Taxonomy and Phylogeny of Piophilidae (Diptera)

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ABSTRACT

The worldwide generic classification of Piophilidae (Diptera) is tested using a morphological and molecular phylogenetic analysis, and the Nearctic species of the family are revised. The taxonomic revision includes geographic distributions, capture notes, species descriptions and an identification key to the 43 Nearctic species. Based on the phylogenetic analysis, 20 genera are recognized in the family. Five genera are synonymized: *Neopiophila* McAlpine, *Boreopiophila* Frey and *Parapiophila* McAlpine with *Arctopiophila* Duda; *Neottiophilum* Frauenfeld with *Mycetaulus* Loew; and *Stearibia* Lioy with *Prochyliza* Walker. One new Holarctic genus, *Borealicola*, is described, and a second new genus, not described in this thesis, is recognized for the Australian species *Protopiophila vitrea* McAlpine. Four new species are described: *Arctopiophila mcalpinei*, *A. variefrontis*, *Borealicola madaros*, and *B. skevingtoni*. Eighteen new combinations are proposed: *Arctopiophila atrifrons* (Melander & Spuler), *A. baechlii* (Merz), *A. dudai* (Frey), *A. flavipes* (Zetterstedt), *A. kugluktuk* (Rochefort & Wheeler), *A. lonchaeoides* (Zetterstedt), *A. nigritellus* (Melander), *A. nitidissima* (Melander & Spuler), *A. pectiniventris* (Duda), *A. penicillata* (Steyskal), *A. setaluna* (McAlpine), *A. tomentosa* (Frey), *A. vulgaris* (Fallén), *A. xanthostoma* (Melander & Spuler), *Borealicola fulviceps* (Holmgren), *B. pseudovulgaris* (Ozerov), *Mycetaulus praeustum* (Meigen) and *Prochyliza nigriceps* (Meigen).

RÉSUMÉ

La classification mondiale des genres appartenant à la famille des Piophilidae (Diptère) est examinée à l'aide d'une analyse phylogénique incluant des caractères morphologiques et moléculaires, et les espèces Néarctique de la famille sont révisées. Cette dernière inclus des distributions géographiques, des notes sur les méthodes de captures, des descriptions d'espèces et d'une clé d'identification des 43 espèces Néarctique. Suite à l'analyse phylogénique mondiale, 20 genres sont reconnus dans la famille. Cinq genre sont devenus des synonymes: *Neopiophila* McAlpine, *Boreopiophila* Frey et *Parapiophila* McAlpine avec *Arctopiophila* Duda; *Neottiophilum* Frauenfeld avec *Mycetaulus* Loew; et *Stearibia* Lioy avec *Prochyliza* Walker. Un nouveau genre Holarctique, *Borealicola*, est décrit, et un second nouveau genre, non décrit dans cette thèse, est reconnu pour l'espèce Australienne *Protopiophila vitrea* McAlpine. Quatre nouvelles espèces sont décrites: *Arctopiophila mcalpinei*, *A. variefrontis*, *Borealicola madaros*, et *B. skevingtoni*. Il y a, de plus, dix-huit nouvelles combinaisons: *Arctopiophila atrifrons* (Melander & Spuler), *A. baechlii* (Merz), *A. dudai* (Frey), *A. flavipes* (Zetterstedt), *A. kugluktuk* (Rochefort & Wheeler), *A. lonchaeoides* (Zetterstedt), *A. nigritellus* (Melander), *A. nitidissima* (Melander & Spuler), *A. pectiniventris* (Duda), *A. penicillata* (Steyskal), *A. setaluna* (McAlpine), *A. tomentosa* (Frey), *A. vulgaris* (Fallén), *A. xanthostoma* (Melander & Spuler), *Borealicola fulviceps* (Holmgren), *B. pseudovulgaris* (Ozerov), *Mycetaulus praeustum* (Meigen) et *Prochyliza nigriceps* (Meigen).

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF APPENDICES

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PREFACE

The thesis is composed of three chapters, one of which is an original manuscript that will be submitted for publication in a refereed journal.

Chapter 1

This chapter is an introduction and literature review on the biology, taxonomy and phylogeny of Piophilidae.

Chapter 2

This chapter is a worldwide phylogenetic analysis of Piophilidae using morphological and molecular characters. It also includes a taxonomic revision of the Nearctic species. This chapter will be divided into two manuscripts in preparation for submission to refereed journals: 1) Rochefort, S., Wheeler, TA. Phylogeny and revised classification of the family Piophilidae (Diptera) and 2) Rochefort, S., Wheeler, TA. Taxonomic revision of the Nearctic Piophilidae (Diptera).

Chapter 3

This chapter is a general discussion and conclusion.

Disclaimer 1: All taxonomic and nomenclatural acts in this thesis are not to be considered published according to the International Code of Zoological Nomenclature until they are published in the primary literature.

Disclaimer 2: Because of McGill University restrictions on the maximum length of M.Sc. theses, only newly described species are illustrated in this thesis. In addition, label data of non-type specimens are presented here in condensed form.

CONTRIBUTION OF AUTHORS

Sabrina Rochefort completed specimen preparation, identifications, species descriptions, illustrations, phylogenetic analysis and writing. Dr. Terry Wheeler provided research funding, training and supervision, access to equipment and laboratory space, and editing of manuscripts.

CHAPTER 1: INTRODUCTION AND LITERATURE REVIEW

Introduction

Piophilidae (Diptera) is a family of small to medium (3–9 mm) saprophagous flies which can be shining black or brown, greyish dull or yellow (Melander & Spuler 1917, McAlpine 1977). They are present on all continents except Antarctica but more than half of the 82 species live in the temperate zone of the northern hemisphere (McAlpine 1977). Most species are present in the Nearctic (37) and Palaearctic (39); 19 of these are Holarctic. Fewer species are found in the Neotropical (11), Australasian (9), Afrotropical (7) and Oriental (5) regions (McAlpine 1977, Pape *et al.* 2009).

Piophilids are also known as "Skipper flies" because of the leaping and jumping behaviour present in the 3rd instar larva which enables it to jump from a feeding substrate (e.g. carcass) to a pupation substrate (e.g. leaf litter) (Mote 1914, Bonduriansky 2002). It accomplishes this movement by forming a "C" shape in order to attach its mouth hooks to the end of its abdomen, and by contracting to propel itself to a distance of 10 to 12 cm (Mote 1914, Bonduriansky 2002). Adult Piophilidae feed and breed in the same protein-rich substances in which the eggs are deposited and where the larvae mature (Zuska & Laštovka 1965). These substrates include bone, garbage, sewage, fungi, decaying vegetation, vertebrate carrion and dung (Melander & Spuler 1917, McAlpine 1977). Some species also mate and lay their eggs in more unusual microhabitats such as discarded antlers, bird nests or bat caves (McAlpine 1977, Bonduriansky & Brooks 1999a).

The male and female adults of most species are morphologically similar. There are, however, some species in which the males and females exhibit sexually dimorphic traits. This is seen in the species *Prochyliza xanthostoma* Walker in which the male has a more elongated head and antennae (Bonduriansky & Rowe 2005, Bonduriansky 2006) and in species of *Amphipogon* Wahlberg in which the male has a beard-like cluster of long curved setae on the gena (McAlpine 1977).

The males of several species in the subtribe Piophilina are known to be extremely aggressive, to engage in male to male combat and to exert competition in detecting and seizing females (Bonduriansky 2003). They engage in fierce boxing matches with other males by raising

their forelegs, charging nearby opponents and attacking using fore-legs and antennae (Bonduriansky 2003). Courtship is also complicated: some will also perform premounting courtship, postmounting palpation and/or male-female struggle (Bonduriansky 2003).

Piophilidae as study organisms

Although they are a small and often uncommon family, Piophilidae has captured researchers' interest in several domains, including sexual selection and behaviour, forensic sciences, pest management and biodiversity studies.

As described above, there have been many studies of piophilid sexual behaviour and mating systems. In two species, *Liopiophila varipes* (Meigen) and *Prochyliza xanthostoma*, females have adapted behaviours or traits that cause males to exert more effort to achieve mating, permitting the control of male quality (Bonduriansky 2003). Females prevent males from mating by showing resistance in bending the abdomen and pushing males away with hind legs in *Liopiophila varipes* and by moving or flying away in *Prochyliza xanthostoma* (Bonduriansky 2003). Because of these adaptations, Piophilidae have been used in studies of mating behaviour, reproductive allocations, mate choice, copulation and oviposition mechanisms and behaviours of Piophilidae (i.e. Bonduriansky & Brooks 1998a, 1998b, 1999a, 1999b).

They are of forensic interest because species such as *Piophila casei* (Linnaeus) and *Stearibia nigriceps* (Meigen) are found on animal carcasses, including human corpses, and are potential indicators of the post-mortem interval (Carvalho *et al*. 2000, Martinez *et al*. 2006, Battán Horenstein *et al*. 2010). Species in other genera (e.g., *Prochyliza xanthostoma, Prochyliza nigrimana* (Meigen), *Liopiophila varipes, Protopiophila latipes* (Meigen), *Parapiophila atrifrons* (Melander & Spuler 1917)) can also be found on carcasses in North America and might be found to be potential indicators in future studies (Martín-Vega 2011, Rochefort *et al.* 2015).

Several Piophilidae are also known as pest species (e.g., *Piophila casei, Prochyliza nigricornis* (Meigen), *Prochyliza nigrimana, Stearibia nigriceps*) which has led to the development of control methods to counterbalance economical loss, and sanitary and medical issues (Simmons 1927, Peckenschneider *et al*. 1952, Zuska & Laštovka 1965). Pest species of Piophilidae can be a particular problem in the cheese and meat industries (Zuska & Laštovka

1965). *Piophila casei* is the most common species in those industries and can, in addition, be found in fruit and fish canneries (Zuska & Laštovka 1965).

Piophilidae is also an interesting family to study in the context of Arctic biodiversity because it is one of the few families to become more diverse and abundant above treeline (McAlpine 1979, Rochefort & Wheeler 2015). In a study of boreal, subarctic and high arctic Piophilidae, Rochefort & Wheeler (2015) found the highest species richness (17 of 18 species) in subarctic sites, and abundance was greatest in the high arctic sites, with 73% of all specimens collected. The lowest abundance and species richness occurred in boreal sites, below treeline.

Evolutionary relationships of Piophilidae

Studies of the higher level classification of Diptera have demonstrated very poor resolution for the Acalyptrate clade (e.g. Wiegmenn et al. 2011). Piophilidae is one of eight families belonging to the acalyptrate superfamily Tephritoidea. According to McAlpine (1977), the monophyly of Tephritoidea is supported by several apomorphies of the male and female genitalia including: female tergite and sternite 7 modified into a stout oviscape; female tergite and sternite 8 divided into longitudinal struts that form part of the ovipositor; fused female cerci with a piercing ovipositor; and a reduced and asymmetrical male tergite 6. McAlpine's phylogeny was, however, not based on an explicit phylogenetic analysis. The monophyly of Tephritoidea has been investigated several times, leading to several hypotheses proposing the families Lonchaeidae, Pallopteridae, Richardiidae or Ulidiidae as potential sister groups of Piophilidae (McAlpine 1989, Korneyev 1999, Han & Ro 2005, Weigmann *et al.* 2011).

Two hypotheses were based on both external and internal morphological characters. The first was proposed by McAlpine (1989) who separated Tephritoidea into nine families (Lonchaeidae, Otitidae (= Ulidiidae), Pallopteridae, Piophilidae, Platystomatidae, Pyrgotidae, Tachiniscidae, Tephritidae and Richardiidae) and in three monophyletic subgroups. Piophilidae was included in the Piophiloid subgroup with Richardiidae and Pallopteridae as sister groups. The three families form a monophyletic group based on the following synapomorphies: one orbital seta, a strong Sc break, strong katepisternal setae and a fultelliform aedeagal apodeme. The second hypothesis was put forward by Korneyev (1999) who reduced the number of families to eight by combining Tachiniscidae with Tephritidae. Unlike McAlpine (1989), Korneyev

(1999) split Tephritoidea into two monophyletic subgroups: the lower and the higher Tephritoidea. Piophilidae was included in the former, less resolved, subgroup with Pallopteridae as a sister group based on a soft, elongated and setulose phallus in both families.

The other two hypotheses were based on the analysis of molecular characters. Han and Ro's (2005) hypothesis included the same eight families as Korneyev (1999) and the division of those families into two monophyletic groups. Piophilidae was included in the first group with a monophyletic Lonchaeidae plus Pallopteridae as a sister group. The second hypothesis based on molecular analysis was proposed by Weigmann *et al.* (2011). They considered nine families because they removed Tachiniscidae from Tephritidae, excluded Pallopteridae from Tephritoidea, and added Ctenostylidae to the superfamily. Two monophyletic subgroups were observed with Piophilidae being in the second subgroup along with Ulidiidae as a sister group.

Piophilidae classification: McAlpine's (1977) and Ozerov's (2004) view

McAlpine (1977) has completed the most exhaustive taxonomic revision of Piophilidae to date including species descriptions, geographic patterns, identification keys and a revised classification.

According to McAlpine (1977), two groups sometimes treated as separate families, Neottiophilidae and Thyreophoridae, form a monophyletic group with Piophilidae. This led him to divide Piophilidae into the two subfamilies Neottiophilinae and Piophilinae. Piophilinae was divided into the two tribes Mycetaulini and Piophilini and the latter into the two subtribes Piophilina and Thyreophorina.

In his revision, McAlpine (1977) included 67 species within 23 genera worldwide. His revision included the description of two new genera (*Neopiophila* and *Parapiophila*) and six new species (*Actenoptera avalona*, *Neopiophila setaluna*, *Protopiophila atrichosa*, *Protopiophila pallida*, *Prochyliza azteca* and *Prochyliza inca*), the proposal of new combinations (e.g. within *Parapiophila* McAlpine and *Prochyliza* Walker) and the synonymy of taxa (e.g. *Clusina* Curran combined with *Protopiophila* Duda). McAlpine (1977) also provided identification keys, a generic phylogeny based on morphological characters he considered informative, and a biogeographic analysis. His identification keys are useful for identifying Piophilidae species in all biogeographic regions. Recently published keys have mostly focused on identification to the

genus level in defined geographic areas: McAlpine (1987) for the Nearctic; Ozerov (2000) for the Palaearctic; and Ozerov & Norrbom (2010) for Central America. A key to the species level has also been published on Neartic Piophilidae in forensic entomology (Rochefort *et al.* 2015).

Ozerov (2004) disagreed with the monophyly of 'Thyreophoridae' plus 'Neottiophilidae' plus Piophilidae. Unlike McAlpine (1977), he treated 'Neottiophilidae' as a distinct family because its larvae exhibit different behaviours and biology, and adults vary greatly in morphology. However, he maintained 'Thyreophoridae' within Piophilidae. Ozerov also disagreed with the division of the tribes Mycetaulini (mycetophagous) and Piophilini (necrophagous) due to the lack of information on the biology of several species, hypothesising that Mycetaulini is included in Piophilini. In addition, Ozerov (2004) proposed a different hypothesis on the generic classification by reducing the number of genera in Piophilidae. He proposed the synonymy of *Arctopiophila*, *Boreopiophila* and *Parapiophila* with *Allopiophila* and *Liopiophila* with *Prochyliza*.

The need for a new classification and taxonomic revision

Both McAlpine's (1977) and Ozerov's (2004) classifications are possible hypotheses on the higher classification of Piophilidae; however, these were not supported by explicit phylogenetic analyses and neither hypothesis has been tested using phylogenetic methods. The discovery of undescibed piophilid species in museum collections has already raised questions about the current generic classification. A robust hypothesis for the classification of the family Piophilidae is needed using phylogenetic analysis, preferably using both molecular and morphological characters, to determine generic limits and to support the monophyly of this family. This new phylogeny is essential as a framework for evolutionary and ecological studies to understand better the evolutionary history of the different taxa within Piophilidae and the relationships that they have with each other, and for formulation and testing hypothesis in ecology and evolution.

There are additional problems with McAlpine's (1977) taxonomic revision and classification. His classification divided Piophilidae into four large genera (*Parapiophila*, *Mycetaulus* Loew, *Protopiophila*, *Prochyliza*), but he also recognized several smaller genera (e.g., *Lasiopiophila* Duda, *Liopiophila* Duda, *Boreopiophila* Frey) which sometimes contain only one species. Ozerov (2004) attempted to solve this problem by synonymising several genera but

these synonymies were not supported with phylogenetic analyses. A revision of the family is thus necessary, especially within the large genera *Parapiophila, Mycetaulus, Protopiophila* and *Prochyliza*, because it includes many species which exhibit colour variation, the known geographic ranges of many species have expanded, and some genera contain undescribed species. Also, since McAlpine's revision, 17 new species of Piophilidae have been described and 3 synonymised increasing the total of species to 82 (Pape *et al.* 2009, Rochefort & Wheeler 2015). These new species need to be added to the classification and be integrated into updated identification keys.

McAlpine's (1977) identification keys are still the primary reference to identify the world species of Piophilidae. However, these keys use many colour-related characters which can cause problems when identifying species which exhibit colour variation. Thus, McAlpine's (1977) keys need to be updated to prevent confusion and misidentifications. Colour variation in several species has, in the past, caused taxonomists to split species into several based on these minor variations. For example, *Parapiophila atrifrons* and *Allopiophila calceata* (Duda) have been considered as two different species due to colour difference in the fore-legs and minor differences in the male genitalia (McAlpine 1977). After the morphological verification of more specimens and the use of molecular evidence, Rochefort and Wheeler (2015) synonymized *Allopiophila calceata* with *Parapiophila atrifrons*.

There is a need not only to update available keys but to also develop more user-friendly identification keys specific to a field of study. This is true not only for the family Piophilidae but for other taxa, making taxonomy more accessible to non-specialists. For example, in forensic entomology, researchers often misidentify species of Piophilidae, such as the European species *Piophila megastigmata* McAlpine with *Piophila casei* (see Prado e Castro *et al*. 2012). Rochefort *et al.* (2015) created a user-friendly key to the Nearctic Piophilidae of forensic interest which could potentially limit misidentifications of similar looking species in North America.

Objectives

In this study, a phylogenetic analysis and taxonomic revision of the Piophilidae world fauna will be undertaken. New species will be described, distribution ranges will be updated and mapped, and existing keys to genus and species will be updated.

The first objective is to reconstruct the phylogeny of the family worldwide using morphological and molecular characters to resolve problems in the current generic classification. A second objective is to complete a taxonomic revision of the Nearctic Piophilidae by providing species descriptions and distribution maps. A last objective is to update generic and species identification keys to make them accessible to both taxonomist specialists and non-specialists.

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CONNECTING STATEMENT

Competing hypotheses on the classification of Piophilidae discussed in Chapter 1 are plausible but these need to be tested using an explicit phylogenetic analysis, preferably using both morphological and molecular characters, to test both generic limits and species concepts. In addition to a new proposed phylogeny for the Piophilidae, an identification key to both the genus and species level is necessary to include species described since the last comprehensice revision in 1977 and the new species described in Chapter 2. These keys combined with the new phylogeny are essential for researchers needing to identify Piophilidae in taxonomic and ecological studies.

CHAPTER 2: PHYLOGENY OF THE FAMILY PIOPHILIDAE AND REVISION OF THE NEARCTIC SPECIES

INTRODUCTION

Piophilidae is a primarily saprophagous family of flies which mainly breed and feed on decomposing matter such as bone, fungi, vegetation, vertebrate carrion and dung (Melander & Spuler 1917, McAlpine 1977). Other species can be found in more unusual microhabitats, such as discarded antlers and on live nestling birds (McAlpine 1977, Bonduriansky & Brooks 1999).

There are 82 species of Piophilidae found on all continents except Antarctica, but they are more abundant and diverse north of treeline in both the Nearctic and Palaearctic regions (McAlpine 1977, Pape *et al.* 2009, Rochefort & Wheeler 2015).

Morphological (J.F. McAlpine 1989, Korneyev 1999) and molecular (Han & Ro 2005, Weigmann *et al.* 2011) classifications place Piophilidae within the superfamily Tephritoidea, although the relationships within the superfamily are unresolved, with Lonchaeidae, Pallopteridae, Richardiidae or Ulidiidae all treated as sister groups of Piophilidae. Comprehensive classifications of Piophilidae to the generic level were proposed by McAlpine (1977) and Ozerov (2004a), but these were not supported by explicit phylogenetic analyses.

McAlpine's (1977) hypothesis included 'Neottiophilidae' and 'Thyreophoridae', sometimes treated as separate families, as monophyletic within Piophilidae. The family was separated into the two subfamilies Neottiophilinae and Piophilinae. Piophilinae was further divided into the tribes Mycetaulini and Piophilini, and Piophilini was once more divided into the subtribes Piophilina and Thyreophorina. McAlpine (1977) recognized 23 genera of Piophilidae worldwide. Ozerov (2004a) partly agreed with McAlpine's (1977) classification; however, he removed 'Neottiophilidae' from Piophilidae, suggesting it is a distinct family. In addition, he combined the tribes Mycetaulini and Piophilini, which were recognized partly on larval habits, due to missing biological information from several species. Ozerov (2004a) also recongnized only 18 genera, synonymising *Arctopiophila* Duda, *Boreopiophila* Frey and *Parapiophila* McAlpine with *Allopiophila* Hendel, and *Liopiophila* Duda with *Prochyliza* Walker.

