoloides* are strict *Lysimachia* specialists. *Macropis* females gather both pollen and floral oils from *Lysimachia* species.

Although nothing is known about the biology of the North American species, Straka and Bogush (2007) gave a detailed account of behaviours associated with nest attack for the European species. These are discussed in detail below with respect to physiology, interspecific interactions, and limiting factors and threats.

### **Life cycle and reproduction**

The life cycle of *Epeoloides pilosulus* is probably similar to that of many summer flying bees (Stephen *et al.* 1969). Males and females spend the winter as mature, post defecating larvae within the nests of their host, and re-commence development in the spring as heat units are accumulated; see Sheffield (2008) for an account of development of another summer flying bee species. Adults emerge in late June/early July, mate, and feed on pollen and nectar. Females then search out nests of their hosts. Unlike most cleptoparasites, *Epeoloides* females stay in host nests for a long time (one hour or more), constructing a cell closure being a major activity (Straka and Bogush 2007). Other activities inside the nest are unknown (Straka and Bogush 2007).

Eggs are laid within the host nest and the larvae consume the food provisions intended for the host's offspring and pass through probably 4 or 5 larval instars before overwintering.

### **Herbivory/predation**

No specific predators have been recorded for *Epeoloides pilosulus* or *Macropis* bees in North America, though like most flying insects, bees are preyed upon by crab spiders and other generalist predators. Although bees are also targeted by parasites, including mites, sarcophagid and phorid flies and some pathogens, no information is currently known for predators that target *Epeoloides*, or *Macropis*.

### **Physiology**

Because no living specimens of *Epeoloides pilosulus* have been observed in 60 plus years (passive trapping has resulted in all 3 recent records), no biological studies involving individual live bees or populations have been conducted. However, as a summer-flying ground-nesting species, it probably displays similar adaptations to the temperate-zone climate as most other bee species within this life zone (see Stephen *et al.* 1969 for a review).

The European species, *Epeoloides coecutiens*, which is also a temperate zone species, does show some thermal preferences as an adult; it flies only when the weather is warm (23-37°C) and sunny (Straka and Bogush 2007). Bogush (2005) reported that the activity of females and males was limited to walking at temperatures below 18°C. As these cleptoparasites fly during warmer temperatures, in hot weather the host females stay at nest entrances, presumably guarding them from attack, usually very successfully (Straka and Bogush 2007). Straka and Bogush (2007) suggest that this guarding behaviour during warm days is a very important strategy for nest defence.

The only physiological studies of *Epeoloides* are those of Dötterl (2008), who looked at electro-antennographic responses to floral constituents of *Lysimachia*. Like their host, *Macropis*, *Epeoloides* show similar responses to the odors of *Lysimachia* pollen and oil; in *Macropis* this probably helps find flowers (Dötterl and Schöffler 2007; Dötterl 2008). Dötterl (2008) suggests that these same odors are used by *Epeoloides* to find the nests of *Macropis*. It is highly probable that *E. pilosulus* uses similar cues.

### **Dispersal/migration**

The distance between *Lysimachia* populations, a plant that usually grows in moist habitats, is often great enough to prevent both host and cleptoparasite from spreading frequently. Solitary bees typically forage within 120–600 m of their nests, the distance increasing with body size (Gathmann and Tschardt 2002). As such, large populations of *Lysimachia* are important for supporting populations of *Macropis*, and reduction in size or loss of plant populations ultimately can lead to local extirpation. However, no studies have been conducted on foraging ranges or movement between floral patches, though *Macropis* females typically nest in close proximity to their floral hosts (Pekkarinen *et al.* 2003).

### **Interspecific interactions**

Other than its interactions with its host bee, the host bee's floral needs and the wider range of nectar plants likely used by *E. pilosulus*, described elsewhere in this report, there are no details on additional interspecific interactions.

### **Adaptability**

*Epeoloides pilosulus* is a member of one of the most specialized set of ecological relationships known for bees: it has a single genus of host which itself forages for pollen and oil on a single genus of plant. Due to this specialization, populations of *Epeoloides* are highly susceptible to any changes in the abundance of *Macropis* and *Lysimachia*; these are not adaptable bees.

## **POPULATION SIZES AND TRENDS**

### **Search effort**

Bee sampling in Canada has increased substantially since 2000. Although data only for the bumble bee component of the entire fauna has been compiled, it is expected that the data for all bees follow a similar pattern. The data show that 4 times as much sampling has occurred since 2000 than in any earlier decade. Consequently, the fact that most records of this species are from periods of less intense sampling and that it has only been found once during the recent period of intense collecting suggests that there has been a decline in the species.

The lack of older records for *E. pilosulus* from Nova Scotia is despite earlier surveys in the province by Atwood (1933) and Brittain (1933). MacKay and Knerer (1979) collected bees extensively in southern Ontario and found *Macropis*, but not its cleptoparasite.

Other than the re-discovery of *Epeoloides pilosulus* in Nova Scotia in 2002 (Sheffield *et al.* 2004), no other specimens have been found in Canada since the early 1960s. Despite numerous yearly attempts by the report writer to find more *Epeoloides* in the site of re-discovery (from 2004-2008), and in other sites in Nova Scotia, the bee has not been found again. From 2004 to 2008, over twenty sites were searched in southern and northwestern Nova Scotia, and no additional specimens of *E. pilosulus* were found. These efforts included yellow pan trap surveys throughout *Lysimachia* flowering at several locations in Nova Scotia in 2008, and with netting and yellow pan traps at three habitats considered most likely in southern Ontario (Guelph area) as part of the work leading to this report. However, the host bee, *Macropis nuda* was collected in all sites. A large series (40+) of *Macropis nuda* were also collected in a riparian zone near the town of Middleton, Nova Scotia in 2007 by L. Best (pers. comm. 2008). However, no *Epeoloides* were collected. In addition to the directed searches for *E. pilosulus*, it is significant that the species has not appeared in the many tens of thousands of bees recently collected in Canada at numerous localities, including those in which its host has been reported (MacKay and Knerer 1979; Gixti and Packer 2006), in Nova Scotia (Sheffield *et al.* 2003), and in Manitoba (Patenaude 2007). As the only recently collected specimens in Canada and the U.S. have been collected in pan traps, it may be possible that this method may be the most reliable means to determine the presence of *E. pilosulus*.

Although bee surveying has been more frequent in recent decades than in the first two-thirds of the previous century, no *E. pilosulus* were found until 2002 and none have been seen in Canada since. However, the damp habitats of the floral hosts of this cuckoo bee's host are not commonly frequented by melittologists and it remains possible that this rare bee persists in Canada. Thus, the widespread occurrence of historical records, combined with a lack of detailed survey work in areas for the species other than in Nova Scotia, makes it impossible to be confident that the species does not persist somewhere in Canada.

## Abundance

This species has likely always been infrequent in North America, without any long series of specimens collected at any given time. Sheffield *et al.* (2004) collected two male specimens within a two week period using yellow pan traps in Nova Scotia, though the population of the host bees was not large (i.e., < 5 individuals were seen foraging at any time). The European species, *Epeoloides coecutiens*, though also considered rare, is much more abundant than the North American species. Bogush (2005) observed the behaviour of 45 individuals among nine localities in the Czech Republic, while Monsevičius (2004) collected almost 300 individuals with Moericke's yellow coloured traps in Ėepkeliai Nature Reserve in South Lithuania between 1997 and 2001.

## Fluctuations and trends

Due to lack of recent collection data (the three exceptions are mentioned above), the large gaps of data in the last 65 years, the rarity of the species and its wide geographic range, discussion of population trends is difficult. Certainly there were more records of *E. pilosulus* before 1960 than since, even though bee survey work has been far more extensive since the 1960s, including the survey-based research noted above. It is possible that this species continues to occur in sites that have not been recently sampled.

## Rescue effect

Given the extreme rarity of recent records for this species and the fragmented nature of the wetland habitat of the floral host of its host bee, the chances of natural recolonization must be minimal.

## THREATS AND LIMITING FACTORS

The rarity of *Epeoloides* in North America in the past 60+ years is evidently due to a cause specific to this continent, as the European species, *Epeoloides coecutiens* remains locally abundant in central and eastern Europe (Monsevičius 2004), and has apparently extended its range north in recent times to Finland and the Baltics (Pekkarinen *et al.* 2003). However, localized populations in certain areas have been recognized as potentially vulnerable (Westrich 1990; Falk 1991), and historically this species has been considered rare (Malyshev 1929) and even to be one of the rarest bees in Europe (Schmiedeknecht 1930).

The causes of rarity for *Epeoloides pilosulus* are not clear, though the special conditions for its existence – the presence of its uncommon host bees (*Macropis*) and host plant (*Lysimachia*) ultimately contribute to its tenuous existence (Sheffield *et al.* 2004).