In addition to his classification, McAlpine (1977) contributed to the taxonomy of Piophilidae by providing identification keys, genus and species level descriptions and

information on geographic distribution. However, his taxonomic work needs to be updated to reflect the description of several new species (Soós 1977, McAlpine 1978, D.K. McAlpine 1989, Ozerov 1989, Ozerov & Barták 1993, Bonduriansky 1995, Merz 1996, Ozerov 2000, 2002, 2004a, 2007, Martín-Vega 2014, Rochefort & Wheeler 2015) and the synonymy of species and genera (D.K. McAlpine 1989, Ozerov 2004, Mei *et al.* 2013, Martín-Vega 2014, Rochefort & Wheeler 2015). The total number of Piophilidae has increased from 67 to 82 species since McAlpine's revision (Pape *et al.* 2009). Identification keys also need to be updated since many characters are colour based and this can be a problem because many species exhibit colour variation (i.e. *Allopiophila luteata* (Haliday), *Prochyliza nigrimana* (Meigen), *Parapiophila atrifrons* (Melander & Spuler), *P. fulviceps* (Holmgren), *P. vulgaris* (Fallén)). In addition, collecting in recent years and the identification of specimens in museums have resulted in expansions of the known ranges of many species.

Previous taxonomic research on Piophilidae was based on morphological characters, but molecular data could be of great value to the generic classification of Piophilidae. A potential gene for testing both species concept and phylogenetic relationships between Piophilidae species is the Cytochrome c oxidase subunit 1 (CO1), because the degree of divergence in its sequence is usually efficient to differentiate individuals at the species level (Hebert *et al.* 2003). The CO1 gene has successfully been used in Diptera to identify species (Boehme *et al*. 2011), for dealing with species exhibiting colour variation as in *Dasysyrphus* Enderlein (Syrphidae) (i.e. Locke & Skevington 2013) and strong sexual dimorphism in species of Platypezidae (Cumming & Wheeler, in review).

The CO1 gene, however, should be used with caution as it may not be successful in all Diptera families for species identification. In the genus *Lucilia* Robineau-Desvoidy (Calliphoridae), CO1 is not favored for species identification since different species (e.g. *L. illustris* (Meigen) and *L. caesar* (Linnaeus)) sometimes were not distinguished from one another (Wells *et al.* 2007). On the other hand, the use of the CO1 gene to verify species identity of Nearctic Musidae from Churchill, Manitoba, Canada has been successful in matching morphological and molecular characters (Renaud *et al.* 2012).

In this study, both morphological and molecular characters will be used to create a worldwide generic phylogeny of the Piophilidae family to test McAlpine's (1977) and Ozerov's

(2004a) classifications. A taxonomic revision of the Nearctic Piophilidae will also be completed based on the new proposed classification, including species descriptions, geographical distributions, ecological notes, and updated identification keys to genera and species.

MATERIALS AND METHODS

Specimen examination and description

Adult Piophilidae specimens were obtained from the following museum collections: Biodiversity Institute of Ontario, Guelph, ON, Canada (BIO); California Academy of Sciences, San Francisco, CA, USA (CAS); Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, ON, Canada (CNC); University of Guelph Insect Collection, Guelph, ON, Canada (DEBU); Collection scientifique de l'Insectarium de Montréal, Montréal, QC, Canada (IMQC); Lyman Entomological Museum, Ste-Anne-de-Bellevue, QC, Canada (LEM); Royal BC Museum, Victoria, BC, Canada (RBCM); Strickland Museum, University of Alberta, Edmonton, AB, Canada (UASM); Spencer Entomological Collection, Beaty Biodiversity Museum, Vancouver, BC, Canada (UBCZ); Ouellet-Robert Collection, Université de Montréal, Montréal, QC, Canada (ORUM) and United States National Museum of Natural History, Smithsonian Institution,Washington, DC, USA (USNM). About 11 000 specimens were examined for the phylogenetic analysis and taxonomic revision.

Specimens were sorted to genus using McAlpine (1987) and to species using McAlpine (1977). All new species described subsequent to McAlpine (1977) were identified using published species descriptions (Soós 1977, McAlpine 1978, D.K. McAlpine 1989, Ozerov 1989, Ozerov and Barták 1993, Bonduriansky 1995, Merz 1996, Ozerov 2000, 2002, 2004a, 2007, Martín-Vega 2014, Rochefort & Wheeler 2015). Descriptions of species in this study were made from specimens in museum collections covering a wide range of localities to account for intraspecific variation.

Fresh specimens were collected in 95% ethanol and chemically dried using Hexamethyldisilazane. Once dried, they were pinned, labelled and identified. Dissections were completed by cutting the abdomen and placing it in 85% lactic acid on a hot plate until the

abdomen softened and cleared. The abdomen was then placed into glycerin for the removal of abdominal tissues. Once cleared, the abdomens were stored in microvials containing glycerin.

Measurements were made on dry specimens only. The body length was measured from the anterior margin of the eye (excluding the antenna) to the posterior end of the abdomen. The wing length was measured from the base to the apex.

Morphological terminology follows Cumming & Wood (2009). Specimens of Piophilidae may vary in colour possibly due to aging, as well as drying and conservation techniques. Thus, when the colour "black" is used, variation may occur where the specimen appears brown.

The geographical distribution of each Nearctic species was based on examined museum specimens from North American museum collections. Nearctic locality records were mapped using Simplemappr (Shorthouse 2010). Additional published locality records for which specimens were not examined were excluded from maps because of potential misidentifications. Non-Nearctic records for species occurring in other regions are not mapped. In both cases, these records are listed under "Additional distribution information" for each species.

Selection of outgroups and exemplar species for phylogenetic analysis

Outgroups were selected based on Piophilidae sister group hypothesis within the Tephritoidea (McAlpine 1989, Korneyev 1999, Han and Ro 2005, Wiegmann *et al.* 2011). At least one species was selected to represent each family. The following outgroups were included in the morphological phylogeny: *Lonchaea* sp. (Lonchaeidae), *Toxoneura superba* (Loew) (Pallopteridae), *Rivellia variabilis* Loew (Platystomatidae), *Chaetopsis massyla* (Walker) (Ulidiidae), and *Melanoloma* sp. and *Richardia* sp. (Richardiidae). The same species were included in the molecular phylogeny except *Lamprolonchaea brouniana* (Bezzi) was chosen instead of *Lonchaea* sp. and no Richardiidae species were represented.

Label data for outgroup taxa and non-Nearctic Piophilidae are listed below. All label data for Nearctic Piophilidae used in the morphological phylogeny are listed under the species in the taxonomic revision.

Lonchaeidae: *Lonchaea* sp.: 1 ♂, 3 ♀. **CANADA. Quebec:** Ste-Anne-de-Bellevue, 26.v.1942, LEM-0017586, LEM-0017590, LEM-0017594, LEM-0017595 (LEM).

Pallopteridae: *Toxoneura superba* (Loew): 2 ♂, 1 ♀. **CANADA. Ontario:** 10 km East Griffith, 3.viii.1984, B.E. Cooper, LEM-0022785, BOLD ID: LYMAA1361-14. **Quebec:** Mont St. Hilaire (45°32.6'N, 73°09.1'W), beech-sugar maple forest, trunk trap, 9-16.vii.2001, E. Fast & S. Hawkins, LEM-0022787, BOLD ID: LYMAA1358-14; same except 25.vi-2.vii.2001, LEM-0022788, BOLD ID: LYMAA1359-14 (LEM).

Platystomatidae: *Rivellia variabilis* Loew: 1 ♂, 2 ♀. **CANADA. Quebec:** Abbotsford, 24.viii.1936, G. Shewell; Lac St-François National Wildlife Area, Northwest of Aménagement Therrien, close to ruisseau Th., (45°00.39'N, 74°30.99'W), Carex meadow, pan trap, 16-23.vii.1999, F. Beaulieu, LEM-0019643; same except LEM-0019650, BOLD ID: LYMAA1195-14 (CNC, LEM).

Richardiidae: *Melanoloma* sp.: 1 ♂, 1 ♀. **COSTA RICA.** Guanacaste, Guanacaste National Park, Pitilla Biological Station, 800m, yellow pan beside stream, 11.ii.1995, L. Masner, LEM-0022697; San José, Tarrazu San Carlos, Reserva Riosparaiso Albergue Pecari, 16 km NNW Quepos, (9°33'53"N, 84°07'32"W), 405m, dung trap, 16-17.ii.2003, J. Savage, LEM-0022753 (LEM).

Richardia sp.: 1 ♂, 1 ♀. **COSTA RICA.** Puntarenas, Peninsula Osa, 23 km North Puerto Jimenez, La Palma, 10m, Malaise trap, vi.1991, P. Hanson, LEM-0022716. **VENEZUELA.** Aragua Rancho Grande Biological Station, (10°21'N, 67°41'W), 1250m, Malaise trap, 14.v.1998, J. Ashe, R. Brooks, R. Hanley, LEM-0022687 (LEM).

Ulidiidae: *Chaetopsis massyla* (Walker): 1 ♂, 1 ♀. **CANADA. Quebec:** Lac St-François National Wildlife Area, Northwest of Aménagement Therrien, close to ruisseau Th., (45°00.39'N, 74°30.99'W), carex meadow, pan trap, 5.vi.1999, F. Beaulieu, LEM-0018086; same except (45°00.17'N, 74°30.63'W), 26.v-3.vi.1999, LEM-0018041 (LEM).

Piophilidae

Amphipogon flavus (Zetterstedt): 2 ♂, 1 ♀. **SWEDEN.** Lapland, Abisko, 9.viii.1951, 17.viii.1951, J.R. Vockeroth; Värmland, Ekshärad, 22.vii.1960, W.R.M. Mason (CNC).

Bocainamyia necrophila Albuquerque: 2 ♂, 1 ♀, 1 ?. **PERU.** Avispas, Madre de Dios, 400m, 10-20.ix.1962, 20-30.ix.1962, L. Pena (CNC).

Centrophlebomyia furcata (Fabricius): 2 ♂, 2 ♀. **ISRAEL.** Migdal Zedek, on dead cow, 14.i.1978, A. Freidberg; Tel Aviv, on dead sheep, 17.xii.1977, A. Freidberg. **UNITED KINGDOM.** Porthcawl, Glamorgan, v.1906, Verrall Bequest. 1911-411, Lt. Col. Yerbury (CNC).

Centrophlebomyia grunini (Ozerov): 1 ♀ paratype. **RUSSIA.** Amurskaya Oblast, G. Vaya, 26.vii.1962, A. Ozerov. 1 ♂. same data as paratype (CNC).

Dasyphlebomyia necrophila Becker: 1 ♂, 1 ♀. **TANZANIA.** Msingi, 30.iii-13.iv.1952, D.O. Afrika Exp. "**OST AFRICA".** 1-20.iii.1959, T.T. Marangu, Lindner leg. (CNC).

Mycetaulus bipunctatus (Fallén): 1 ♂, 1 ♀. **SWEDEN.** Väemland, Eshärad, 20.vii.1960, 22.vii.1960, W.R.M. Mason (CNC).

Mycetaulus confusus Soós: 1 ♂. **KAZAKHSTAN.** Medeo, Okresní. Alma-Ata, elbnik na *Picea schrenkiana*, 24.viii.1969, Gorodkov (CNC).

Neottiophilum praeustum (Meigen): 2 ♂, 1 ♀. **SWITZERLAND.** Delemont, 1-6.v.1969, Herting & Wood. **UNITED KINGDOM.** Farnham Royal, Bucks, 1928, P.A. Buxton; same except 1898, from nest of finch (CNC, USNM).

Piophila megastigmata McAlpine: 1 ♂, 1 ♀ paratypes. **SOUTH AFRICA.** Transvaal, Kruger National Park Parfuri, ex impala carcass, i.1978, L. Braak (CNC).

Piophilosoma palpatum (Hendel): 2 ♂. **AUSTRALIA.** Adelaide, vi.1962, C. Watts; Harcourt, Victoria, 6.iv.1968, J.W. Boyes (CNC).

Piophilosoma scutellatum (Malloch): 1 ♂, 1 ♀. **AUSTRALIA. New South Wales:** Botany Bay , H. Petersen. **South Australia:** Adelaide, vi.1962, C. Watts (CNC, USNM).

Prochyliza azteca McAlpine: 2 ♂, 4 ♀. **COSTA RICA.** Puntarenas, Monteverde Biological Station, 1500m, white pans in kitchen compost, 12.vi.2000, 13.vi.2000, M. Buck, debu00131191; same except site C Malaise, 20-26.viii.1993, E.R. Barr; San Jose, Zurqui De Moravia, 1600m, x-xii.1990, P. Hanson. **PANAMA.** Chiriqui Province, 2 km West of Cerro Punta, 1700m, 19.v-9.vi.1977 (CNC, DEBU).

Prochyliza inca McAlpine: 1 ♀ allotype. **EQUATOR.** Azuay, 10 km W. Sta. Isabel, 1500 m, 10-13.iii.1965, L. Pena. 1 ♀ paratype. **MEXICO.** Chiapas, San Cristobal de Las Casas, 7087', 12.vi.1969, B.V. Peterson. 1 ♂. same data as allotype (CNC).

Protopiophila aethiopica (Hennig): 1 ♂ paratype. **SOUTH AFRICA.** Transvaal, Johannesburg, Zumpt, Commonwealth Institute of Entomology Collection, No 12005 (CNC).

Protopiophila atrichosa McAlpine: 1 ♀ allotype. **PERU.** Avispas, Madre de Dios, 400m, 10-20.ix.1962, L. Pena. 1 ♂, 4 ♀ paratypes. **BELIZE.** British Honduras, Caves Branch, St. Hermans Cave, 400', 23.vii-21.viii.1972, S. & J. Peck. **PERU.** same data as allotype except 10-20.ix.1962, 20-30.ix.1962, 1-15.x.1962 (CNC).

Protopiophila australis Harrison: 5 ♂, 3 ♀. **AUSTRALIA. New South Wales:** Sydney, 9.ii.1964, E. Cheah; same except 21.xi.1966, R. Pilfrey, Narrabeen MiddleCreek, swept, 23.ix.1956. **UNITED STATES OF AMERICA. Hawaii:** Oahu, Honolulu, 24.viii.1966, 25.viii.1966, 11.ix.1966, 30.x.1966, J.R. Vockeroth (CNC).

Protopiophila contecta (Walker): 7 ♂, 3 ♀, 1 ?. **AUSTRALIA.** North Queensland, Upper Nesbit River, Claudie Creek, Rocky Scrub Lakelands, 1500ft, 18.viii.1948, G.M. Tate. **INDIA.** Yercaud, near Salem, 4500', 12.iv.1962, G.J. Spencer. **JAPAN.** Bonin Island, Chichi Jima, Omura, 'Camp beach', 5.iv-9.v.1958, F.M. Snyder. **MALAYSIA.** Pahang, Tanah Rata, 1460m, 10.i.1990, J.R. Vockeroth. **PAPUA NEW GUINEA.** Central Province, Moreguipa, 24.vii.1982, J.W. Ismay; Misima Island, Narian, 0-50 m, 3.viii.1956, L.J. Brass, No.8; National Capital District, Saraga, garden, 24.ii.1985, J.W. Ismay; New Ireland, Lelet PI., Limbin, pig bones, 1.ix.1981, J.W. Ismay (CNC).

Protopiophila nigriventris (Curran): 3 ♂, 1 ♀. **BOLIVIA.** La Paz, Heath River Wildlife Centre, 21km SSW Puerto Heath, (12°40'S, 68°42'W), 29.iv-12.v.2007, S.M. Paiero, debu00288320, debu00288329, debu00288562, debu00288577 (DEBU).

Protopiophila scutellata Harrison: 1 ♀. **UNITED STATES OF AMERICA. Hawaii:** Honolulu, Plane 7080, 15.ii.1944 (CNC).

Protopiophila pallida McAlpine: 1 ♀ allotype. **PERU.** Madre de Dios, Avispas, 400m, 20-30.ix.1962, L. Pena. 1 ♂. **BRAZIL.** E do Rio, Petropolls, 27.xii.1968, H.S. Lopes (CNC).

Protopiophila vitrea D.K. McAlpine: 1 ♂. **AUSTRALIA. New South Wales:** Quorrobolong, Cessnock Farm study site, (32°55'38"S, 151°23'35"E), ex. dead pig, P12, 36, 22.v.2008, N. Haskell, debu00319049 (DEBU).

Pseudoseps signata (Fallén): 1 ♂, 1 ♀. **SCOTLAND.** Methy Bridge, Inverness, 1.vi.1934, 7.vi.1934, Yerbury (CNC)

Character states for morphological phylogenetic analysis

A total of 62 characters (55 binary and 7 multistate) were chosen from the head (11), thorax (19), wing (7), legs (10), male genitalia (12) and female genitalia (3).

HEAD

1. Subvibrissa: (0), absent; (1), present
2. Vibrissa: (0), absent; (1), present
3. Beard-like cluster of long curved setae on male gena: (0), absent; (1), present
4. Pedicle length dimorphic between males and females: (0), absent; (1), present
5. Flagellomere length: (0), less than two times longer than wide; (1), two times or more longer than wide
6. Ocellar setae strong and well-developed: (0), absent; (1), present
7. Posterior orbital setae: (0), absent; (1), present
8. Anterior orbital setae: (0), absent; (1), present
9. Clypeus: (0), small; (1), moderately large; (2), well developed
10. Distinct oval marking around posterior orbital setae: (0), absent; (1), present
11. Frons colour: (0), entirely black, brown, blue or grey; (1), partly or entirely yellow

WINGS

12. Wing apex and/or crossveins: (0), clear; (1), with black shading
13. Apex of wing: (0), clear; (1), vein R_{2+3} and R_{4+5} with black shading; (2), vein R_{2+3}, R_{4+5} and M_{1+2} with black shading
14. Crossvein r-m and/or dm-cu: (0), clear; (1), with black shading
15. Stigmal space: (0), clear; (1), fumose
16. R_1 setulose: (0), absent; (1), present
17. Costal spines: (0), absent; (1), present
18. Cell bm: (0), absent or incomplete; (1), present

LEGS

19. Mid tibia preapically with several strong and curved ventral spurs: (0), absent; (1), present
20. Mid tibia of male with row of stout ventral setae: (0), absent; (1), present

21. Mid tibia of male with preapical patch of long blond setae ventrally: (0), absent; (1), present

22. Mid femur with a row of stout anterior ventral setae: (0), absent; (1), present

23. Hind femur of male with one to several rows of long ventral setae: (0), absent; (1), present

24. Hind femur with several short, stout ventral setae: (0), absent; (1), present

25. Mid coxa of male with 2 long sinuate spines: (0), absent; (1), present

26. Hind trochanter of male with a row of very short and stout ventral setae: (0), absent; (1), present

27. Mid basitarsus of male with setae forming a fan-like shape: (0), absent; (1), present

28. Front tarsomere 2 to 5 laterally flattened: (0), absent; (1), present

THORAX

29. Anterior thoracic spiracle: (0), slit-like; (1), circular

30. Posterior postpronotal setae: (0), absent; (1), one; (2), two

31. Anterior postpronotal setae: (0), absent; (1), present

32. Prosternum: (0), short; (1), long, reaching neck

33. Prosternum with a pair of setae: (0), absent; (1), present

34. Three dorsocentral rows of acrostichals: (0), absent; (1), present

35. Presutural dorsocentral setae: (0), absent; (1), present

36. Postsutural dorsocentral setae: (0), one; (1), two; (2), three or four

37. Thorax, and rest of body, extensively hairy: (0), absent; (1), present

38. Prescutellar acrostichal setae: (0), absent; (1), present

39. Scutellum with wart-like tubercle on each side of subapical setae: (0), absent; (1), present

40. Subapical scutellar setae strong and thick in male: (0), absent; (1), present

41. Scutellum longer in male than in female: (0), absent; (1), present

42. Anepisternum setulose: (0), absent; (1), present

43. Anepisternum with one to several setae at posterior margin: (0), absent; (1), present

44. Anepimeron: (0), bare; (1), setulose on at least half of anterior portion

45. Black spots around setae on scutum and scutellum: (0), absent; (1), present

46. Thorax colour: (0), black/brown; (1), gray; (2), yellow and black/brown; (3), yellow; (4), greyish blue

47. Thorax and abdomen entirely yellow and bulky: (0), absent; (1), present

MALE GENITALIA

48. Sternite 5 with cluster of setae in center of posterior margin: (0), absent; (1) present

49. Sternite 5 with inward-facing projection at posterior margin: (0), absent; (1), present

50. Sternite 5 weakly sclerotized medially: (0), absent; (1), present

51. Sternite 6 with two sclerotized teeth at posterior margin: (0), absent; (1), present

52. Sternite 7 with one to three soft projections at posterior margin: (0), absent; (1), present

53. Shape of distiphallus: (0), narrow; (1), inflated

54. Distiphallus curled or coiled: (0), absent; (1), present

55. Distiphallus with spines: (0), absent; (1), present

56. Distiphallus with orange blunt structures in one or several rows laterally: (0), absent; (1), present

57. Length of postgonite lobes: (0), shorter than pregonite; (1), about same length as pregonite; (2), longer than pregonite

58. Number of lobes on pregonite: (0), one; (1), two; (2), three; (3), four or more

59. Surstylus with at least one stout short seta: (0), absent; (1), present

FEMALE GENITALIA

60. Number of spermathecae: (0), one; (1), two; (2), three

61. Spermathecae well sclerotized: (0), absent; (1), present

62. Spermathecae texture: (0), smooth; (1), wrinkled

Morphological Phylogeny

A morphological character state matrix was built using Mesquite 2.75 (Maddison & Maddison 2011) (Appendix 1). All characters were treated as unordered. A parsimony analysis was completed using the TNT 1.0 software (Goloboff *et al.* 2003). A heuristic search was completed using tree-bisection-reconnection (TBR) branch swapping. A memory of 1000 trees was set with 1000 replicates and 100 trees saved per replicate. Branches were collapsed when the maximum length was zero. A 70% majority-rule consensus tree was also run. Percentage frequency values

were calculated for the consensus and selected most parsimonious trees from the heuristic search. Bootstrap values were calculated using 100 replicates. Trees were viewed and primary modifications for publication were produced using FigTree 1.4 (Rambaut 2012).