Loss or reduction of *Macropis* nest aggregations is probably the most likely general threat to *Epeoloides pilosulus* in North America (Ascher 2005), though data supporting this are lacking, and other factors also likely contribute to the uncommonness of bee host and cleptoparasite. As *Macropis* species are dependent upon *Lysimachia* species for pollen and floral oils, their populations are vulnerable to changes in abundance (i.e., reduction of populations) of these foodplants. Several of the 19 *Lysimachia* species occurring in North America are widespread (Table 3) and abundant, and Ascher (2005) reported that *Lysimachia* flowers can still be found at many of the historic collection sites of *Epeoloides*, though most populations located recently in New York are relatively small and unlikely to provide sufficient resources for a metapopulation of the parasite. *Macropis* populations have typically been found at relatively undisturbed sites. However, in Nova Scotia *Macropis nuda* has been found on *Lysimachia terrestris* (Figure 3) growing in small patches along roadsides, and in larger “weedy” patches growing in recently cleared areas (Figure 4). Similarly, more than half of the study sites in which Bogusch (2005) found *Epeoloides coecutiens* in the Czech Republic were anthropogenic.

Populations of *Lysimachia* are typically scattered and/or fragmented, found in moist habitats usually at distances much greater than the flight range of most medium sized bees (Gathmann and Tschardt 2002). This alone contributes to the uncommonness of *Macropis*, thus the rarity of *Epeoloides*. In fact, the uncommonness of *Macropis* may be represented in the reproductive strategy of *Lysimachia* populations. Although several bee species visit *Lysimachia* flowers (primarily halictid bees, Sheffield (unpublished observation); and see McCall and Primack 1985, who do not mention *Macropis* as floral visitors), their pollination contributions have never been assessed (Simpson *et al.* 1983). In Nova Scotia, populations of *Lysimachia terrestris*, in the absence of *Macropis nuda*, often reproduce by asexual means (see MacDougal 1901, Figure 5).



Figure 4. Examples of habitats where native Canadian *Lysimachia* can be found. Small populations of *Lysimachia terrestris* in roadside ditches in A) Kings Co., and B) Yarmouth Co., Nova Scotia; C) *L. ciliata* growing next to a river in Guelph, Ontario; D) a large stand of *L. terrestris* at the edge of a lowbush blueberry field in Hants Co., Nova Scotia.



Figure 5. Reproduction in *Lysimachia terrestris* (Myrsinaceae). A. Flowering, B. Sexual reproduction resulting in seed capsule production, C. Asexual reproduction via bulbil production; this mode of asexual reproduction is only known for this species among the genus *Lysimachia*.



Figure 6. Introduced *Lysimachia* growing A) in an urban park flower bed in Guelph, Ontario, and B) at roadside in a rural setting in Digby Co., Nova Scotia.

A few *Lysimachia* species are endangered at least in parts of their range. For instance, Fraser's Loosestrife (*Lysimachia fraseri*) is listed as critically imperiled throughout most of its range (Heikens 2003). Simpson *et al.* (1983) indicated that *Macropis* females (*Macropis ciliata*, *M. patellata*, and *M. steironemata* are found within its range) collect oils and pollen from *L. fraseri* flowers. However, *L. fraseri* is suspected of not being dependent on *Macropis* for reproduction because the species reproduces asexually (i.e., is rhizomatous), may be autogamous, and is occasionally visited by other species of bees (Simpson *et al.* 1983). Another species, *Lysimachia radicans* (Creeping Loosestrife) is listed as endangered in Illinois (Ascher 2005), but the status of associated *Macropis* bees is unknown. For most species of *Lysimachia*, the actual contributions of floral visitors in pollination, including *Macropis*, have not been assessed.

Established *Lysimachia* populations may be at risk due to loss and degradation of appropriate habitat, which includes swamps, and stream, pond, and lake margins (Ray 1956). Another potential threat is usurpation of *Lysimachia* habitat by invasive weeds such as Purple Loosestrife (*Lythrum salicaria*, Lythraceae) and *Phragmites australis* subsp. *australis*. In North America, four additional *Lysimachia* species have been introduced and apparently are oil producers (Table 3). A few of these are widespread and able to grow in a variety of habitats, including dry areas within urban habitats (Figure 6A) and rural areas (Figure 6B). One species, *L. vulgaris* is considered the main pollen and oil plant of *Macropis* bees in western Europe, though *L. nummularia* and *L. punctata* (from Asia) are also used (Pekkarinen *et al.* 2003). It would seem reasonable to conclude that North American populations of *Macropis* may be able to use these species as suitable food plants, but this needs to be evaluated. Sheffield (unpublished observation) found that female *Macropis nuda* only foraged on native *Lysimachia* species adjacent to a river in Guelph (Figure 4C), despite a nearby (<20 m) stand of an ornamental species which was much more abundant (Figure 6A). If these introduced species of *Lysimachia* prove suitable as floral hosts, it may be possible to supplement stands of native species with them. If they are not suitable hosts, their presence is likely a threat.