Molecular phylogeny analysis

The molecular phylogeny was built using the barcode region of Cytochrome Oxidase 1 (CO1). Sequences were obtained from the Biodiversity of Life Data Systems (BOLD) and from GenBank. Sequences from BOLD varied between 549–658bp in length and those from Genbank varied from 465–483bp except for *Lamprolonchaea brouniana* (Lonchaeidae) which was of 658bp (Appendix 2). Due to the short length of some sequences, two molecular phylogenies were built, one using a total of 483bp and another using 658bp, to determine if shorter sequences had an effect on tree resolution. The outgroups used to root both molecular trees were *Lamprolonchaea brouniana* (Lonchaeidae), *Toxoneura superba* (Pallopteridae), *Rivellia variabilis* (Platystomatidae) and *Chaetopsis massyla* (Ulidiidae).

The species identity of all Piophilidae specimens from BOLD was verified by S. Rochefort based on examination of voucher specimens. Genbank sequences and outgroup species were not confirmed by examination of vouchers.

All sequences were combined in a matrix in Mesquite 2.75 (Maddison & Maddison 2011) and were aligned using Muscle (Edgar 2004). The aligned sequences were analysed in the phylogeny.fr portal using default parameters: aligned sequences were curated using Gblocks (Castresana 2000), a maximum likelihood tree with bootstrap values was built using PhyML (Guidon & Gascuel 2003) with the aLRT statistical test (Anisimova & Gascuel 2006), and the tree diagram was created using TreeDyn (Chevenet *et al.* 2006).

RESULTS AND DISCUSSION

Phylogeny of Piophilidae: Morphological characters

In the morphological phylogenetic analysis, 30 most parsimonious trees were obtained. Two of those trees (Fig. 1, 2) shared several similiarities and were selected as the basis for the revised classification of the family.

Previous studies (J.F. McAlpine 1989, Korneyev 1999, Han & Ro 2005, Weigmann *et al.* 2011) have suggested Lonchaeidae, Pallopteridae, Richardiidae and Ulidiidae as sister groups to the Piophilidae. In this study, Lonchaeidae is proposed as the sister group of Piophilidae based on the following apomorphies: absence of shading on the r-m and/or dm-cu crossveins (12:0, 13:0) and wing apex (14:0), and the absence of a fumose stigmal space (15:0).

The monophyly of Piophilidae is well-supported by six character states: vibrissae present (2:1), small clypeus (9:0), prosternum long and reaching neck (32:1), presutural dorsocentral setae present (35:1), three or four postsutural dorsocentral setae (36:2) and two pregonite lobe (58:1). The morphological analysis divided the Piophilidae into two monophyletic clades, separating the genera previously treated as Thyreophorina from the rest of the family.

THYREOPHORINAE

McAlpine (1977) and Ozerov (2004a) both considered the subtribe Thyreophorina as being part of Piophilidae, although other authors treat it as a separate family. The 30 most parsimonious trees obtained in this study support the monophyly of Thyreophorina within Piophilidae, however, instead of a subtribe, it is treated as the subfamily Thyreophorinae. Apomorphies for this subfamily are the presence of a subvibrissa (1:1), preapical mid tibia with several strong curved ventral spur (19:1), hind femur of male with row(s) of long setae ventrally (23:1), subapical scutellum setae very strong and thick in males (40:1), and a longer scutellum in males (41:1). The monophyly of Thyreophorinae is supported with a Bremer value of four (Fig. 1, 2).

Only six out of the fourteen described Thyreophorinae species were included in the morphological analysis due to the availability of museum specimens. More species would be needed to verify if the genus *Protothyreophora* Ozerov (type species: *P.grunini* Ozerov) is actually a junior synonym of *Centrophlebomyia* Hendel as proposed by Mei *et al.* (2013). Although *Protothyreophora* was synonymised with *Centrophlebomyia* (Mei *et al.* 2013), Ozerov may have been correct by assigning it in a distinct genus, because *Protothyreophora grunini*, the type species, does not form a monophyletic group with *Centrophlebomyia furcata* (Fabricius) (Figs. 1 and 2).

PIOPHILINAE

Actenoptera Czerny

McAlpine (1977) and Ozerov (2004a) disagreed on the phylogenetic relationship of Neottophilinae (including *Actenoptera* Czerny and *Neottiophilum* Frauenfeld) with Piophilidae. McAlpine (1977) supported the inclusion of Neottiophilinae as a subfamily of Piophilidae, while Ozerov (2004a) suggested it is a distinct family as proposed by previous taxonomists. The present phylogenetic analysis partly agrees with McAlpine's (1977) hypothesis since both genera are included in the Piophilidae. However, in contrast with both McAlpine's (1977) and Ozerov's (2004a) classifications *Actenoptera* and *Neottiophilum* are not monophyletic. *Actenoptera* is the sister group to the remaining Piophilinae based on the presence of prescutellar acrostichal setae (38:1), sternite 7 of male without soft projections at posterior margin (52:0) and distiphallus narrow (53:0), but *Neottiophilum* is nested within *Mycetaulus*.

New genus A and *Protopiophila*

The phylogenetic analysis divided *Protopiophila* into two clades, leaving the species *Protopiophila vitrea* separated. In Figures 1 and 2, the species is placed on its own as the sister group of the Piophilinae excluding *Actenoptera*. This species was first described as *Piophila vitrea* D.K. McAlpine and was placed in *Protopiophila* by Ozerov (2004a). In this study, we propose that *vitrea* be placed in a new genus. The apomorphy for this new genus is the presence of an inward projection at the posterior margin of the male sternite 5 (49:1). Apomorphies shared by other *Protopiophila* species and absent in *P. vitrea* are a flattened front tarsomere 2 to 5 (28:1) and the presence of an anterior postpronotal seta (31:1). This genus will be described in a separate publication since it is not present in the Nearctic.

Lasiopiophila Duda, *Liopiophila* Duda, *Prochyliza* Walker and *Piophila* Fallén

These genera form a weakly supported monophyletic group. The genus *Lasiopiophila* is also supported as monophyletic, containing the following apomorphies: a very hairy body (37:1), scutellum with wart-like tubercle on each side of subapical setae (39:1) and a principally gray thorax (57:1). Ozerov (2004a) also suggested the synonymy of *Liopiophila* with *Prochyliza* but in the present phylogenetic analysis, the two genera do not form a monophyletic group.

Liopiophila is supported as a separate genus with the following apomorphies: posterior postpronotal setae absent (30:0), a setulose anepimeron (44:1), a postgonite and pregonite of about the same length (57:1), the presence of only one pregonite lobe (58:0) and a wrinkled spermathecae (62:1).

The apomorphy for *Prochyliza* (including *Stearibia*) is the absence of a medially weakly sclerotized sternite 5 in males (50:0). In this study, *Stearibia* is proposed as a junior synonym of *Prochyliza* since it was placed among *Prochyliza* species in all 30 most parsimonious trees. *Stearibia nigriceps* (Meigen) has, however, many autapomophies which make it a highly modified *Prochyliza* species: flattened front tarsomere 2 to 5 (28:1), setulose anepisternum absent (42:0), orange blunt structures on distiphallus absent (56:0), postgonite lobe longer than pregonite lobes (57:2), two pregonite lobes present (58:1) and spermathecae wrinkled (62:1). *Prochyliza lundbecki* is another highly modified species with the following apomorphies: mid tibia of males with preapical patch of long blond setae ventrally (21:1), hind femur with several stout ventral setae (24:1), hind trochanter of male with row of stout setae ventrally (26:1), sternite 5 of male weakly sclerotised medially (50:1) and orange blunt structures on distiphallus absent (56:0).

The genus *Piophila* is also part of this clade and is considered as monophyletic with the following apomorphies: posterior orbital setae absent (7:0), three dorsocentral rows of acrostichals (34:1) and one spermathecae present (60:0).

Pseudoseps Becker

The genus *Pseudoseps* is considered monophyletic with the following apomorphies: wing apex and/or crossveins with shading (12:1) and apex of wing shaded black at veins R_{2+3}, R_{4+5} and M_{1+2} (13:2).

Allopiophila Hendel, *Amphipogon* Wahlberg and *Mycetaulus* Loew

Ozerov (2004a) synonymised several genera treated as distinct in McAlpine's (1977) classification. He suggested that *Allopiophila*, *Arctopiophila*, *Boreopiophila* and *Parapiophila* be combined into a single genus: *Allopiophila*. In Figures 1 and 2, *Allopiophila* is instead supported as a genus with the following apomorphy: prosternum with a pair of setae (33:1). It is not closely

related to *Boreopiophila*, *Parapiophila* and *Arctopiophila* as proposed by Ozerov (2004a), but is more closely related to *Mycetaulus* and *Amphipogon*, with the latter forming its sister group.

The monophyly of *Amphipogon* is supported with a strong Bremer value of 7 and with the following apomorphies: male with beard-like cluster of long curved setae on gena (3:1), mid tibia of males with row of stout ventral setae (20:1), hind femur of male with row(s) of long setae on ventral side (23:1), mid basitarsus of males with setae forming a fan-like shape (27:1), sternite 5 of male weakly sclerotised medially (50:1), distiphallus narrow (53:0), surstyli with 1 stout short seta (59:1) and spermathecae not well sclerotised (61:0).

Neottiophilum is placed within *Mycetaulus*, suggesting it should be treated as a junior synonym of *Mycetaulus*. Shared apomorphies among *Mycetaulus* and *Neottiophilum* are shading on wing apex and/or crossveins (12:1), and apex of wing shaded black at veins R_{2+3} and R_{4+5} (13:1). *Neottiophilum praeustum* (Meigen) has several apomorphies not found in other *Mycetaulus* species implying that *Neottiophilum* could be a highly modified *Mycetaulus*. These characters include the presence of a subvibrissa (1:1), shading black at wing apex on veins R_{2+3}, R_{4+5} and M_{1+2} (13:2), the presence of shading at crossveins r-m and/or dm-cu (14:1), a setulose R_1 (16:1), the presence of costal spines (17:1), a subapical scutellum with very strong and thick setae in males (40:1), and an entirely yellow and bulky thorax and abdomen (47:1). Because *Neottiophilum* is the only Piophilidae known to live in bird nests and feed on nestlings, it might be that its change in habits has greatly modified its morphology compared to other *Mycetaulus* species.

Arctopiophila Duda

Arctopiophila, Boreopiophila and *Parapiophila* (including *Parapiophila* sp.A (*Arctopiophila mcalpinei* n. sp.)), are not grouped with *Allopiophila* as proposed by Ozerov (2004a). Instead, they form a monophyletic clade with the genus, *Neopiophila*, and two species previously placed in *Mycetaulus*, *M. nigritellus* Melander and *M.* sp.A (*Arctopiophila variefrontis* n. sp.). The monophyly of the large genus *Parapiophila* was not supported in the parsimony trees, as reflected in the consensus tree (Fig. 3). *Parapiophila*, *Boreopiophila* and *Neopiophila* are thus proposed as junior synonyms of *Arctopiophila*. In addition, a new combination is proposed:

Arctopiophila nigritellus. The apomorphy for *Arctopiophila* in the present phylogeny is a narrow distiphallus (53:0).

Borealicola Rochefort n. genus

The morphological analysis has defined a separate monophyletic group combining species previously placed in *Parapiophila* McAlpine. This clade will be described in the taxonomic revision section as the new genus *Borealicola* Rochefort, and includes *B. fulviceps* (Holmgren), *B. pseudovulgaris* (Ozerov), *B.* sp. B (*B. madaros* n. sp.) and *B.* sp. C (*B. skevingtoni* n. sp.). Species C was not placed with the remaining *Borealicola* species in the 30 most parsimonious trees; however, because it is very similar to *B. pseudovulgaris* and information for female genitalia was absent from the matrix, the species is tentatively included in *Borealicola*. The apomorphy for *Borealicola* is a postgonite of about the same length as the pregonite (57:1).

The equally parsimonious trees in Figures 1 and 2 shared many similarities on the generic divisions, however, there were several differences in sister group relationships. In Figure 1, *Lasiopiophila* is the sister group to *Liopiophila* + *Prochyliza* + *Piophila*, while in Figure 2, *Lasiopiophila* is the sister group to: 1) *Liopiophila* + *Pseudoseps* + *Arctopiophila* + *Borealicola* + *Mycetaulus* + *Amphipogon* + *Allopiophila* and 2) *Prochyliza* + *Piophila*. Another major difference is that *Liopiophila* is the sister group to *Prochyliza* + *Piophila* in Figure 1 and to *Pseudoseps* + *Arctopiophila* + *Borealicola* + *Mycetaulus* + *Amphipogon* + *Allopiophila* in Figure 2. A final difference occurs at the species level in *Prochyliza*, where in figure 1, it is unclear if *P. nigricoxa* (Melander & Spuler) or *P. azteca* McAlpine is the sister group to the remaining species, while in Figure 2, *P. azteca* is defined as the sister group.

Phylogeny of Piophilidae: Molecular characters

Two molecular phylogenies were produced, one with 483 bp (Fig. 4) and another with 658 bp (Fig. 5), to account for differences in sequence length between genes obtained from the BOLD and GenBank databases. Although single-gene phylogenies, especially using a small set of examplar species, are not always robust, these trees are used as additional support for parts of the morphological phylogeny.

Additional support for the monophyly of Piophilidae, including 'Thyreophoridae' and 'Neottiophilidae' was obtained from the molecular evidence. Also, *Parapiophila*, *Boreopiophila* and *Arctopiophila* were a monophyletic group. As in the morphological tree, *Stearibia nigriceps* (Meigen) is placed with *Prochyliza*. *Liopiophila* is also considered as a separate genus from *Prochyliza*, in contrast to what was suggested by Ozerov (2004a). Differences from the morphological tree include the placement of *Neopiophila* and *Mycetaulus nigritellus* outside *Arctopiophila*.

The CO1 gene is useful within the Piophilidae to test species concepts and bring additional support to a morphological phylogeny. However, some species were not differentiated from one another although they have obvious morphological differences. *Prochyliza brevicornis* Melander and *P. xanthostoma* Walker were not differentiated from one another. The males of *P. xanthostoma* display sexual dimorphism, and phenotypic characters differentiating the two species are coded on another gene or evolution driven by sexual selection has probably occurred faster then the divergence in CO1. In *Prochyliza xanthostoma*, head and antenna length are two male sexual traits which are influence by female selection and can speed up the evolution of sexual dimorphism (e.g. Bonduriansky and Rowe 2005). Other species were also not differentiated, such as *Parapiophila dudai* (Frey) and *Parapiophila pectiniventris* (Duda). On the other hand, two species, *Mycetaulus bipunctatus* (Fallén) and *Parapiophila kugluktuk* Rochefort & Wheeler, were successfully separated; however, they had conflicting CO1 data with the morphological matrix and they were not combined with their respective genera in the molecular trees.

Taxonomic revision of Nearctic Piophilidae species

Nearctic Piophilidae species share the following diagnosic traits: **Description.** Body length 1.8–5.8 mm, wing length 2.0–6.0 mm. **Head:** Head usually as high as wide; colour varying from entirely black to entirely yellow; eyes round and bare; 1 ocellar, 1 divergent postocellar, 1 inner and 1 outer vertical setae; 1–2 fronto orbitals (*Actenoptera* with 3–4); 1 vibrissae (absent in *Borealicola madaros*). **Thorax:** Varying from entirely black to entirely yellow; thorax usually glossy but dull in *Lasiopiophila pilosa* and *Arctopiophila tomentosa*; katatergite, metapleuron and anatergite with silvery-white microtomentum; 1 posterior postpronotal (absent in *Prochyliza*

and *Piophila*; *Protopiophila* with additional anterior postpronotal); 2 notopleurals, 1 supra-alar, 1 postalar setae; presutural intra-alar usually present (absent in *Borealicola madaros*, *Lasiopiophila pilosa*, *Liopiophila varipes*, *Piophila casei*, *Prochyliza brevicornis*, *P. nigrimana*, *P. xanthostoma*); 1 intrapostalar seta usually present (absent in *Amphipogon flavus*, *Arctopiophila nigritellus* (present or absent), *Borealicola madaros*, *B. pseudovulgaris*, *B. skevingtoni*, *Mycetaulus costalis*, *M. longipennis*); acrostichal setulae in 6–12 rows (3 in *Piophila casei*); 1 weak proepisternal; 0–5 katepisternum setulae at dorsal margin; anepisternum bare except in *Prochyliza* (excluding *P. nigriceps*) and *Piophila*; anepimeron bare except in *Liopiophila*; 1 pair of basal and subapical scutellar; scutellum usually convex. **Wing:** Hyaline, with wing patterns on crossveins and apex present in *Mycetaulus*; black shading along costa in *Allopiophila*, *Amphipogon* and some *Mycetaulus* species; calypter and fringe usually white, fringe brown in some species; R_1 setulose in *Actenoptera*; alula and anal lobe well developed; cell bm usually present, but absent or incomplete in *Arctopiophila arctica*, *A. nigerrima*, *A. setaluna*, *Borealicola fulviceps*, *B. madaros* and *Mycetaulus lituratus.* Halter white. **Legs:** Legs varie from entirely yellow to black; fore femur with several outstanding setae; mid and hind legs usually with short hairs only except for stout ventral setae on mid femur in *Actenoptera avalona* and on hind femur in *A. avalona* and *A.hilarella*; claws brownish-yellow proximally and black distally. Males of *Amphipogon hyperboreus* and *Prochyliza lundbecki* with secondary sexual characters on mid and hind legs. **Abdomen:** Abdomen usually black but yellow in *Allopiophila testacea* and *Actenoptera*, and black with yellow on syntergite 1+2 in *Allopiophila luteata* and *Arctopiophila kugluktuk*; five spiracles in males and seven in females; abdomen covered with short and fine setae except for *Arctopiophila setaluna* and *Lasiopiophila pilosa* who are extensively hairy; a row of longer setae present along posterior ventral side of sternites and tergites. **Male genitalia:** Sternite 8 round and convex, with several sparse short setae; epandrium with outstanding setae along posterior margin (varying from none to a row, or several rows in *Amphipogon hyperboreus*); surstylus separated from epandrium; postgonite usually strongly sclerotised and pregonite weakly sclerotised; distiphallus usually short and narrow in *Actenoptera*, *Amphipogon*, *Arctopiophila* and *Mycetaulus*, long and twisted in *Prochyliza*, *Lasiopiophila*, *Liopiophila*, *Piophila* and *Protopiophila*, and long and inflated in *Allopiophila* and *Borealicola*; distiphallus usually with hairs. **Female genitalia:** Ovipositor piercing-type; two

spermathecae (except 1 in *Piophila casei*); spermathecae either wrinkled or smooth; spermathecae well sclerotised (except in *Amphipogon hyperboreus*, *Arctopiophila nigritellus*, *A. variefrontis* and *Mycetaulus lituratus*).

PIOPHILINAE

ACTENOPTERA Czerny 1904

(Figures 6, 7)

Gymnomyza Strobl 1894: 85, type species *Heteromyza hilarella* Zetterstedt 1847: 2467 (preoccupied).

Actenoptera Czerny 1904: 202 (new name for *Gymnomyza* Strobl 1894).