One additional factor may also contribute to the rarity of this species – unrealized fecundity. Cleptoparasitic bees typically tend to have more ovarioles (potential eggs) per ovary than non-cleptoparasitic taxa, and thus produce more eggs during their life span than do solitary bees (Alexander and Rozen 1987). In addition, a larger number of the eggs are mature at any given time, allowing cleptoparasitic bees to deposit eggs in rapid succession (Alexander and Rozen 1987). As such, female cleptoparasites can lay several eggs within a day while attacking the nests of several host bees. Typically, bees, whether the host taxa or cleptoparasite, lay a single egg on or near the food provision; one pollen “loaf” is used to produce one bee only. However, *Epeoloides* may not reach its full fecundity due to intraspecific competition. According to Straka and Bogush (2007), intraspecific competition between *Epeoloides coecutiens* larvae occurs within nests of the host, indicating that multiple female cuckoos may attack the same nest. Straka and Bogush (2007) believe the very brief first larval instar (followed by molting to the second instar which is the “killing” stage) is a selective pressure for intraspecific conflict (versus elimination of the host). This may be the case; female *Macropis* use effective nest guarding against *Epeoloides* females (Straka and Bogush 2007), so easily accessed nests may be in short supply, leading to multiple attacks of single nests and high levels of intraspecific competition and death of larval cuckoos, effectively reducing the fecundity of *Epeoloides*, an already rare bee.

Overall fecundity may also be reduced by the production of sterile males in place of females. In the very small, isolated populations which are likely now the norm for this species, local extirpation may be due to intrinsic factors linked to the haplodiploid reproductive system of bees, i.e., the production of sterile or inviable diploid males instead of fertile females as population size declines (Zayed and Packer 2005). As such, fewer egg-laying females would be produced within populations, which exacerbates the other impacts of small population size.

### **SPECIAL SIGNIFICANCE OF THE SPECIES**

The disjunct distribution of Old and New World *Epeoloides* from the other members of the tribe Osirini makes this rare species a unique member of the global bee fauna. This tribe is entirely cleptoparasitic, and all known host taxa are oil-collecting specialists. *Epeoloides* is the only member of its genus in North America and only one of two species in the genus globally. The status of this species and its close relationship with its host and its host’s floral host provide an interesting example of how many species depend upon each other in complex ways.

## PROTECTION, STATUS, AND RANKS

Presently there is no legal protection for *Epeoloides pilosulus* in North America, and no protection actions or policies are in place. The Xerces Society however, has listed this species in their Red List of pollinators (Ascher 2005). It is listed as G1 (globally) and N1 (for Canada) by NatureServe.

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### **BIOGRAPHICAL SUMMARY OF REPORT WRITER**

Cory S. Sheffield has been studying bees and pollination since 1993, as part of undergraduate honours studies at Acadia University, Wolfville, NS. He continued graduate studies (MSc) of insect-plant interactions at Acadia, and at Agriculture and Agri-Food Canada (AAFC), Kentville, NS from 1994-1998. From 1999-2006, Cory did graduate studies (PhD) at the University of Guelph, ON while continuing to work out of AAFC. These studies focused on the bee fauna of Nova Scotia, including their diversity and contributions to crop pollination. During that time, Cory and several co-authors published on the re-discovery of *Epeoloides pilosulus* in Nova Scotia, which was thought extinct. At the present time, Cory is involved in post-doctoral studies at York University. His research continues to focus on bees: he has published on the taxonomy of Canadian/North American bees, the utility of DNA barcoding for bees, bee physiology, pollination contributions and diversity of the Canada bee fauna.

## COLLECTIONS EXAMINED

The following is a list of entomological collections examined by the report writer for this report and other studies related to the bees of Canada:

- 1) The Canadian National Collection of Insects and Arachnids (CNC), Ottawa, ON
- 2) The Nova Scotia Museum of Natural History, Halifax, NS
- 3) The insect collection at Agriculture and Agr-Food Canada, Kentville, NS
- 4) Nova Scotia Insectary, Shubenacadie, NS
- 5) Lyman Entomological Museum, McGill University, Macdonald Campus, Ste-Anne-de-Bellevue, QC
- 6) Packer's Apoidea Collection, Department of Biology, York University, Toronto, ON
- 7) Royal Ontario Museum, Toronto, ON
- 8) University of Guelph Insect Collection, Department of Environmental Biology, University of Guelph, Guelph, ON
- 9) J.B. Wallis Museum of Entomology, Department of Entomology, Faculty of Agricultural & Food Sciences, University of Manitoba, Winnipeg, MB
- 10) E.H. Strickland Entomological Museum, Department of Biological Sciences, University of Alberta, Edmonton, AB
- 11) Snow Entomological Collection, Division of Entomology, University of Kansas, Lawrence, KS USA
- 12) USDA-ARS Bee Biology and Systematics Laboratory, Logan, UT USA
- 13) American Museum of Natural History, New York, NY USA (and others reported by J.S. Ascher (pers. comm. 2008 Ascher 2005)).