Diagnosis. *Actenoptera* can be recognised by its bulky yellow body, the presence of 3–4 fronto-orbitals and a dorsally setulose R_1. **Description.** Body length 4.4–5.7 mm; wing length 4.4–6.0 mm. Body entirely glossy yellow except for brown on legs of *Actenoptera avalona*. Setae and hairs black. **Head:** Head as high as long, glossy yellow; eyes round; lunule bare; short hairs scattered on occiput, between inner and outer vertical setae, from postocellar setae to anterior end of ocellar triangle, and on anterior portion of frons and fronto-orbital plates; row of short setae along anterior margin of frons; 1 lateroclinate posterior fronto-orbital, and 1 lateroclinate and 1–2 medioclinate anterior fronto-orbitals; inner and outer verticals of equal length; ocellar setae as long as vertical setae; postocellar setae slightly longer than verticals; first flagellomere round; arista pubescent; arista about 2 times length of first flagellomere; base of arista yellow with rest brown. **Thorax:** Glossy yellow; metapleuron, anatergite, meron and posterior half of anepimeron dull yellow; 1 posterior postpronotal, 1 presutural intra-alar, 1 supra-alar, 1 postalar, 1 intrapostalar, 1 presutural and 3–4 postsutural dorsocentral setae; dorsocentral setae weak except for posteriormost which is strong; prescutellar acrostichal seta present; acrostichal setulae in 9–10 rows; prosternum bare; anepisternum bare; anepimeron bare. **Wing:** Hyaline with pale brownish tinge; veins brown, except R_{4+5}, R_{2+3} and M_{1+2} yellow from apex of wing to level of crossvein r-m, as well as costal vein, R_1, and veins of cell A and bm; calypter white with brown margin; fringe yellow, in some specimens pale brown; vein R_1 setulose dorsally; length of crossvein dm-cu about 3 times length of crossvein r-m; length of C between Sc and R_1 almost 2 times length of crossvein h; length of M_1 between crossveins r-m and dm-cu slightly more than 2

times length of dm-cu. Halter yellow. **Legs:** Legs mainly yellow but with brown on leg segments of *A. avalona*; 2 rows of stout setae along ventral side of hind femur (in *A. avalona* this character is also found on the fore femur). **Abdomen:** Glossy yellow, but brown may be present on margin of tergites and sternites in *A. avalona*; short hairs scattered, more developed on lateral margins of tergite 3; row of setae along posterior margin of both sternites and tergites. **Male genitalia:** Sternite 8 round and convex, with several short setae on middle of segment; epandrium wider than high, saddle shaped; epandrium with setae on both sides along posterior margin and with setulae behind up to anterior margin; surstylus reduced and separated from epandrium; postgonite strongly sclerotised either with one lobe (*A. hilarella*) or bi-lobed (*A. avalona*); pregonite weakly sclerotised with one rounded lobe and one proximal and lateral projection; distiphallus bare, short and membranous; cerci weakly sclerotised, separated from epandrium, oval in ventral view and with several short scattered setae. **Female genitalia:** Cerci with 1 pair of setae dorsally and 1 ventrally, with additional setulae below these; two oval sclerotised spermathecae.

Actenoptera includes three species: *Actenoptera avalona* McAlpine 1977, *A. hilarella* (Zetterstedt 1847) and *A. shatalkini* Ozerov 2000. Only *A. avalona* and *A. hilarella* are present in the Nearctic.

Actenoptera avalona McAlpine 1977

(Figure 6)

Actenoptera avalona McAlpine 1977: 23 (type locality: Canada, Newfoundland and Labrador, St. John's).

Type material examined. 1 ♂ holotype. Agricultural Experiment Station, St. John's, Nfld., Malaise trap, 16.vii.1967, J.F. McAlpine, Holotype *Actenoptera avalona* McAlpine (CNC). 1 ♀ allotype. **Newfoundland and Labrador:** same data as holotype except 19.vii.1967 (CNC). 1 ♂, 3 ♀ paratypes. **CANADA. Newfoundland and Labrador:** same data as holotype except Malaise trap, 16.vii.1967, 19.vii.1967, 20.vii.1967, 31.vii.1967 (CNC).

Other material examined. 2 ♂. **CANADA. British Columbia:** Queen Charlotte Islands, Graham Island, Naikoon Provincial Park, Tow Hill, 15.vii.1988, S. Marshall. **UNITED STATES OF**

AMERICA. Alaska: Nome, Kougarok Road mi 1755, (64°42'22"N, 165°17'50"W), Malaise, 26-28.vi.2005, J. & A. Skevington, debu00304673 (DEBU) (Fig. 6).

Notes on capture: This species has been captured using Malaise traps.

Diagnosis. This species differs from *A. hilarella* by the following characters: 2 ventral rows of stout setae on fore and hind femora and 1 row on mid femur, bare scutellum with 2 pairs of marginal setae, legs partly brown and surstylus separated from epandrium. **Description.** Body length 4.4–5.7 mm; wing length 4.4–5.7 mm. McAlpine (1977) has seen specimens with 7 mm body length. Body glossy yellow with brown on legs. **Head:** Height of eye 2.6–3.2 times genal height; 3–5 short setae along gena; palpus with 1–2 long preapical ventral setulae and several scattered short setulae over surface. **Thorax:** 1 posterior postpronotal but some specimens with 1–2 additional long strong hairs on both sides of seta; 1 proepisternal seta, with an additional hair in some specimens; katepisternum with 3 large setae and several short hairs on upper margin; scutellum convex and bare, with 2 pairs of marginal setae (one specimen was seen with a hair between scutellar setae). **Wing:** Same as genus description. **Legs:** All coxae yellow, some specimens with medial surface of fore coxa entirely brown; fore femur yellow with distal end and sometimes ventral and anterior side brown; mid and hind femora usually yellow (distal end of hind femur brown in some specimens); all tibiae yellow, brown distally (mid tibia entirely yellow in some specimens); fore tarsus brown, mid and hind tarsi mainly brown, but lighter than fore tarsus; 2 rows of stout setae along ventral side of fore and hind femora, and 1 row of stout setae on anterior ventral side of mid femur. **Abdomen:** Glossy yellow, in some specimens with brown along posterior margin of tergites and sternites; row of setae along posterior margin weak on both sternites and tergites. **Male genitalia:** Surstylus greatly reduced to small rounded lobes (longer than high) with sparse short and fine setulae; postgonite strongly sclerotised with two small and narrow lobes of equal length; pregonite weakly sclerotised, one rounded lobe with a subtriangular proximal and lateral lobe; 1 seta present at ventral base of pregonite. **Female genitalia:** Sternite and tergite 7 and 8 with fine setulae; 1 pair of seta on epiproct; epiproct heart-shaped, with point facing posteriorly; hypoproct reduced; cerci short, as wide as long; two sclerotised spermathecae; spermathecae oval and elongated, with smooth surface.

Actenoptera hilarella (Zetterstedt 1847)

(Figure 7)

Heteromyza hilarella Zetterstedt 1847: 2467.

Actenoptera hilarella; Czerny 1904: 202; 1930: 10.

Material examined. 37 ♂, 65 ♀ from the following Nearctic localities: **CANADA. Alberta:** Elk Island National Park; George Lake; Kananaskis; Waterton Lake National Park. **British Columbia:** Cowichan Lake; Robson. **Newfoundland and Labrador:** St. John's; Terra Nova. **Ontario:** 7 mi East Griffith; Iroquois Falls. **Quebec:** Gatineau; Great Whale River; Johnville Bog & Forest Park. **Saskatchewan:** Prince Albert National Park. **Yukon Territory:** Dempster Highway (near North Fork Pass; mi 87; km 82; km 128; km 140.5; km 141; km 155); Kluane. **UNITED STATES OF AMERICA. Alaska:** 36 km North Willow, Trapper Creek; Dalton Highway; Kenai Peninsula Co., Renfro's Lakeside Retreat, North of Seward. **Montana:** Glacier Park, Lake McDonald. **Utah:** Summit Co., Bear River R.S. **Washington:** Mt. Rainier, Tahoma Fork (BIO, CNC, DEBU, LEM, UASM, UBCZ) (Fig. 7).

Additional distribution information: *Actenoptera hilarella* is also present in the following Palaearctic regions: Austria, Czech Republic, Finland, Lithuania, Norway, Poland, Russian Karelia, Slovakia, Sweden and Switzerland (McAlpine 1977, Merz 1996, Ozerov 2004b, Greve 2005, Roháček & Ševčík 2009, Kahanpää & Winqvist 2014).

Notes on capture: *Actenoptera hilarella* has been captured in the Nearctic from June to August using Malaise traps according to data labels, and with sweep nets according to Greve (2005). It is present in the tundra, in forested areas (*Populus*, *Picea*, *Betula*) and near ponds and bogs.

Diagnosis. *Actenoptera hilarella* can be differentiated from *A.avalona* by its entirely yellow body, mid femur without stout setae, scutellum with several short hairs between marginal setae and surstylus fused with epandrium. **Description.** Body length 4.8–5.8 mm; wing length 5.0–6.0 mm. Body glossy yellow. **Head:** Height of eye about 3.4 times genal height; 2–3 setae along gena; palpus with 1 long preapical ventral setulae and several scattered short setulae over surface. **Thorax:** 1 proepisternal seta; katepisternum with 2–3 large setae and several short hairs on upper margin; scutellum convex and with several short hairs on side margins between the 2 pairs of marginal setae (some specimens with hairs also present on dorsal side of scutellum). **Wing:** Same as genus description. **Legs:** Leg yellow with tarsal segment 3, 4 and 5 possibly shaded black; 1 row of 4–5 setae along posterior ventral side of fore femur. **Abdomen:** Glossy

yellow; row of setae (stronger than in *A. avalona*) along posterior margin of both sternites and tergites; sternites with 1–2 strong setae on posterolateral margins. **Male genitalia:** Surstylus reduced; postgonite strongly sclerotised, small and oval with pointed tip; pregonite sclerotised (more sclerotised towards base) with one well developed rounded lobe, slightly wrinkled, and with an additional strongly sclerotised disque lobe proximally and laterally; cerci larger than in *A.avalona*. **Female genitalia:** Sternite and tergite 7 and 8 with a row of setae along posterior margin and fine setulae on remaining surface; epiproct and hypoproct weakly sclerotised or reduced; cerci about 2 times longer than wide, with setulae stronger than in *A. avalona*; spermathecae oval and knobish, with smooth surface.

ALLOPIOPHILA Hendel 1917

(Figure 8)

Allopiophila Hendel 1917: 37, type species *Piophila luteata* Haliday 1883: 169 (by original designation).

Diagnosis. *Allopiophila* differs from other Piophilidae as it has a pair of seta on the prosternum and it has a mainly yellow head and abdomen. **Description.** Body length 2.4–4.4 mm; wing length 2.7–4.4 mm. Body mainly yellow in *A. testacea* and partly black in *A. luteata*. Setae and hairs black. **Head:** Head higher than long; head yellow except in *A. luteata* where ocellar triangle is black, and posterior fronto orbital plate and upper half of occipital region may be black or yellow; eyes round; lunule bare; short hairs scattered on occiput, from postocellar setae to anterior end of ocellar triangle, frons, fronto-orbital plates and gena; lateroclinate posterior fronto-orbitals and 1 smaller lateroclinate anterior fronto-orbitals; inner and outer vertical setae of equal length; ocellar setae slightly longer than vertical setae; postocellar setae 1.5 times longer than vertical setae; arista pubescent; arista about 2 times length of first flagellomere; base of arista yellow with rest brown; palpus with sometimes 2 slightly longer and darker setulae, remaining of surface with short setulae. **Thorax:** Thorax yellow except in *A. luteata* where thorax varies in yellow and black proportions; proepisternum, anatergite, metapleuron and meron posteriorly dull; 1 posterior postpronotal, 1 weak presutural intra-alar, 1 supra-alar, 1 postalar, 1 intrapostalar, 1 postsutural dorsocentral setae; acrostichal setulae in 10–11 rows; 1 proepisternal seta; prosternum with 1 pair of seta; anepisternum bare; anepimeron bare; katepisternum with

usually 2 setae on upper margin; scutellum convex and bare, with 2 pairs of marginal setae. **Wing:** Hyaline with black shading along costal vein; stigmal space fumose; veins yellow to brown; calypter and fringe white. Halter white. **Legs:** Legs mainly yellow with fore tarsus black, except *A. luteata* with black present on tibia and occasionally on femora. **Abdomen:** Glossy yellow in *A. testacea* and glossy black with syntergite 1+2 black or yellow in *A. luteata*; dull reflections present on tergites; short hairs scattered, and more developed on lateral margins of tergite 3; sternites with row of short setae along posterior margin. **Male genitalia:** Sternite 6 and 7 strongly sclerotised at anterior margin; sternite 8 round and convex, with several short setulae; epandrium saddle shaped, on lateral view ventral and dorsal sections about same width; epandrium with 4–6 setae along posterior margin and with setulae behind these; surstylus not fused with epandrium, elongated and rectangular with rounded edges, convex, with short setae; postgonite strongly sclerotised, elongated, narrow with rounded tip, medially incurved; pregonite with a large oval lobe and two additional projections; pregonite with several short setae on oval upper lobe; distiphallus asymmetrically inflated proximally to half of length, then gradually narrowing down to distal end; distiphallus membranous, densally spinulose on basal half, rest bare; distiphallus long, reaching anterior end of sternite 3; cerci not fused with epandrium but ventrally fused with surstylus; cerci oval, with two long setulae and several small setulae. **Female genitalia:** Sternite and tergite 7 and 8 with several setae laterally and several setulae below these; cerci about 2 times as long as wide, with 1 pair of seta ventrally and 1 dorsally; two sclerotised spermathecae; spermathecae cylindrical, elongate, and indented at tip, with wrinkled surface.

Three species are included in this genus: *Allopiophila luteata* (Haliday 1883), *A. pappi* Ozerov 2004, and *A. testacea* (Melander 1924). *Allopiophila luteata* and *A. testacea* are the only Nearctic species. Some *Allopiophila* specimens have been seen with undeveloped seta on prosternum and can be mistaken for *Arctopiophila* (McAlpine 1977). However, these are less extensively black (McAlpine 1977).

Allopiophila luteata (Haliday 1833)

(Figure 8)

Piophila luteata Haliday 1833: 169 (type locality: Northern Ireland, Holywood).

Allopiophila luteata; Hendel 1917: 37.

Piophila pectoralis Zetterstedt 1847: 2515 (type locality: Sweden, near Lund) synonym in Duda 1924.

Piophila spiculata Pandellé 1902: 427 (type localities: Hautes Pyrénées, Gavarnie; France, Lyon; Poland, Prusse oriental) synonym in Duda 1924.

Allopiophila caucasica Ozerov 1991: 8 (type locality: Russia, Alania, environs of Buron) synonym in Ozerov 2004a: 603.

Material examined. 8 ♂, 12 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff; Elk Island National Park; Waterton Lakes National Park. **British Columbia:** West Bench Penticton. **Manitoba:** 10 km Southeast Churchill, Farnworth Lake; 26 km Southeast Churchill, Twin Lakes fen; Deer River mi 473, Hudson Bay Railway. **Northwest Territories:** Horton River. **Nova Scotia:** Cape Breton Highlands National Park, North Mt. Bog. **Quebec:** Great Whale River. **Yukon Territory:** Herschel Island. **UNITED STATES OF AMERICA. Alaska:** 11 mi South Anderson Jct., Rt. 3, mi 270; 36 mi North Willow; Valdez. **Colorado:** Mt. Evans, Doolittle Ranch; Nederland, Science Lodge (BIO, CAS, CNC, LEM, UBCZ) (Fig. 8).

3 ♂ from the following Palaearctic locality: **CZECHOSLOVAKIA.** Halbatadt (USNM).

Additional distribution information: *Allopiophila luteata* is also known in the Palaearctic from Britain, Czech Republic, Danish mainland, Finland, France, Germany, Hungary, Northern Ireland (type locality), Norway, Poland, Russia Northwest, Slovakia, Sweden, Switzerland, The Netherlands and Ukraine (Merz 1996, Ozerov 2004b, Greve 2005, Roháček & Ševčík 2009, Misiachna and Korneyev 2015).

Notes on capture: This species has been captured in the Nearctic from May to August with Malaise traps (not baited and baited with dung). It is present in the forest (Aspen, *Alnus-Populus-Picea*), rose bushes understory, rangeland/orchard edge, the tundra, fen and bog.

Diagnosis. *Allopiophila luteata* can be differentiated from *A. testacea* by the presence of black on its ocellar triangle (occasionally also on fronto-orbital plate and occipital region), parts of thorax and legs, and on most of its abdomen (with sometimes yellow on syntergite 1+2).

Description. Body length 2.4–3.5 mm; wing length 2.7–3.7 mm. Head mainly yellow with black on ocellar triangle, and sometimes on posterior fronto-orbital plate and occipital region. Thorax glossy black and yellow. Legs yellow with black segments. Abdomen glossy black with yellow

on first tergite. **Head:** Height of eye 2.1–2.4 times genal height; first flagellomere round with usually a black spot on dorsal margin and exterior lateral side. **Thorax:** Prescutum and scutum mainly glossy black with presence of yellow along lateral, anterior and posterior sides; remaining of thorax vary from mostly black to mainly yellow; scutellum yellow or black; postalar and intrapostalar setae weak unlike in *A. testacea*. **Wing:** Length of crossvein dm-cu about 3 times length of crossvein r-m; length of C between Sc and R_1 1.5 times the length of crossvein h; length of M_1 between crossveins r-m and dm-cu between 2–2.5 times lengths of dm-cu. **Legs:** Coxae yellow; femora yellow (some specimens with distal end of fore, mid and hind femora black); fore tibia mainly black with yellow on proximal end; mid tibia yellow; hind tibia mainly yellow with black on distal half; fore tarsus black; mid tarsus yellow with black tarsal segment 4 and 5, sometimes also segment 3; hind tarsus usually black (in some specimens may be identical to mid tarsus). **Abdomen:** Glossy black with syntergite 1+2 either black or yellow. **Male genitalia:** Epandrium with 4 setae along posterior margin and with setulae behind these; pregonite with one large oval lobe with a pointed projection dorsally and ventrally towards apex, and a second small rounded lobe at base (the second lobe at base is strongly sclerotised as on dorsal margin). **Female genitalia:** Same as genus description.

Allopiophila testacea (Melander 1924)

(Figure 8)

Mycetaulus testaceus Melander 1924: 81 (type locality: United States of America, Idaho, Moscow Mt.).

Allopiophila testaceus; McAlpine 1977: 32.

Type material examined. 1 ♂ holotype. Moscow Mt. ID, 24.vi.1919, A.L. Melander, Type *Mycetaulus testaceus* Mel, A.L. Melander Collection 1916, Holotype *Mycetaulus testaceus* Melander 1924: 81, det. A.L. Ozerov 2002 (USNM). 2 ♂ paratypes. **UNITED STATES OF AMERICA. Washington:** Ilwaco (USNM).

Other material examined. 6 ♂, 12 ♀ from the following Nearctic localities: **CANADA. Alberta:** Frank; Waterton Lakes National Park. **British Columbia:** Kinbasket Lake; Vancouver, Point Grey. **Saskatchewan:** Indian Head. **UNITED STATES OF AMERICA. Alaska:** Valdez.

Washington: Lake Crescent; Lake Crescent, Fairholm; Mt. Rainier, Eagle Peak (CAS, CNC, RBCM, USNM) (Fig. 8).

Notes on capture: This species has been captured from May to August with Malaise traps.

Diagnosis. *Allopiophila testacea* differs from *A. luteata* by its entirely glossy yellow body with only black present on tarsi and with usually strong postalar and intrapostalar setae. **Description.** Body length 2.7–4.4 mm; wing length 2.9–4.4 mm. Body glossy yellow with black fore tarsi, and usually mid and hind tarsi. Abdomen usually glossy yellow, but some specimens with black on parts of tergites and sternites. Setae and hairs black. **Head:** Head entirely yellow; height of eye about 1.7–3.3 times genal height; first flagellomere round with sometimes black shading at base were arista inserted. **Thorax:** Entirely glossy yellow; postalar and intrapostalar setae usually strong unlike *A. luteata*. **Wing:** Length of crossvein dm-cu 2.5 times length of crossvein r-m; length of C between Sc and R_1 1 time length of crossvein h; length of M_1 between crossveins r-m and dm-cu 1.5 times length of dm-cu. **Legs:** Coxae, femora and tibiae yellow; fore tarsus black (some specimens with yellow tarsal segment 1 and 2); mid and hind tarsi variable, varying from entirely yellow to mainly black. **Abdomen:** Glossy yellow (some specimens with brown on posterior margin of tergites). **Male genitalia:** Same as in *A. luteata* except epandrium with 6 setae along posterior margin; pregonite similar than *A. luteata* except large oval lobe with only one short pointed projection dorsally, none ventrally, and with a second small rounded lobe at base. **Female genitalia:** Same as genus description.

AMPHIPOGON Wahlberg 1845

(Figure 9)

Amphipogon Wahlberg 1845(1844): 217, type species: *Amphipogon spectrum* Wahlberg 1845: 217 (= *flavum* (Zetterstedt, 1838) (by monotypy).

Macrochira Zetterstedt 1838: 784, type species: (preoccupied by *Macrochira* Meigen 1803), *M. flava* Zetterstedt (by monotypy).

Ambopogon Greene 1919: 126, type species: *Ambopogon hyperboreus* Greene 1919: 126 (by original designation).

Diagnosis. This genus differs with a head longer than high, male with beard-like cluster of long curved brown and white setae on gena end epandrium, and with male dimorphic leg characters.

The *Amphipogon* genus contains two species: the Palaearctic *Amphipogon flavus* (Zetterstedt 1838) and the Holarctic *Amphipogon hyperboreus* (Greene 1919) (found in the Palaearctic according to Ozerov 2004a). *Amphipogon hyperboreus* is the only species present in the Nearctic.

Amphipogon hyperboreus (Greene 1919)

(Figure 9)

Ambopogon hyperboreus Greene 1919: 127 (type locality: United States of America, Alaska-Yukon Boundary).

Type material examined. 1 ♂ holotype. Alaska-Yukon Boundary, Lat. 69-10, Long. 141, 14-17.viii.1912, J.M. Jessup Collector, 10, type No. 22322, USNM *Ambopogon hyperboreus* C.T.G. Greene, (USNM).

Other material examined. 22 ♂, 40 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff, Sulfur Mt.; Lemon Creek; Waterton Lakes National Park, Akamina Parkway. **British Columbia:** Glacier National Park; Penticton, Apex Mt. **Newfoundland and Labrador:** Aklavik; Torngat Mountains National Park (Ivitak Valley; Torrgat Base Camp). **Northwest Territories:** Horton River. **Quebec:** Indian House Lake. **Yukon Territory:** Dawson Road mi 2; Dempster Highway (mi 87; km 240); Simpson Lake, 81 km North Watson Lake; Whitehorse, Lewes River Rapids. **UNITED STATES OF AMERICA. Alaska:** 11 mi South Anderson Jct., Rt. 3, mi 270; Big Delta; Chena River, Rec. Area 30 mi East Fairbanks; Dalton Highway. **California:** El Dorado Co., Echo Lake. **Colorado:** Chaffee Co., Garfield, on South Arkansas River. **Idaho:** Mt. Moscow. **Oregon:** 12 mi West of Elgin. **Utah:** Duchesne Co., Mirror Lake. **Washington:** Mt. Rainier (Fairfx Trl.; Eagle Peak; Paradise Park; Mt. Adams; Mt. Spokane). **N. Western U.S.A.** (BIO, CAS, CNC, DEBU, LEM, UBCZ, USNM) (Fig. 9).

Additional distribution information: Ozerov (1989) has recorded for the first time *Amphipogon hyperboreus* in the Palaearctic from the Amur Province, Zeya, USSR. One female from that locality in the CNC collection has been observed (data label: **RUSSIA.** Amurskaya obl., G.Vaya, 14.viii.1981, A. Ozerov), but since it is a female specimen and females of *Amphipogon flavus* and *hyperboreus* are much similar, a male specimen needs to be verified to

confirm the identity. However, Ozerov (1989) has compared a male from the same locality to a *hyperboreus* specimen from North America, suggesting the accuracy of the identification.

Notes on capture: *Amphipogon hyperboreus* has been captured in the Nearctic from June to September using sweep nets, and Malaise traps with or without dung as bait. It is present on mushrooms, in spruce-fir meadow, on plants along creeks and in forested areas (*Picea* (i.e. *P. glauca*), *Pinus*, *Salix*, *Alnus*, *Populus*). Greene (1921) has also collected this species by sweeping fallen logs and the undergrowth of cedars.

Diagnosis. This species differ from the Palaearctic species *A. flavus* by male genitalic characters: epandrial rows of posterior setae not divided medially by a well defined separation on dorsal side and cerci shorter than in *A. flavus*. **Description.** Body length 4.0–5.8 mm; wing length 3.9–5.4 mm. Body mainly glossy black with yellow on parts of head, legs and along margins of thoracic sclerites. Setae and hairs black. Male with sexual shape dimorphism on head, legs and genitalia.

Head: Head longer than high, yellow with ocellar triangle, posterior fronto-orbital plate and parts of occiput glossy black (ocellar triangle and fronto-orbital plate entirely yellow in some specimens); eyes round; height of eye 4.5–5.8 times genal height; male gena with beard-like cluster of long curved brown and white setae; female with short setae and hairs along gena, more abundant close to vibrissa (a female specimen has been seen with two vibrissae); short hairs scattered on occiput, from postocellar setae to anterior end of ocellar triangle, on frons and on fronto-orbital plates; 2 lateroclinate posterior fronto-orbitals (upper no more than twice as long as lower); inner and outer vertical setae of equal length; ocellar setae either as long as vertical setae or slightly shorter; postocellar setae slightly longer than verticals; first flagellomere oval, sometimes shaded black around arista; arista pubescent; arista about 3 times length of first flagellomere; base of arista yellow with rest brown; palpus with short setulae, longest ventrally.

Thorax: Glossy black with variable yellow on postpronotum, laterally on prescutum, on scutum and scutellum (these yellow sections can sometimes be glossy black); specimens can vary in yellow quantities, some have 3 yellow lines medially across part of prescutum and scutum in the acrostichal area, others also have does 3 lines and yellow from the posterior end of those lines reaching the scutellum; some males and females, in the USNM, also have entirely yellow thorax; a silvery-white microtomentose strip of variable width occurs in the acrostichal area, starting on prescutum and ending between the 2 postsutural dorsocentral setae; posterior half of meron,

katatergite, anatergite and metapleuron with silvery-white microtomentum, sometimes also laterally along prescutum and scutum; 1 posterior postpronotal, 1 presutural intra-alar, 1 supra-alar, 1 postalar and 2 postsutural dorsocentral setae; intrapostalar absent; acrostichal setulae in 6–8 rows; 1 proepisternal seta with additional short hairs; prosternum bare; anepisternum bare; anepimeron bare; katepisternum with 2 strong setae on upper margin; scutellum convex and bare, with 2 pairs of marginal setae. **Wing:** Fumose; stigmal space and costal cell shaded black; veins yellowish brown, in some specimens entirely brown, with veins R_{2+3} and M_{3+4} being the darkest; calypter and fringe white; length of crossvein dm-cu 4 times length of crossvein r-m; length of C between Sc and R_1 3 times length of crossvein h; length of M_1 between crossveins r-m and dm-cu slightly more than 2 times length of dm-cu. Halter white. **Legs:** Fore coxa yellow, mid and hind coxae variable (completely yellow to mostly brown); coxae with possible silvery-white microtomentum; fore leg black with yellow at proximal end of tibia, and both proximal and distal end of femur; mid leg mainly yellow except for black tarsal segment 4 and 5, in some specimens black present on distal end of both femur and tibia; hind leg yellow with variable black on femur, tibia, and tarsal segment 4 and 5; males with the following sexual dimorphism: dorsal bump on mid femur; row of stout ventral setae on mid tibia; thick dorsal hair patch on first tarsomere of mid tarsus; hind femur, on proximal half, with patch of long blond setae ventrally and ventro-posteriorly; 1 long ventral sinuate spine on both mid coxa. **Abdomen:** Glossy black; setae short and scattered; 1 outstanding seta along each sides of posterior margin of tergites. **Male genitalia:** Sternite 4 and 5 with long thick blonde setae; sternite 4 and 5 less sclerotised medially; sternite 6 and 7 stongly sclerotised along anterior margin; sternite 8 round and convex with several short setae; epandrium higher than long, convex, entirely fused dorsally; epandrium on lateral view convex on ¾ of length and square shaped at base on the last ¼ of the length (width on dorsal view same as on lateral view at midpoint, but more narrow where square shaped); epandrium with several rows of very long and strong blond setae (rows weakly separated medially on dorsal view but seem almost in a single tuft) along posterior margin and with short setae on squared portion; surstylus not fused with epandrium, well-developed, on lateral view shape of an upside down foot; surstylus with 2 stout short setae (tooth-like at posterio-lateral end distally; surstylus with short setae on surface with long blond setae dorso-anteriorly; postgonite strongly sclerotised, oval shaped with 3 pointed short projections dorsally; pregonite with short oval

projection with several short setae and 2 strongly sclerotised tooth-like projections dorsally; distiphallus short (does not cross posterior margin of sternite 5) and with short and fine hairs; cerci not fused with epandrium, strongly sclerotised and developed, and expending posteriorly were epandrium is squared; cerci widest at base, narrowest at midpoint and with knob-like apex; apex of cerci with many blond setae, brush-like. **Female genitalia:** Sternite and tergite 7 and 8 with strong setae laterally and several shorter ones; cerci short and narrow with 2 pairs of outstanding dorsal setae and 2 pairs of ventral setae; 2 weakly sclerotised spermathecae; spermathecae elongated, cylindrical and asymmetrical, with wrinkled surface.

ARCTOPIOPHILA Duda 1924

(Figures 10–20)

Arctopiophila Duda 1924: 109 (as subgenus of *Piophila*), type species *Piophila nigerrima* Lundbeck 1901: 301 (by monotypy).

Boreopiophila Frey 1930: 86, type species *B. tomentosa* Frey 1930: 84 (by monotypy) **new synonym**.

Neopiophila McAlpine 1977: 33, type species *N. setaluna* McAlpine (designated by McAlpine 1977) **new synonym**.

Parapiophila McAlpine 1977: 48, type species *Piophila vulgaris* Fallén 1820 (designated by McAlpine 1977) **new synonym**.

Diagnosis. *Arctopiophila* differs from other genera by having an entirely black thorax and abdomen (except *A. tomentosa* which is partly dull grey, and *A. kugluktuk* which occasionally has yellow on postpronotum (also *A. nigritellus*, *A. varifrontis*) and syntergite 1+2 (only *A. kugluktuk*), an entirely black head which can be partly yellow on gena, face, frons and anterior fronto-orbital plates (*A. tomentosa* also partly dull grey on head), and a usually short (not reaching posterior margin of sternite 4) and narrow distiphallus which is slightly longer in *A. arctica* and *A. kugluktuk*. **Description.** Body length 1.8–5.0 mm; wing length 2.0–5.3 mm. Glossy black body with possible yellow on gena, face, frons and anterior fronto-orbital plates, and on postpronotum (*A. kugluktuk*, *A. nigritellus*, *A. varifrontis*) and syntergite 1+2 in *A. kugluktuk*. Also, dull grey is present in one species: *A. tomentosa*. Setae and hairs black. **Head:** Head higher than long (as high as long in *A. kugluktuk*, *A. mcalpinei*, *A. nigritellus*, *A. tomentosa*,

A. variefrontis), entirely black in some species (i.e. *A. arctica*) and with yellow on gena, face, frons and anterior fronto-orbital plates in others (i.e. *A. vulgaris*); eyes round; lunule bare (setulose in *A. setaluna*); short hairs scattered on occiput, from postocellar setae to anterior end of ocellar triangle, on frons, fronto-orbital plates and gena; inner and outer vertical setae of equal length (inner shorter than vertical in *A. flavipes*); ocellar setae as long as vertical setae (ocellar setae weak in *A. flavipes*); postocellar setae 1.2–1.5 times length of ocellar setae (about same length in *A. arctica, A. nigerrima, A. nitidissima, A. pectiniventris,* and *A. penicillata,* 2–2.5 in *A. flavipes*); 2 posterior fronto-orbitals (*A. nigritellus* with 1 posterior and 1 anterior fronto-orbitals); arista with very short pubescence; base of arista yellow with rest brown (entirely black or brown in *A. arctica, A. dudai, A. nigerrima, A. pectiniventris, A. penicillata, A. setaluna, A. tomentosa, A. xanthopoda*); palpus with several short setulae, longest along ventral margin in some species (*A. arctica, A. nigerrima*). **Thorax:** Glossy black, except dull grey in *A.tomentosa,* and yellow sometimes present on postpronotum of *A. kugluktuk, A. nigritellus* and *A. variefrontis,* and yellow sometimes on proepisternum of *A..mcalpinei, A. nigritellus* and *A. vulgaris*; silvery-white microtomentum on katatergite, anatergite and metapleuron, and in most species on meron; 1 posterior postpronotal bristle, 1 presutural intra-alar, 1 supra-alar, 1 postalar, 1 intrapostalar (absent or present in *A. nigritellus*), 1 postsutural dorsocentral seta except 2 in *A. nigritellus* and *A. variefrontis*; acrostichal setulae in 9–12 rows; 1 weak proepisternal setae without additional hairs (hairs present in *A. arctica, A. nigerrima, A. setaluna*); prosternum bare except with long fine setulae in *A. setaluna*; anepisternum and anepimeron glossy and bare; katepisternum with 1–5 weak setae along dorsal margin; scutellum convex, with 2 pairs of marginal setae, and bare, sometimes with scattered hairs in *A. arctica* and *A. nigerrima* and always haired in *A. setaluna*. **Wing:** Hyaline (stigmal space, basal costal and costal cell fumose in *A. setaluna*); veins whitish/yellow except brownish/yellow in *A. arctica, A. nigerrima, A. nigritellus, A. pectiniventris, A. setaluna, A. variefrontis*; calypter black (black shading in *A. arctica* and *A. nigerrima*); fringe white (black in *A. arctica, A. nigerrima, A. setaluna*); dm-cu about 3–4 times length of crossvein r-m; length of C between Sc and R_1 2–3 times length of crossvein h (1–1.5 in *A. lonchaeoides, A. nitidissima, A. setaluna, A. vulgaris, A. xanthopoda*); length of M_1 between crossveins r-m and dm-cu 1.75–2.2 times length of dm-cu. Halter whitish/yellow (shaded black in *A. arctica, A. nigerrima, A. setaluna*). **Legs:** Legs greatly

variable within and between species. Legs partly yellow and black (i.e. *A. vulgaris*), to mostly black (i.e. *A. arctica*, *A. nigerrima*), and yellow (i.e. *A. kugluktuk*, *A. xanthopoda*). **Abdomen:** Glossy black; dull reflections present on some tergites; covered with short scattered setae (setae well developed in *A. setaluna*), slightly longer along posterior margin of sternites and tergites (setae much longer along posterio-lateral margins in *A. arctica* and *A. nigerrima*). **Male genitalia:** Sternite 6 and 7 strongly sclerotised along anterior margin; sternite 8 round and convex with several short setae; epandrium in lateral view higher than wide, anterior and ventral margin straight, posterior margin curved (epandrium more rectangular in *A. tomentosa*, and funnel shaped in *A. setaluna*); epandrium with 1 setae to a row of setae on posterior margin, remaining of surface with shorter setae; surstylus not fused with epandrium; surstylus with many short and fine setae, longest posterio-ventrally; postgonite with 1–2 lobes (in *A. nitidissima* with many short pointed projections); pregonite with 1–3 lobes; distiphallus membranous, narrow and short (longer in *A. arctica*, *A. kugluktuk*, *A. mcalpinei*); distiphallus with short and fine hairs (bare in *A. variefrontis*); cerci separated from epandrium, weakly sclerotised (well sclerotised in *A. dudai*, *A. tomentosa*) with several setae; cerci either linear, subtriangular or oval. **Female genitalia:** Sternite and tergite 7 and 8 with strong setae laterally and several shorter ones; cerci with 1–2 pairs of dorsal and ventral setae, with few small setae; 2 sclerotised spermathecae (except weakly sclerotised in *A. nigritellus* and *A. variefrontis*); spermathecae cylindrical (oval in *A. flavipes*, *A. nitidissima*, *A. pectiniventris*, *A. tomentosa*) with wrinkled surface.

Following the phylogenetic analysis, *Boreopiophila*, *Neopiophila* and *Parapiophila* are synonymised with *Arctopiophila*. *Mycetaulus nigritellus* has also been moved to *Arctopiophila* and two new species are described. *Arctopiophila* now contains 20 species: *A. arctica* (Holmgren 1883), *A. atrifrons* (Melander & Spuler 1917), *A. baechlii* (Merz 1996), *A. dudai* (Frey 1930), *A. flavipes* (Zetterstedt 1847), *A. kugluktuk* (Rochefort & Wheeler 2015), *A. lonchaeoides* (Zetterstedt 1838), *A. mcalpinei* Rochefort n.sp., *A. nigerrima* (Lundbeck 1901), *A. nigritellus* (Melander 1924), *A. nitidissima* (Melander & Spuler 1917), *A. pectiniventris* (Duda 1924), *A. penicillata* (Steyskal 1964), *A. setaluna* (McAlpine 1977), *A. tomentosa* (Frey 1930), *A. uralica* (Ozerov 2002), *A. variefrontis* Rochefort n.sp., *A. vernicosa* (Ozerov & Barták 1993), *A. vulgaris*

(Fallén 1820) and *A. xanthopoda* (Melander & Spuler 1917). Only *A. vernicosa* and *A. uralica* are not present in the Nearctic.

Arctopiophila arctica (Holmgren 1883)

(Figure 10)

Piophila arctica Holmgren 1883: 177 (type locality: USSR, Vaigatsh I, Cap Grebenii).

Arctopiophila arctica; McAlpine 1977: 1.

Allopiophila arctica; Ozerov 2004a: 606.

Piophila aterrima Becker 1897: 402 (type locality: USSR, Nova Zemlya) synonym in Hennig 1943: 37.

Material examined. 315 ♂, 322 ♀, 3? from the following Nearctic localities: **CANADA. Northwest Territories:** 20 mi East Tuktoyaktuk; 21 mi East Tuktoyaktuk; Banks Island (Aulavik National Park; Masik River); Holman; Mould Bay, Prince Patrick Island; Padley; Reindeer Depot, Mackenzie Delta; Salmita Mines. **Nunavut:** Axel Heiberg Island, Wolf River; Baffin Island (Clyde; Frobisher Bay Pond Inlet); Baker Lake; Bathurst Inlet; Bathurst Island; Bernard Harbour; Cambridge Bay; Chesterfield; Ellesmere Island (Fosheim Peninsula; Hazen Camp; Hazen Lake); Eskimo Point; few km North of Arviat; Igloolik Island; Iqaluit; Kugluktuk; Repulse Bay; Southampton Island, Coral Harbour; Spence Bay; Truelove Lowland, Devon Island; Victoria Island. **Quebec:** Payne Bay; Port Harrison; Sugluk. **Yukon Territory:** Dempster Highway (km 131; km155); Herschel Island. **UNITED STATES OF AMERICA. Alaska:** Barrow; Cape Thompson; Point Barrow; Umiat. **GREENLAND.** Nedre Midsommer Sö (CNC, DEBU, LEM, UASM, USNM) (Fig. 10).

Additional distribution information: *Arctopiophila arctica* is also present in the Palaearctic in USSR, Novaya Zemlya (McAlpine 1977) and in Vaigatsh, Cap Grebenii according to the type locality (Zuska 1984).

Notes on capture: This species has been captured in the Nearctic from June to September using Malaise, pan and carrion traps. *Arctopiophila arctica* has been found in mesic habitats, wet tundra, in fox burrows, on dung, near ponds in the tundra, in grasses, *Salix* barrens, in *Salix-Dryas,* associated with *Dryas* flowers, in garbage and in sedge meadow. It also has been collected on beef carcass and has been reared from duck carcass.

Diagnosis. It can be differentiated from other *Arctopiophila* species by having an entirely black head which is slightly higher than long, 2 lateroclinate posterior fronto-orbitals, fringe on calypter black, shaded black halters and black legs with yellow proximally on all tibiae. *Arctopiophila arctica* is closely related to *A. nigerrima.* Characters to differentiate it from *A. nigerrima* are the presence of yellow proximally on tibiae, the absence of stout setae on mid and hind femora, and sternite 8 of males glossy. **Description.** Body length 3.0–3.6 mm; wing length 3.2–3.9 mm. In McAlpine (1977), specimens have been seen measuring up to 5 mm in body length. Body entirely black except for yellow present proximally on all tibiae. **Head:** Head slightly higher than long, entirely black; silvery-white microtomentum present on gena posteriorly and on entire surface of occiput; height of eye 3.2–4.6 times genal height; palps enlarged; row of seta along ventral margin of gena; 2 lateroclinate posterior fronto-orbitals (both of equal length or upper longer than lower); postocellar setae slightly longer than vertical setae; first flagellomere large and round; arista 2–2.5 times length of first flagellomere; arista black. **Thorax:** Glossy black; proepisternum anterio-ventrally, anepimeron posteriorly, anepisternum dorsally and meron, with silvery-white microtomentum (remaining of thorax with microtomentum in some areas, especially along margins of sclerites); acrostichal setulae in 9–10 rows; 1 proepisternal seta with additional hairs; katepisternum with 2–5 setae along upper margin; scutellum either bare or with several scattered hairs. **Wing:** Veins brownish yellow; calypter white with some black shading; fringe black. Halter shaded black. **Legs:** Legs black with yellow proximally on all tibiae; all coxae with silvery-white microtomentum. **Abdomen:** Sternite and tergite with longer setae posterio-laterally. **Male genitalia:** Epandrium with 1 long seta on posterio-ventral margin, remaining of surface with shorter setae; surstylus well developed, rectangular with posterior margin rounded; surstylus with many short and fine setae, longest posterio-ventrally; postgonite weakly sclerotised, elongated and narrow (widest at base and narrowest at apex) and incurved medially at pre-apex; pregonite rectangular at base (longer than wide) with apex extended in 2 rounded lobes; pregonite folded along medial line with several setae dorsally; pregonite more sclerotised than postgonite; distiphallus membranous, narrow and long but not crossing anterior margin of sternite 4; distiphallus with very short and fine hairs; cerci weakly sclerotised and linear with 4 setae. **Female genitalia:** Cerci about 2

times as long as wide; cerci with 2 pairs of dorsal setae and 2 pairs of ventral setae, with few additional small setae; spermathecae cylindrical, asymmetric and elongated.

Arctopiophila atrifrons (Melander & Spuler1917)

(Figure 10)

Piophila atrifrons Melander & Spuler 1917: 66 (type locality: United States of America, Idaho, Troy) **new combination**.

Parapiophila atrifrons; McAlpine 1977: 48.

Allopiophila atrifrons; Ozerov 2004a: 606.

Allopiophila calceata Duda 1924: 174 (type locality: Sweden: Gellivara and Abisko) synonym in Rochefort & Wheeler 2015: 232.

Type material examined. 1 ♂ lectotype. Troy, Idaho, 14.vi.08, Paratype *Piophila atrifrons* M-S, Lectoholotype *P. atrifrons*, d. G Steyskal 1963, Lectotype *Piophila atrifrons* Melander, Spuler, 1917: 66, by Steyskal, 1964: 177, det. A Ozerov, 2002, (USNM). 2 ♀ paralectotypes. **UNITED STATES OF AMERICA. Washington:** Oroville (USNM).

Other material examined. 147 ♂, 385 ♀, 5 ? from the following Nearctic localities: **CANADA. Alberta:** 8 km West Nordegg; Banff; Banff, Johnston Canyon; Bilby; Cadomin, Base Prospect Mtn; Calgary; 20 mi West Calgary, Jumping Pd. Creek; Gleichen; Goose Lake, Northwest Fort Assiniboine; Lethbridge; Lundbreck Falls Provincial Recreational Area, 3 km West Lundbreck; Manyberries; near Fort Assiniboine; Onefour; Slave Lake; Twin Butte; Waterton; Waterton Lakes National Park. **British Columbia:** Alaska Highway (Martin Creek; Muncho Lake Provincial Park, Muncho Lake; mi 392, Summit Lake); Atlin; Bevan; Creek at Moyie River, South of Moyie Lake; Duncan; Garibaldi Provincial Park, Black Tusk; Horsefly; Horseshoe Bay; King Salmon Lake; Kleanza Creek, 14 mi East Terrace; Ladysmith; Penticton, Apex Mt; Remo, 7 mi East of Terrace; Robson; Shames, 17 mi West Terrace; Summerland; Terrace; Trinity Valley; Vancouver, Point Grey; Vancouver Island, Victoria, Lost Lake; Victoria. **Manitoba:** 10 km Southeast Churchill, Farnworth Lake (Landing Lake); Churchill; Hudson Bay Railway (mi 473, Deer River; mi 500). **New Brunswick:** Birch Cove, near Chamcook; Kouchibouguac National Park; St. Andrews. **Newfoundland and Labrador:** St. John's. **Northwest Territories:** 21 mi East Tuktoyaktuk; Aklavik; Fort Liard; Fort McPherson; Fort Smith; Muskox Lake;

Norman Wells; Padley; Reindeer Depot, Mackenzie Delta; Salmita Mines; Wrigley. **Nunavut:** Kugluktuk. **Ontario:** Algonquin Park (Fisher; Hyb.; Wildlife Research Station); Fathom Five National Park; Moosonee; Neys Provincial park; Ogoki; St. Lawrence Island National Park, Mcdonald Island; ValleyFord. **Quebec:** 23 km South Atlin, Warm Spring; Duncan Lake, near Rupert; Great Whale River; Mingan Archipelago National Park Reserve, Quarry Island; Polaris River; Saguenay (La Baie), Hameau, Saint-Louis-de-Bagot; Saguenay, Parc Monts-Valin; St. Ambroise; Schefferville, McGill Subarctic Research Station; Sherbrooke, Bishop's University Campus. **Saskatchewan:** Cypress Hills; Saskatoon. **Yukon Territory:** Alaska Highway (13.1 km West Takhini River; at M'Clintock River; Base Camp, Erebia Creek); Canyon Creek; Dawson; Dempster Highway (Eagle River Crossing; km 47, Scoutcar Creek; km 72, Tombstone Campground; km 108; km 141; km 151; km 172; km 205.5; mi 28); Erebia Creek; Gravel Lake, 58 mi East Dawson; Klondike Highway (at Emerald Lake; km 300; Meadow Creek, 24 km South Dempster Corners; South Carmacks); Klondike Loop, 33 km North Whitehorse; Kluane; La Force Lake; Mt. White above Little Atlin Lake, 5 km South Jakes Corner; Old Crow; Ross River; Snag; Swim Lakes; Takhini Hot Springs; Whitehorse; Whitehorse, Wolf Creek Campground. **UNITED STATES OF AMERICA. Alaska:** 3 mi South Tok; Alaska Highway (12 mi North Tok Jct; Anchorage; mi 1404, Sawmill Creek, 18 mi South Delta Jct; Moon Lake); Baker Creek; Big Delta; Elliot Highway mi 27.8, White Mtn. Trail; Fairbanks, mile 35; Glenn Highway, Tolsona River State Campground; King Salmon, Naknek River; Matanuska; Naptorune; Richardson Highway (mi 313; Squirrel Creek Campground); Skagway; Tanana; Unalakleet. **Arizona:** Coconino Co., Flagstaff; Portal, Southwestern Research Station; Santa Catalina Mtns. **Colorado:** Georgetown; Larimer Co., 8 mi Northwest Red Feather Lakes; Mt. Evans (Doolittle Ranch; Echo Lake); Rio Grande Co., South Fork. **Idaho:** Moscow Mt. **Montana:** Gardiner Vall.; Glacier Park, Avalanche Lake; Sheridan Co., Medicine Lake. **New Mexico:** Catron Co., 6 mi South Luna; Questa, Red River; Santa Fe Co. (14 mi Northeast Santa Fe; Santa Fe Baldy); Taos, Hondo Canyon. **Utah:** Duchesne Co., Uinta Mts., Rocky Sea Pass; Henry Mts., 24 mi South Hanksville. **Washington:** Holland; Pend Oreille Co., Sullivan Lake; ValleyFord; Wawawai. **Wyoming:** Teton Co., Grand Teton National Park (BIO, CAS, CNC, DEBU, IMQC, LEM, RBCM, UASM, UBCZ, USNM) (Fig. 10).

1 ♂, 3 ♀ from the following Palaearctic localities: **SWEDEN.** Lapland, Abisko; Muodo-Slompola (CNC).

Additional distribution information: *Arctopiophila atrifrons* is also found in Findland and Russia North (Ozerov 2004b, under *Parapiophila calceata*)

Notes on capture: This species has been captured in the Nearctic from March to October with sweep nets, and baited pan (dung, mushroom), non-baited pan, Malaise, flight intercept, Jeep, box (carrion), beef-baited and rotary traps. It has been collected on carrion (molluscs, fish, moose, pig), bones, skull and antlers. This species has also been bred on radish and reared from the soil. *Arctopiophila atrifrons* has been collected in various habitats: along roadside, on dung, in open air lavatory, tundra (spruce-fir tundra and rocky tundra), mesic, vegetation at stream, bog, on South facing grass slope, pond in both meadow and pine forest, in grasses, on *Salix*, *Splachnum luteum*, *Tetraplodon mnioides*, on alfalfa, wild cherry blossom, on flowers of *Veratium*, hemlock, on oak, *Picea glauca*, *Alnus crispa*, sedges at river edge, Aspen, pond, dwarf birch, willow, spruce, dry spruce lichen area, on *Achillea*, Spruce and Equisetus.

Diagnosis. *Arctopiophila atrifrons* can be differentiated from other species by its black head with yellow present on the antennae, and sometimes on face and palpus, and by tarsal segment 1 of fore tarsus which is white. **Description.** Body length 1.9–2.8 mm; wing length 2.2–3.1 mm. Body glossy black with yellow on antennae, sometimes on face and palpus, and on parts of legs; tibiae either entirely yellow or with black on middle portion. **Head:** Head glossy black with yellow antennae; yellow sometimes present on face and palpus; a specimen from Alaska (DEBU) has yellow on gena along eye margin and on lunule; height of eye 4.8–5.5 times genal height; 2 weak lateroreclinate posterior fronto-orbitals; flagellomere round with sometimes black shading; arista about 2.5 times length of first flagellomere. **Thorax:** Glossy black; meron with silvery-white microtomentum on at least half of surface; thoracic setae strong except for presutural intra-alar and intrapostalar setae which are weak; acrostichal setulae in 10 rows. **Wing:** As in genus description. **Legs**: Coxae black; femora black with yellow distally; tibiae yellow or with black on middle portion (in DEBU, specimens from Catron, New Mexico, USA, had a yellow fore tibia with black on ¾ of tibia, and this dorsally and extending ventrally on middle portion); fore tarsus with tarsal segment 1 white and remaining of tarsal segments black; mid and hind tarsi yellow with black sometimes on tarsal segments 4 and 5. **Abdomen:** As in

genus description. **Male genitalia:** Epandrium with 3 long setae along posterior margin and shorter setae on remaining surface; surstylus short and squared with rounded projections at dorsal and ventral posterior corners; surstylus with several short setae; postgonite with 2 elongated well sclerotised lobes, the dorsal one longer and wider than ventral one; pregonite well sclerotised with 2 rounded lobes; in some specimens pregonite with a rounded and pointed projection; distiphallus membranous and short, not crossing middle of sternite 5; distiphallus with very short hair; cerci weakly sclerotised and subtriangular; cerci with 1 long and strong setae, and 4 shorter setae. **Female genitalia:** Cerci short; cerci with 2 pairs of dorsal and 2 pairs of ventral setae and few smaller setae; spermathecae cylindrical, asymmetric and elongated.

Arctopiophila baechlii (Merz 1996)

(Figure 11)

Parapiophila baechlii Merz 1996: 350 (type locality: Switzerland, Lenzerheide), **new combination**.

Allopiophila baechlii; Ozerov 2004a: 606.

Material examined. 29 ♂, 32 ♀ from the following Nearctic localities: **CANADA. Alberta:** 8 km West Nordegg; Kananaskis, Sheep River Provincial Park. **British Columbia:** Alaska Highway mi 392, Summit Lake; Atlin; Lisadele Lake; Pete Lake. **Manitoba:** Fort Churchill. **Yukon Territory:** 1-5 km East Boundary; Base Camp, Erebia Creek; Dempster Highway (km 47, Scoutcar Creek; km 72, Tombstone Campground; km 141; km 141, Blackstone River; km 172); Klondike Highway, Meadow Creek, 24 km South Dempster Corners; Kluane; Whitehorse (Robert Service Campground; Wolf Creek Campground). **UNITED STATES OF AMERICA. Alaska:** 12 mi Summit, 86 mi ENE. Fairbanks, Highway 6; Elliot Highway mi 27.8, White Mtn. Trail. **Colorado:** Loveland Pass, West slope; Mt. Evans, Doolittle Ranch. **Wyoming:** Old Faithful Nature Trail, Yellowstone Park (CNC, DEBU, LEM, UBCZ) (Fig. 11).

2 ♂, 1 ♀ from the following Palaearctic localities: **SWEDEN.** Lapland, Abisko. **USSR.** Cherskiy (CNC, LEM).

Additional distribution information: *Arctopiophila baechlii* is also present in the Palaearctic in Switzerland (Merz 1996).

Notes on capture: This species has been captured in the Nearctic from June to August with sweep nets, and dung, pan, carrion pan, flight intercept traps, and by using fish and mushroom as bait. It has been collected in vegetation, dung, carrion, alpine meadow with *Arnica* and *Achillea*, near a creek, in the tundra, in a bog, in *Sphagnum*, on *Picea glauca*, at river, and among Spruce and *Equisetum*.

Diagnosis. This species can be differentiated by its glossy black head with yellow on face, anterior portion of fron, lower eye margin along gena, antennae and lunule, and with the gonite shape of male genitalia. **Description.** Body length 2.1–3.1 mm; wing length 2.7–3.3 mm. Body glossy black with yellow on parts of head and legs. **Head:** Glossy black with yellow on face, anterior portion of frons, lower eye margin along gena, antennae and lunule; black shading may occur on lunule and first flagellomere; height of eye 4.3–6 times genal height; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); first flagellomere round; arista about 2.5 times length of first flagellomere; arista brown, slightly paler at base. **Thorax:** Glossy black; meron with silvery-white microtomentum; thoracic setae strong except for presutural intra-alar and intrapostalar setae which are weak; acrostichal setulae in 10 rows. **Wing:** Same as genus description. **Legs:** Fore coxa yellow; mid and hind coxae black; femora black with yellow distally and proximally; tibiae yellow; fore tarsus with tarsal segment 1 partly yellow and black, and tarsal segments 2–5 black; mid and hind tarsi yellow with possible black shading on tarsal segment 3–5. **Abdomen:** Same as genus description. **Male genitalia:** Epandrium with several long setae along posterior margin and shorter setae on remaining surface; surstylus on lateral view rectangular (wider than high) with several short setae on posterior margin; postgonite long, elongated and narrow, well sclerotised proximally and slightly less distally; pregonite oval with an elongated and rectangular projection dorso-posteriorly; distiphallus membranous with small spinules; distiphallus reaches posterior margin of sternite 4; cerci weakly sclerotised, oval and with 1 strong setae and 1 shorter setae. **Female genitalia:** Cerci about 3 times as long as wide; cerci with 1 pair of dorsal and 1 pair of ventral setae, with few small setae; spermathecae short and cylindrical.

Arctopiophila dudai (Frey 1930)

(Figure 11)

Piophila (Allopiophila) dudai Frey 1930: 86 (type locality: USSR, Kandalakscha), **new combination**.

Parapiophila dudai; McAlpine 1977: 48.

Allopiophila dudai; Ozerov 2004a: 606.

Material examined. 27 ♂, 10 ♀, 1 ? from the following Nearctic localities: **CANADA. Manitoba:** 2 mi West Stockton; Ninette. **Northwest Territories:** 21mi East Tuktoyaktuk; Fort Smith; Horton River; Muskox Lake; Norman Wells; Padley; Reindeer Depot, Mackenzie Delta; Salmita Mines. **Nova Scotia:** Cape Breton Highlands National Park, Pleasant Bay. **Nunavut:** Coppermine. **Ontario:** Petawawa. **Quebec:** Gatineau Park, Harrington Lake. **Yukon Territory:** Dempster Highway mi 51; Firth River. **UNITED STATES OF AMERICA. Alaska:** Nome, Kougarok Road, mi 55 (CNC, DEBU, LEM) (Fig. 11).

Additional distribution information: *Arctopiophila dudai* is also present in the Palaearctic in Finland and Russia (North, Northwest) (Frey 1930, Ozerov 2004b).

Notes on capture: This species has been captured in the Nearctic from May to August with sweep nets and Malaise traps in mixed forest, and on Aspen and *Picea glauca*.

Diagnosis. This species is differentiated from other species by the combination of a glossy black head (in some specimen pedicel and scape yellow), legs mainly black with yellow on tibiae distally and proximally, and yellow on mid and hind tarsi, and by the shape of the male gonites.

Description. Body length 1.8–3.2 mm; wing length 2.3–3.0 mm. Body entirely black with yellow on tibia and tarsi, and in some specimens, on pedicel and scape. **Head:** Glossy black; pedicel and scape yellow in some specimens; height of eye 4–5 times genal height; gena with 2–3 setae along gena; 2 lateroclinate posterior fronto-orbitals (upper slightly stronger than lower); first flagellomere round; arista about 2.5 times length of first flagellomere; arista black. **Thorax:** Glossy black; meron and anepimeron posteriorly with silvery-white microtomentum; thoracic setae strong except for presutural intra-alar and intrapostalar setae which are weaker; 1 postsutural dorsocentral seta, but some specimens with 2 (the anterior one being weak); acrostichal setulae in 10 rows. **Wing:** Same as genus description. **Legs:** Coxae and femora black; tibiae black with yellow distally and proximally; fore tarsus black with first tarsal segment yellow proximally in some specimens; mid and hind tarsi yellow with possible black shading on tarsal segment 3–5. **Abdomen:** Same as genus description. **Male genitalia:** Epandrium with

several long setae along posterior margin and shorter setae on remaining surface; surstylus elongated, rectangular and rounded at posterior margin; posterior margin of surstylus with many long setae and several shorter setae on remaining surface; postgonite well sclerotised and developed, elongated and narrow, curved at midpoint and pointing downward at distal end; pregonite strongly sclerotised with 3 short projections; distiphallus membranous with short spinules towards apex; distiphallus short, reaching posterior margin of sternite 4; cerci sclerotised, linear, with 1 strong setae and 3–4 shorter setae. **Female genitalia:** Cerci short, with 1 pair of dorsal setae and 1 pair of ventral setae and few small setae; spermathecae short and cylindrical.

Arctopiophila flavipes (Zetterstedt 1847)

(Figure 11)

Piophila flavipes Zetterstedt 1847: 2518 (type locality: Sweden, Jemtland, "Westrogothia" and Skalstugan), **new combination**.

Parapiophila flavipes; McAlpine 1977: 48.

Allopiophila flavipes; Ozerov 2004a: 606.

Allopiophila staegeri Duda 1924: 176 (type locality: Sweden) synonym in Hennig 1943.

flaviceps, error.

Material examined. 22 ♂, 203 ♀ from the following Nearctic localities: **CANADA. British Columbia:** Robson. **Newfoundland and Labrador:** Labrador, Pinware River Provincial Park. **Northwest Territories:** Reindeer Depot, Mackenzie Delta. **Ontario:** Algonquin Park (Scott Lake; Wildlife Research Station). **Quebec:** Great Whale River; Parc du Mont Tremblant; Ste-Anne-de-Bellevue, Stoneycroft Pond. **Yukon Territory:** Dawson; Dempster Highway (km 141, Blackstone Rim; km 416); Klondike Highway (km 562, Moose Creek Campground; Meadow Creek, 24 km South Dempster Corners); Old Crow; Swim Lakes. **UNITED STATES OF AMERICA. Alaska:** Alaska Highway mi 1404, Sawmill Creek, 18 mi South Delta Jct; Elliot Highway mi 27.8, White Mtn. Trail. **California:** Plumas Co., Gold Lake Camp (CNC, DEBU, LEM, ORUM, UBCZ, USNM) (Fig. 11).

Additional distribution information: *Arctopiophila flavipes* is also found in the Palaearctic in Sweden, Scandinavia and Finland (McAlpine 1977, Kahanpää & Winqvist 2014).

Notes on capture: This species has been captured from May to September using beef baited, Malaise, carrion (box, flight intercept flight with carrion), pan and dung traps. This species is also present on carrion (moose, fish, grouse) and moose antler.

Diagnosis. *Arctopiophila flavipes* is differentiated from other species with its weak ocellar setae and fifth tarsomere of fore tarsus yellow (remaining of tarsus black). **Description.** Body length 1.9–2.7 mm; wing length 2.5–2.8 mm. Head glossy black, with yellow on antennae, face, lunule and palps in some specimens; thorax and abdomen black; legs variable. **Head:** Glossy black; in some specimens, antennae, face, lunule and palps may be yellow; height of eye 5–5.3 times genal height; 2 lateroclinate posterior fronto-orbitals (similar in length); ocellar setae weak; inner vertical setae shorter than outer vertical setae; postocellar setae 2–2.5 times length of ocellar setae; first flagellomere round; arista about 2 times length of first flagellomere. **Thorax:** Glossy black; thoracic setae strong except for postpronotal, presutural intra-alar and intrapostalar setae which are weaker; acrostichal setulae in 12 rows. **Wing:** Same as genus description. **Legs:** Fore coxa yellow to black; mid and hind coxae black; femora yellow to black; tibiae yellow; fore tarsus black except for yellow tarsal segment 5 (in some specimens fore tarsus with tarsal segment 1 partly yellow proximally); mid and hind tarsi entirely yellow; many female specimens from British Columbia (UBCZ) have been seen with entirely yellow legs (excluding the coxae). **Abdomen:** Same as genus description. **Male genitalia:** Sternites short and wide (sternite 5, 5.5 times as wide as high); epandrium with several short setae; surstylus elongated (about same length as postgonite), widest at base and narrowest at distal end, with rounded apex (almost linear); surstylus weakly sclerotised and with several setae along lateral margin; postgonite well sclerotised; postgonite on dorsal view elongated with 2 pointed projections pointing towards the exterior (at about 90°) (the distal most projection being the longest); pregonite with a rounded base and a longer rectangular projection dorsally with rounded edges at apex; pregonite less sclerotised than postgonite; distiphallus membranous, short, narrow (widest at distal end), with very short and fine hairs; cerci weakly sclerotised, oval, with 2 long setae and several shorter ones. **Female genitalia:** Cerci about 4 times as long as wide; cerci with 2 pairs of dorsal setae and 1 pair of ventral setae, and few small setae; spermathecae oval with slightly wrinkled surface.

Arctopiophila kugluktuk (Rochefort & Wheeler 2015)

(Figure 12)

Parapiophila kugluktuk Rochefort & Wheeler 2015: 233 (type locality: Canada, Nunavut, Kugluktuk), **new combination**.

This species has recently been described by Rochefort and Wheeler (2015). The description is accurate except the distiphallus is not bare but has very fine hairs especially towards base. Also, some additional specimens have been seen with brown not only on fore femur, but also on the hind femur, and another with brown slightly on ventral distal end of mid femur.

Additonal Material examined. 30 ♂, 39 ♀, 1 ? from the following Nearctic localities: **CANADA. Alberta:** Banff National Park (2 km North from Johnston Lake wetland; Baker Creek); near Fort Assiniboine. **British Columbia:** Alaska Highway, waterfall at Peterson Creek #4; Robson. **Manitoba:** 10 km Southeast Churchill, Farnworth Lake; 11 km South Churchill, Goose Creek road; 12 km ESE Churchill, Launch Road; Churchill. **Newfoundland and Labrador:** Torngat Mountains National Park, Torngat Base Camp. **Northwest Territories:** Granet Lake. **Yukon Territory:** Blow River; Dempster Highway, km 128; Kluane; Old Crow. **UNITED STATES OF AMERICA. Alaska:** Matanuska; Tanana (BIO, CAS, CNC, LEM, UASM, UBCZ, USNM) (Fig. 12, includes localities in Rochefort & Wheeler 2015).

Notes on capture: From specimens in various collections (including specimens from Rochefort & Wheeler 2015), *A. kugluktuk* has been captured from May to September in Malaise (non baited and baited with dung), pan and flight intercept traps. It has been collected in forest (Aspen, *Pinus contorta* var. *latifolia, Salix*, *Betula*, Alder-Poplar-Spruce, *Picea-Betula*) in Sneezeweed, on dung, on snowfield, near a pond, in mesic, aspen, bog, and in the tundra.

Arctopiophila lonchaeoides (Zetterstedt)

(Figure 12)

Piophila lonchaeoides Zetterstedt 1838: 773 (type locality: Sweden, "In alpibus Dalekarlicis"), **new combination**.

Parapiophila lonchaeoides; McAlpine 1977: 48.

Allopiophila lonchaeoides; Ozerov 2004a: 606.

Material examined. 4 ♂, 12 ♀ from the following Nearctic localities: **CANADA. Manitoba:** 11 km South Churchill, Goose Creek; 23 km East Churchill, Ramsay Creek. **Northwest Territories:** Salmita Mines. **Quebec:** Payne Bay. **Yukon Territory:** British Mtns; Dempster Highway (km155; mi 87) (BIO, CNC) (Fig. 12).

Additional distribution notes: *Arctopiophila lonchaeoides* is also known from the Palaearctic in Finland, Norway and Sweden (McAlpine 1977, Ozerov 2004b, Greve 2005).

Notes on capture: This species has been captured from June to August. It has been captured using a Malaise trap in Sneezeweed.

Diagnosis. This species differ from other *Arctopiophila* by its body size (only *A. nigerrima* can get as large, however, *A. nigerrima* has many small specimens), by the first flagellomere which is round and enlarged, and by the male genitalia. **Description.** Body length 3.4–4.8 mm; wing length 3.7–4.6 mm. Body glossy black with yellow on frons, lunule, face, palps, antennae and gena, and parts of legs. **Head:** Glossy black with yellow on part of anterior fron (sometimes entirely brown or black), lunule, face, palps, antennae, anterior margin of eyes and part of gena below lower eye margin; height of eye 2.5–3 times genal height; 2 lateroclinate posterior fronto-orbitals (usually with upper stronger than lower, but in some specimens both orbitals are of equal length); first flagellomere round and enlarged, sometimes shaded black along dorsal margin; arista about 2 times length of first flagellomere. **Thorax:** Glossy black; thoracic setae all strong; acrostichal setulae in 12 rows; katepisternum with 1–2 setae along upper margin. **Wing:** Length of C between SC and R_1 1.5 times length of crossvein h. **Legs:** Coxae varies from entirely yellow to black; femora entirely black in darker specimens; in paler specimens: fore femur black with yellow proximally and yellow distally, mid and hind femora yellow (sometimes with small dark spot distally); tibia of both dark and pale specimens vary from entirely black to yellow; fore tarsus black; mid and hind tarsi yellow with black tarsal segment 3–5; several specimens were seen with entire tarsi black. **Abdomen:** Same as genus description. **Male genitalia:** Sternite 5 incurved medially at posterior margin; epandrium with 5 long setae along posterior margin; surstylus developed, rectangular with rounded edges and with many long setae along posterior margin; postgonite with two well-developed elongated narrow projections (with rounded apex), one projection directed dorsally (strongly sclerotised) and one directed ventrally (only strongly sclerotised on distal half); pregonite subtriangular and elongated, and well sclerotised on distal

half; distiphallus with short hairs, stronger towards base; distiphallus short, reaching sternite 5 at posterior margin; cerci weakly sclerotised, oval and with 1 strong setae and 5 smaller ones. **Female genitalia:** Cerci short, with 2 pairs of dorsal setae and 1 pair of ventral setae and few additional small setae; spermathecae cylindrical and elongated.

Arctopiophila mcalpinei Rochefort n. sp.

(Figures 13, 14)

Holotype ♂. YT: km 44.8 Dempster Hwy., FIT, along stream (boreal), 17.vi-13.vii.1987, S. Marshall, Det: R. Bonduriansky (DEBU) (Fig. 13).

Diagnosis. *Arctopiophila mcalpinei* is very similar to *A. kugluktuk* but differs in it has yellow on proepisternum, no yellow present on abdomen and differs in male genitalia. **Description.** Body 2.9 mm; wing 2.5 mm. **Head:** Head as long as high, yellow with black ocellar triangle, posterior fronto-orbital plate and occiput; height of eye 3 times genal height; 2 fronto-orbitals (upper no more than twice as long as lower), postocellar setae 1.3 times length of vertical setae; first flagellomere round, yellow with black shading; arista about 2 times length of first flagellomere. **Thorax:** Glossy black with yellow on proepisternum; meron with silvery-white microtomentum; acrostichal setulae in 10 rows; katepisternum with 2 setae along upper margin. **Wing:** Same as genus description. **Legs:** Coxae yellow; femora yellow with brown distally; fore and hind tibia brown with yellow proximally, mid tibia yellow; tarsi brown. **Abdomen:** Same as genus description. **Male genitalia** (Fig. 14): Epandrium with row of long setae along posterior margin and several shorter setae along remaining surface; surstylus slightly wider than high with several short setae dorsally; postgonite narrow and elongated (longer and much narrower than in *A. kugluktuk*); pregonite rounded with a well sclerotised dorsal margin which is elongated into a short rounded lobe; distiphallus membranous, narrow, reaching anterior margin of sternite 4; distiphallus with short hairs, especially towards base; cerci oval with 3 outstanding setae and several shorter ones. **Female:** unknown.

Etymology: This species is named after J. F. McAlpine to recognise his immense contribution to the taxonomy and classification of worldwide Piophilidae species. His extensive research has had great implications for my phylogenetic and systematic studies on this family.

Arctopiophila nigerrima (Lundbeck 1901)

(Figure 13)

Piophila nigerrima Lundbeck 1901: 301 (type locality: Greenland).

Allopiophila nigerrima; Ozerov 2004a: 606.

Material examined. 16 ♂, 12 ♀ from the following Nearctic localities: **CANADA. Northwest Territories:** Victoria Island; Victoria Island, Holman. **Nunavut:** Baffin Island, Pond Inlet; Ellesmere Island, (Alert; Hazen Camp; Hazen Lake); Resolute Bay; Southampton Island, Coral Harbour; Spence Bay (CNC, DEBU, USNM) (Fig. 13).

Additional distribution information: *Arctopiophila nigerrima* is also present in Greenland in the Nearctic (McAlpine 1977).

Notes on capture: This species was captured from June to August.

Diagnosis. This species is very close to *Arctopiophila arctica* and can be differentiated by its entirely glossy black body, enlarged palps, row of short and stout setae present ventrally at proximal end on mid and hind femora, and silvery-white microtomentum on sternite 8 of males (as in *A. tomentosa*). **Description.** Body length 2.7–5.0 mm; Wing length 2.9–5.3 mm. McAlpine (1977) has examined specimens measuring up to 7 mm. Body entirely black. **Head:** Head slightly higher than long, entirely black; silvery-white microtomentum posteriorly on gena and on entire occiput; height of eye about 2.5–3.3 times genal height; palps enlarged; row of seta along ventral margin of gena; 2 lateroclinate posterior fronto-orbitals (both of equal length or upper longer than lower); postocellar setae slightly longer than vertical setae; first flagellomere large and round; arista 2–2.5 times length of first flagellomere; arista black. **Thorax:** Glossy black; proepisternum anterio-ventrally, anepimeron posteriorly, anepisternum dorsally and meron with silvery-white microtomentum, remaining of thorax with microtomentum in some areas, especially along margins of sclerites; acrostichal setulae in 10 rows; 1 proepisternal seta with additional hairs; katepisternum with 2–5 setae along upper margin; scutellum either bare or with several scattered hairs. **Wing:** Veins brown (in some specimens can be yellowish-brown); calypter white (with some black shading); fringe black. Halter shaded black. **Legs:** Legs entirely black; silvery-white microtomentum on coxae; mid and hind femora of male with row of short but stout setae ventrally at proximal end; claws black (some specimens with pale brown proximally). **Abdomen:** Sternite and tergite with longer setae posterio-laterally. **Male genitalia:**

Sternite 3–5 medially depressed and less sclerotised; sternite 5 divided into 2 convex bumps; sternite 7 with a folded oval projection; sternite 8 with silvery-white microtomentum; epandrium with 1 long seta on posterio-ventral margin; surstylus well developed, boot-shaped on lateral view with base of "boot" situated posteriorly; surstylus with several long setae at middle of posterior margin and several short setae posterio-dorsally; postgonite elongated and narrow, widest at base, and narrowest at apex (as in *A. arctica*); postgonite weakly sclerotised and incurves medially at pre-apex (as in *A. arctica*); postgonite as in *A. arctica* except has long setae present on ventral margin; pregonite rectangular at base (longer than wide) with apex extended in 2 rounded lobes; pregonite folded along medial line; pregonite with several setae dorsally and more sclerotised than postgonite; distiphallus membranous and short; distiphallus with very short and fine hairs; cerci weakly sclerotised, hard to distinguish shape, but with many setae. **Female genitalia:** Sternites medially depressed and less sclerotised, dividing each sternite in 2 convex bumps; hypoproct linear and strongly sclerotised in this species; hypoproct fused with cerci, projecting behind sternite 8; cerci large at base and narrow at apex (width of cerci at base 2 times width at apex); cerci with 2 pairs of dorsal and 2 pairs of ventral setae, with few small setae; spermathecae cylindrical, asymmetric and elongated.

Arctopiophila nigritellus (Melander 1924)

(Figure 15)

Mycetaulus nigritellus Melander 1924: 79 (type locality: United States of America, Idaho, Priest Lake, Lookout Mt.), **new combination**.

Type material examined. 1 ♂ holotype. Priest L., ID, Lookout Mt., 20.viii.1919, A.L. Melander, Type *Mycetaulus nigritellus* Mel, A.L. Melander Collection 1961, Holotype, *Mycetaulus nigritellus* Melander 1924: 79, det. A. Ozerov 2002, (USNM). 7 ♂, 6 ♀ Paratypes. **UNITED STATES OF AMERICA. Idaho:** Moscow Mt; Priest Lake. **Montana:** Lake McDonald, Glacier Park. **Washington:** Mt. Spokane (USNM).

Other material examined. 70 ♂, 72 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff ; Banff, Sulfur Mt; Banff National Park (Baker Creek hydro trail mature forest; 2 km North from Johnston Lake wetland); Jasper National Park (Bald Hills; Highway 16/93A jct.); Kananaskis, Country Sheep River Provincial Park; Kananaskis Field Station; Laggan;

Powderface Ridge; Waterton Lakes National Park (Akamina Parkway; Cameron Lake Road; Foothills parkland region; Highway 6 pulloff East of 2 Flags Lookout montane forest). **British Columbia:** Brillian; Cathedral Provincial Park, Quiniscoe Lake; Glacier National Park; Ilgachuz Mtns., Pan Creek; Penticton, Apex Mt. **Northwest Territories:** Horton River. **Yukon Territory:** 1 km North Carcross, Carcross Desert. **UNITED STATES OF AMERICA. Alaska:** Richardson Highway, Squirrel Creek Campground. **California:** Donner Summit; Madera Co., Southeast slope of Green Mt; Modoc Co., Cedar Pass Campground; Nevada Co. (Carpenter Ridge; Donner Summit); Sagehen Creek Field Station; Siskiyou Co., Poker Flat. **Colorado:** Boulder Co., Corona Pass; Chaffe Co., Garfield on South Arkansas River; Clear Creek Co., West Chicago Creek; 2 mi Northwest Eldora; Gilpin Co., 3 mi West of Rollinsville; Gould; Hoosier Pass; Loveland Pass; Mt. Evans (Doolittle Ranch; Echo Lake); Nederland, Science Lodge. **Idaho:** Blaine Co., Galena; Custer Co., 25 mi West of Stanley; Moscow Mt; Waha. **Montana:** Deer Lodge Co., 2.8 km from Highway 1, on Storm Lake Road. **New Mexico:** Santa Fe Co., 14 mi Northeast Santa Fe. **Oregon:** Joseph. **Utah:** Beaver Creek, Logan Canyon; Big Brush Creek, 22 mi North of Vernal; Duchesne Co., Mirror Lake; Wasatch Mts. **Wyoming:** Big Horn Mts., 34 mi East Lovell; East side Teton Pass; Sierra Madre Range, Battle Lake Road (BIO, CAS, CNC, DEBU, LEM, RBCM, UBCZ, USNM) (Fig. 15).

Notes on capture: This species has been captured from June to October using sweep nets, and Malaise and pan traps. It has been found in forest (lodgepole pine, fir, aspen, birch, poplar), dry subalpine forest, alpine, meadow as well as along a creek, river and stream.

Diagnosis. This species is differentiated by its mainly yellow head with black on parts of frons, ocellar triangle and occiput, with the presence of 1 posterior and 1 reclinate fronto-orbital seta, 2 postsutural dorsocentral setae, and prescutum and scutum usually partly greyish microtomentum.

Description. Body length 2.2–3.4 mm; wing length 2.4–3.2 mm. Head mainly yellow with black on occiput, fronto-orbital plate and ocellar triangle. Thorax and abdomen glossy black. In some specimens, the postpronotum has dull sections and varies from yellow to black; legs black and yellow, varying in proportions. **Head:** Head as high as long, yellow but black on posterior fronto-orbital plate, ocellar triangle and part of occiput; eyes oval (1.2 times wider than high); height of eye 4–4.3 times genal height; 1–2 setae along gena; 1 strong reclinate posterior fronto-orbital and 1 weak reclinate anterior fronto-orbital seta; inner and outer vertical setae usually of

equal length, but in some specimens, the inner is 1.2 times longer than the outer; postocellar 1.2 times longer than inner vertical and ocellar setae; first flagellomere round, with black shading on apical tip to entire surface in some specimens; arista about 3 times length of first flagellomere. **Thorax:** Glossy black, with either a yellow or black postpronotum; anterior margin of prescutellar to presutural intra-alar and anterior postsutural dorsocentral setae with usually greyish microtometum; 1/3 of meron dull black; 2 postsutural dorsocentral setae; intrapostalar seta absent or present, if present varies from weak to strong; acrostichal setulae in 9–10 rows; scutum with short hairs present between dorsocentral rows but not exceeding posterior dorsocentral setae; katepisternum with 2–3 setae on upper margin. **Wing:** Veins brown. **Legs:** Coxae yellow; fore and hind femora yellow with black distal end; mid femur and tibia entirely yellow or with black at distal end; fore tibia mainly black with yellow at proximal end; mid and hind tibiae yellow; fore tarsus with black tarsal segment 1, remaining either yellow or black; mid and hind tarsi yellow (some specimens with black tarsal segment 4 and 5). **Abdomen:** Tergites and sternites with a line of setae along posterior margin, setae stronger on segments 4 and 5. **Male genitalia:** Epandrium with a row of 6–7 short setae along posterior margin and with several setulae behind these; surstylus rectangular, longer than wide, and setulose; postgonite small, with one pointed lobe, curved downwards from mid section to distal point; pregonite strongly sclerotised along margins; pregonite bilobe, upper lobe squared with small projections at dorsal apex, lower lobe rounded with small projection at midpoint on dorsal margin; distiphallus membranous, bare and short (length varies between specimens); cerci small, oval and slightly setulose. **Female genitalia:** Cerci about 3–3.5 times longer than wide, with 2 pairs of setae ventrally, 1 pair dorsally and several additional setulae; spermathecae weakly sclerotised, hard to distinguish.

Arctopiophila nitidissima (Melander & Spuler)

(Figure 15)

Piophila nitidissima Melander & Spuler 1917: 66 (type locality: United States of America, Idaho, Coeur d'Alene), **new combination**.

Parapiophila nitidissima; McAlpine 1977: 48.

Allopiophila nitidissima; Ozerov 2004a: 606.

Type material examined. 1 ♂ lectotype. Coeur d'Alene, Ida. 24.viii.1916, A.L. Melander, Paratype, *Piophila nitidissima* M.-S., A.L. Melander Collection 1961, Lectotype, *Piophila nitidissima*, M.-S., Steyskal 1974, (USNM). 1 ♂, 6 ♀ paralectotypes. **UNITED STATES OF AMERICA. California:** Yosemite. **Idaho:** Coeur d'Alene; Moores Lake; Moscow Mt. (USNM).

Other material examined. 109 ♂, 228 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff; Banff, Sulfur Mt; Lake Louise; Pincher Creek; Waterton National Park, Cameron Lake Road. **British Columbia:** Hazelton; Manning Park, Pinewoods; Oliver; Robson; Top of Moyie Mtn., East Kootenays. **UNITED STATES OF AMERICA. Alaska:** Healy; Fort Yukon; Livengood. **Arizona:** Coconino Co., Flagstaff. **California:** Echo Lake; Eldorado Co., Echo Portals; Fallen Leaf, Lake Tahoe; Lassen Co. (Caribou Lake; South end Eagle Lake); Manzanita; Modoc Co., Cedar Pass Campground; Mono Co. (Tioga Pass; Twin Lakes, Southwest of Mammoth Lakes; White Mts., 3 mi North of Inyo Co., near Naval Research Station, North fork of Crooked Creek); Mono Lake; Nevada Co., Truckee River, 4.5 mi East of Truckee Highway 40; Plumas Co., Gold Lake Camp; Sierra Co., Gold Lake; Trinity Co., French Cove; Truckee; Tuolumne Co., Pinecrest. **Colorado:** 36 km West Fort Collins; Cameron Pass; Gothic; Longs Peak Inn; Loveland Pass; Mt. Evans (Doolittle Ranch; Echo Lake). **Idaho:** Blaine Co., Galena Summit; Moscow Mt; Potlatch; Yale. **Montana:** Cold creek; Gardiner; Mackenzie River. **Nevada:** 12 mi Southwest Wells, Angel Lake. **Oregon:** Crater Lake National Park; Wallowa Mts. **Utah:** Allen Canyon, Beaver Creek, Logan Canyon; Cache National Forest, Wasatch Mtns; Fish Lake; Guardsman Pass near Brighton; Henry Mts., 24 mi South Hanksville; Soldier Summit; Summit Co., Henrys Fork Camp; Uinta Mts., Hole In Rock.**Washington:** Kettle Falls; Lake Chelan, Lucerne; Mt. Rainier, Paradise Park; Mt. Spokane; Valleyford. **Wyoming:** Jackson Lake; Park Co., Pahaska Tepee; Sublette Co., 5 mi North Bondurant; Teton Co. (Moran Jct; Togwotee Pass); Teton Pass; Unita Co. (8 mi Seast Evanston; Lonetree); Yellowstone Lake; Yellowstone Park (Canyon camp; Firehole River; Madison River; Old Faithful; Old Faithful Nature Trail; Riverside) (CAS, CNC, DEBU, UBCZ, USNM) (Fig. 15).

Additional distribution information: *Arctopiophila nitidissima* is also known from Washington, Pullman in the Nearctic (Melander & Spuler 1917).

Notes on capture: This species has been captured from May to October. It has been captured with Malaise (non-baited and with carrion) and flight traps. It has been collected near carrion in sage-grass pines, sage steppe, riparian sage-grass zone and sage-brush. It has also been collected in pond pine meadow, along grassy lakeshore, dry hillside, along marshy lake and stream margin, at stream with pine-aspen and willows, and on *Arceuthobium cyanocarpum* and *Pseudotsuga axifolia*.

Diagnosis. *Arctopiophila nitidissima* differ with a glossy black head with yellow on anterior portion of frons, antennae, face, parts of gena, and by characters of male genitalia: oval epandrium, surstylus boot-shaped in lateral view, postgonite S shaped and pregonite C shaped.

Description. Body length 2.1-2.4 mm; wing length 2.3-3.4 mm. In the species description, in Melander and Spuler (1917), specimens with 3 mm body length have been observed. Head black with yellow on anterior frons, antennae, face, part of gena (some specimens with yellow only on antennae and face), thorax and abdomen black, and legs partly yellow and black. **Head:** Glossy black with yellow on anterior frons above lunule, antennae, face, part of gena along lower margin of eyes; some specimens have been seen with only yellow on antennae and face; palps black with sometimes small yellow sections; height of eye 4.4–5 times genal height; 2 lateroclinate posterior fronto-orbitals of equal length; postocellar setae slightly longer than ocellar setae; first flagellomere round with black shading; arista about 2.5 times length of first flagellomere. **Thorax:** Glossy black; metapleuron sometimes with silvery-white microtomentum; thoracic setae strong; acrostichal setulae in 10 rows. **Wing:** Length of C between Sc and R_1 at costa 1–1.5 times length of crossvein h. **Legs:** Coxae black; fore femur black with yellow distally; mid and hind femora yellow; tibiae yellow; fore tarsus black except tarsal segment 1 which can be slightly to completely yellow; mid and hind tarsi yellow with sometimes tarsal segment 4 and 5 shaded black. **Abdomen:** Sternite and tergite with 1 strong setae on posterio-lateral margin. **Male genitalia:** Epandrium in lateral view large and oval; epandrium with row of stronger setae along posterior and ventral margin; surstylus well-developed, boot-shape in lateral view with posterior margin at base of boot and with short setae on posterior margin; postgonite long and narrow forming an upside-down S, at tip with several short pointed projections; pregonite C shaped (turned 270°), widest proximally and narrowest and pointed distally; pregonite strongly sclerotised, postgonite less sclerotised; distiphallus

membranous, short, with short hairs strongest dorsally from midpoint to preapex; distiphallus narrow, widest at distal end which is asymmetrical; distiphallus with line of orange blunt from base to midpoint; cerci weakly sclerotised, large, subtriangular and with many long and short setae. **Female genitalia:** Cerci about 3 times as long as wide; cerci with 2 pairs of dorsal and 1 pair of ventral setae, with few small setae; spermathecae oval.

Arctopiophila pectiniventris (Duda 1924)

(Figure 16)

Piophila pectiniventris Duda 1924: 172 (type localities: Germany, Ilfeld and Crimderode), **new combination**.

Parapiophila pectiniventris; McAlpine 1977: 48.

Allopiophila pectiniventris; Ozerov 2004a: 606.

Material examined. 12 ♂, 43 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff National Park (Corral Creek; Storm Mountain); Elk Island National Park; Jasper National Park; Jasper National Park, Highway 16, Athabasca River wetland; Waterton Lakes National Park. **Manitoba:** Twin Lakes, 22 km Southeast Churchill. **Newfoundland and Labrador:** Gros Morne National Park, James Callaghan Trail. **Ontario:** Algonquin Provincial Park. **Yukon Territory:** Base Camp, Erebia Creek; Dempster Highway (km 44.8; km 141; km 151; km 161; km172; km 165, Sulfur Spring (Engineer creek); near North Fork Pass); Klondike Highway, Meadow Creek, 24 km South Dempster Corners; Old Crow; Richardson Mts., Erebia Creek. **UNITED STATES OF AMERICA. Alaska:** Alaska Highway, 12 mi North Tok; Nome, Kougarok Road mi 55; Umiat (BIO, CNC, DEBU, LEM, UBCZ) (Fig. 16).

1 ♂, 1 ♀ from the following Palaearctic locality: **SWEDEN.** Lapland, Abisko (CNC).

Additional distribution information: *Arctopiophila pectiniventris* is also known from other Palaearctic regions: Czech Republic, Finland, Germany, Russia Northwest, Switzerland (Zuska & Laštovka 1965, McAlpine 1977, Merz 1996, Ozerov 2004b).

Notes on capture: This species has been captured in the Nearctic from May to July. It has been captured with Malaise, flight intercept, baited pan (mushroom, fish, dung), non-baited pan and carrion traps. It has been collected in low alpine dry slope, emergent white birch/willow/trembling aspen forest, in fir/lodgepole pine stand with aspen/birch understory, in

subalpine conifer forest in mountain valley, in mature conifer stand with balsam fir, in the tundra, along a stream in the boreal, on dung, on carrion, limestone scree, bog and mesic. **Diagnosis.** *Arctopiophila pectiniventris* has a completly black body with small portion of yellow on legs (distally and proximally on tibiae, parts of tarsi) and in some specimens on pedicel of antennae. It is very close to *A. dudai* and *A. penicillata* but differs with the presence of cluster of setae in middle of sternite 3, 4 and 5, close to posterior margin. **Description.** Body length 2.4–2.7 mm; wing length 2.7–3.2 mm. Head glossy black with yellow on pedicel in some specimens; thorax and abdomen black; legs mainly black with yellow on parts of tibia and tarsi. **Head:** Head black, pedicel yellow in some specimens; height of eye 3.5–3.9 times genal height; 4–5 short setae along gena; 2 lateroreclinate posterior fronto-orbitals (upper no more than twice as long as lower); postocellar setae slightly longer than ocellar setae; first flagellomere round; arista about 2 times length of first flagellomere; arista brown. **Thorax:** Glossy black; proepisternum, meron and anepimeron posteriorly with silvery-white microtomentum; thoracic setae strong except for presutural intra-alar which is sometimes weak; acrostichal setulae in 11 rows. **Wing:** Veins brownish yellow. **Legs:** Coxae and femora black; coxae with possible silvery-white microtomentum; tibiae black with yellow distally and proximally; fore tarsus black, with sometimes some yellow on tarsal segment 1; mid and hind tarsi black with tarsal segment 1 yellow and tarsal segment 2 either yellow or partly black. **Abdomen:** Same as genus description. **Male genitalia:** Cluster of setae in middle of sternite 3, 4 and 5, close to posterior margin; epandrium with row of long setae along posterior margin and several shorter setae along remaining surface; surstylus well-developed, slightly folded medially, rectangular (longer than wide) with rounded apex; surstylus with many setae posteriorly; postgonite well sclerotised, triangular with pointed apex, curved upwards (dorsally); pregonite well sclerotised, elongated and narrow, widest at base and narrowest at distal end; pregonite slightly curved inwards (toward centre of body); distiphallus membranous, narrow, short (not reaching sternite 4); distiphallus with hairs up to distal end where spinules; cerci oval but slightly asymmetrical, with 2–3 long setae and several short ones. **Female genitalia:** Cerci 4–5 times as long as wide; cerci with 2 pairs of dorsal setae and 1 pair of ventral setae, with few small setae; spermathecae elongated and oval.

Arctopiophila penicillata (Steyskal 1964)

(Figure 16)

Piophila (Allopiophila) penicillata Steyskal 1964: 178 (type locality: Canada, Northwest Territories, Aklavik), **new combination**.

Parapiophila penicillata; McAlpine 1977: 48.

Allopiophila penicillata; Ozerov 2004a: 606.

penicullata error in Ozerov 2004a: 606.

Type material examined. 1 ♂ holotype. Aklavik N.W.T., 8.vii.1931, Bryant Lot 245, Holotype *Piophila penicillata* Steyskal, 66858, (USNM). 1 ♀ allotype. **CANADA. Northwest Territories:** Aklavik, 8.vii.1931, Bryant, Lot 245, (USNM). 9 ♂, 17 ♀ paratypes. **CANADA. Alberta:** Calgary; Edmonton. **Northwest Territories:** Aklavik (USNM).

Other material examined. 135 ♂, 190 ♀, 3 ? from the following Nearctic localities: **CANADA. Alberta:** Banff; Grimshaw; Onefour. **British Columbia:** 15 mi Northwest Beaton River; Alaska Highway (281.6 km, Buckinghorse Provincial Campground; mi 392, Summit Lake; Muncho Lake Provincial Park, Muncho Lake); Atlin; Craigellachie, "The Last Spike"; Cranbrook; Robson; Trinity Valley; Tupper. **Manitoba:** Churchill; Fort Churchill; Hudson Bay Railway mi 504-505. **Newfoundland and Labrador:** Cartwright; Goose Bay; Hebron; Tallik Bay, Nagvak Fjord. **Northwest Territory:** 3 mi Southeast Fort Simpson; 21 mi East Tuktoyaktuk; Aklavik; Ford Lake; Fort Liard; Fort McPherson; Fort Smith; Muskox Lake; Norman Wells; Padley; Reindeer Depot, Mackenzie Delta; Salmita Mines; Sawmill Bay; Wholdaia Lake; Yellowknife. **Nunavut:** Bathurst Inlet. **Ontario:** LowBush, Lake Abitibi; Maynooth; Moose Factory. **Quebec:** Fort Chimo; Great Whale River; Indian House Lake; Payne Bay. **Saskatchewan:** Saskatoon; Uranium City. **Yukon Territory:** Alaska Highway (Koidern River; Morley River Territorial Campground); Base Camp, Erebia Creek; Dempster Highway (km 141; km 141, Blackstone River; km 155); La Force Lake; North Fork Crossing, mi 42 Peel Plt. Road; Old Crow; Rampart House; Sheldon Lake; Swim Lakes; Whitehorse, Wolf Creek Campground. **UNITED STATES OF AMERICA. Alaska:** Anchorage; Fairbanks; Matanuska; Richardson Highway (km 206; mi 206, Isabel Pass); Umiat. **Colorado:** Mt. Evans, Doolittle Ranch (CAS, CNC, DEBU, UBCZ, USNM) (Fig. 16).

Notes on capture: This species has been captured from May to August with sweep nets, and dung, carrion, Malaise, rotary and flight intercept traps. It has been collected on wild cherry blossom, on vegetation, meat, *Picea glauca, Picea-Larix* forest, on *Sphagnum*, Spruce-*Equistum*, along a creek, on carrion at a cliff in the tundra, on shale and on a dry slope above a beaver pond. **Diagnosis.** *Arctopiophila penicillata* has a glossy black head with sometimes yellow on antennae and part of face. It is much similar to *A. dudai* and *A. pectiniventris* and can be differentiated by the cluster of setae on middle of sternite 5 posteriorly. Sternite 3 and 4 has also long setae in middle but is not regrouped into a cluster as in *A. pectiniventris*; it is more divided. **Description.** Body length 2.3–3.1 mm; wing length 2.8–3.4 mm. Head usually black (yellow sometimes on antennae and parts of face); thorax and abdomen black; legs black with usually yellow tibia, and parts of yellow on femora and tarsi. **Head:** Head black, in some specimens antennae and face partly yellow; height of eye 3–3.3 times genal height; 5 short setae along gena; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); postocellar setae slightly longer than ocellar setae; first flagellomere round; arista pubescent; arista about 2 times length of first flagellomere; arista brown. **Thorax:** Glossy black; proepisternum, meron and anepimeron posteriorly with silvery-white microtomentum; thoracic setae all strong; acrostichal setulae in 11 rows. **Wing:** Same as genus description. **Legs:** Coxae black and with possible silvery-white microtomentum; femora black with yellow distally; tibiae yellow, black may be present on middle section; fore tarsus black with tarsal segment 1 entirely yellow or with some black; mid and hind tarsi yellow with tarsal segment 4 and 5 shaded black. **Abdomen:** Same as genus description. **Male genitalia:** Cluster of setae at middle of sternite 5 posteriorly, sternite 3 and 4 with long setae in middle but not regrouped into a cluster, more divided; epandrium with 2 rows of long setae posteriorly; surstylus elongated, rectangular and with many setae towards dorsal posterior end; postgonite long but shorter than pregonite, rectangular with pointed apex which is incurved posteriorly; pregonite elongated and more narrow than postgonite, with rounded apex; pregonite distally incurved inwards toward center lateral line of body; distiphallus short and narrow, not crossing anterior margin of sternite 5, covered with fine hair; cerci subtriangular with several setae. **Female genitalia:** Cerci about 2 times as long as wide; cerci with 2 pairs of dorsal setae and 1 pair of ventral setae, with few small setae; spermathecae cylindrical.

Arctopiophila setaluna (McAlpine 1977)

(Figure 17)

Neopiophila setaluna McAlpine 1977: 33 (type locality: Canada, Northwest Territories, 21 miles east of Tuktoyaktuk), **new combination**.

Type material examined. 1 ♂ holotype. N.W.T. -21 m.e. Tuktoyaktuk, 17-21.vi.1971, D.M. Wood, Holotype *Neopiophila setaluna* McAlpine (CNC). Allotype ♀. N.W.T. -21 m.e. Tuktoyaktuk, 20-25.vi.1971, D.M. Wood, Allotype *Neopiophila setaluna* McAlpine (CNC). 6 ♂, 11 ♀ Paratypes. **CANADA. Manitoba:** Churchill, 15.vi.1930, O. Bryant. **Northwest Territories:** Muskox L., (64°05'N, 111°15'W), 2.viii.1953, J.G. Chillcott; Salmita Mines, (64°05'N, 111°15'W), 1.vii.1953, J.G. Chillcott; 20 mi E. Tuktoyaktuk, 15.vii.1971, W.R.M. Mason; 21 mi E. Tuktoyaktuk, 20-25.vii.1971, D.M. Wood. **Quebec:** Sugluk, 28.vi.1954, H. Huckel. **Yukon Territory:** Firth River, 27.vii.1956, 5.viii.1956, E.F. Cashman; same except 3.viii.1956, R.E. Leech (CNC).

Other material examined. 16 ♂, 13 ♀, 1 ? from the following Nearctic localities: **CANADA. Manitoba:** Churchill. **Nunavut:** Cambridge Bay; Kugluktuk. **Yukon Territory:** British Mts.; Dempster Highway (near North Fork Pass; km 151; km 161; km 257.5, Start Eagle Plaine); North Richardson Mtns. **UNITED STATES OF AMERICA. Alaska:** Eagle Summit (DEBU, LEM, USNM) (Fig. 17).

Notes on capture: This species has been captured from June to August with sweep nets, dish bait and pan, Malaise, mushroom and carrion traps. It has been collected in mesic sites, tundra, and in limestone scree and valley.

Diagnosis. *Arctopiophila setaluna* differs from other *Arctopiophila* species by its very hairy body, setulose lunule, eyes round but slightly extending towards face, palps enlarged, legs entirely black (yellow on part of tibiae and first tarsal segment in some specimens), prosternum with long fine setulae and with greatly reduced distiphallus. **Description.** Body length 2.4–3.1 mm; wing length 2.0–2.9 mm. In McAlpine (1977), specimens have been seen with body length up to 4 mm. Body glossy black with yellow on parts of head and in some specimens on legs; very hairy body. **Head:** Head black, with yellow antennae (with black shading, especially on dorsal margin), yellow on face, anterior portion of frons and part of gena along eye margin; eyes round slightly extending towards face; height of eye 3.2–4.3 times genal height; lunule setulose;

2 reclinate posterior fronto-orbital (usually lowest seta ¾ length of upper); first flagellomere round; arista about 2 times length of first flagellomere; arista brown; palps enlarged. **Thorax:** Glossy black; posterior portion of meron dull; acrostichal setulae in 12 rows; 1 proepisternal seta with additional hairs; prosternum with long fine setulae; katepisternum with several setulae and hairs; scutellum hairy on all surface. **Wing:** Stigmal space, basal costal and costal cell fumose; veins brown; fringe brown; length of C between Sc and R_1 1.5 times the length of crossvein h. Halter usually with black shading on apex of knob and dorsally along base of stem. **Legs:** Coxae black; remaining of leg segments black, but some specimens with yellow on proximal area of all tibiae and sometimes distally; some specimens with first tarsal segment of mid and hind leg yellow. **Abdomen:** Well developed hairs scattered. **Male genitalia:** Sternite 5 slightly incurved medially on posterior margin; epandrium on lateral view higher than wide, rectangular with basal half slightly funnel shaped with straight base; epandrium with setae along surface, setae longer along posterior margin; surstylus subtriangular and elongated, with rounded apex; surstylus with short and fine setulae; postgonite strongly sclerotised, narrow, rectangular on ventral view, and slightly incurved on lateral view; pregonite strongly sclerotised ventrally and distally, rectangular with 2 apical rounded lobes; pregonite on ventral view 2 times wider than postgonite; distiphallus membranous and greatly reduced; cerci narrow and linear with 2 long setulae and several short setulae; cerci separated from epandrium but connected ventrally to surstylus. **Female genitalia:** Epiproct well sclerotized, oval and bare; cerci almost 2 times as long as wide; cerci with 2 pairs of setae dorsally and 1 ventrally; spermathecae elongated, cylindrical and narrowest at apex.

Arctopiophila tomentosa (Frey 1930)

(Figure 17)

Boreopiophila tomentosa Frey 1930: 84 (type locality: Finland "auf dem Fjelde Petsikko auf der Grenze zwischen Imari and Utsjoki in der Regio subalpina"), **new combination**.

Allopiophila tomentosa; Ozerov 2004a: 606.

Material examined. 30 ♂, 12 ♀ from the following Nearctic localities: **CANADA. Manitoba:** Churchill, 12 km East on Launch Road. **Nunavut:** Kugluktuk. **Yukon Territory:** Dempster Highway (near North Fork Pass; km 47, Scoutcar Creek; km 153, Windy Pass; km 116; km 125;

km 128; km 172); Ogilvie Mts., North Fork Pass; North Richardson Mtns; White Mtns.
UNITED STATES OF AMERICA. Alaska: Elliot Highway mi 27.9, White Mtn. Trail; Nome, Kougarok Road mi 55 (CNC, DEBU, LEM, UBCZ) (Fig. 17).
Additional distribution information: *Arctopiophila tomentosa* is also known from Finland in the Palaearctic according to the holotype (Frey 1930).
Notes on capture: This species has been captured in the Nearctic from June to July with sweep nets, and Malaise, pan and mushroom baited traps. It was collected in the tundra, in mesic area, tundra, fen, bog, pond, near a creek, in sedge, and on limestone hilltop and ridge.
Diagnosis. This *Arctopiophila* species can be differentiated mainly by its dull grey body with yellow on parts of head and legs. The male genitalia can also be used to differentiate this species from others by silvery-white microtomentum on sternite 8 and epandrium (as in *A. nigerrima*) and sternite 6 with a weakly sclerotised small projection. **Description.** Body length 2.2–3.1 mm; wing length 2.2–3.1 mm. Body dull grey with yellow on parts of head and legs. **Head:** Head as high as long, dull grey, with yellow face and palps, yellow on anterior portion of frons, and part of gena along eye margin; antenna yellow except for first flagellomere which varies from entirely black to partly yellow; vertical height of eye 4–5 times genal height; row of short setulae along gena; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); first flagellomere oval; arista 2 times length of first flagellomere; arista brown. **Thorax:** Dull gray; acrostichal setulae in 9 rows; katepisternum with usually 1–3 setae on upper margin. **Wing:** Same as genus description. **Legs:** Fore coxa yellow, dull gray dorsally; mid and hind coxae dull gray; fore femur black; mid and hind femora black microtomentum with possible yellow at both distal and proximal end; fore tibia mainly black microtomentose with yellow at both distal and proximal end, and sometimes on ventral side; mid and hind tibiae mainly yellow to mainly black; fore tarsus usually black (some specimens with tarsal segment 1 yellow); mid and hind tarsi yellow with black tarsal segments 4 and 5. **Abdomen**: Dull gray; short hairs scattered, with longer hairs laterally; tergite and sternite 4 to 6 with long setae along posterior margin. **Male genitalia:** Sternite 4 and 5 with medially incurved at posterior margin forming 2 oval bumps; sternite 6 with a weakly sclerotised small projection; sternite 8 and epandrium silvery-white microtomentum; epandrium longer than wide, in lateral view about same width dorsally and ventrally; epandrium with 1 strong seta ventro-medially; surstylus elongated, rounded ventrally

and with a minute oval projection posteriorly at apex; surstylus with 4 setae laterally on ventral margin; postgonite with 1 very narrow lobe, rounded at tip and curving downwards; pregonite large and oval with a pointed projection at apex dorsally; postgonite and pregonite strongly sclerotised; distiphallus small, bare and membranous; cerci sclerotised, oval and with 2 long setulae. **Female genitalia:** Sternites 3–6 with posterior margin 'v' shaped; cerci short with 2 pairs of setae ventrally and 1 pair dorsally; spermathecae oval and short.

Arctopiophila variefrontis Rochefort n. sp

(Figures 17, 18)

1 ♂ Holotype. Colo., Mt. Evans, Echo L., 10 600', 24.viii.1961, C.H. Mann (CNC). Paratypes: **CANADA. Alberta:** Kananaskis, For. Exp. Sta. Seebe, 30.vii.1968, H.J. Teskey (1 ♀, CNC). **UNITED STATES OF AMERICA. California:** Mts. Calif., Warner, Ceder Pass, 6000', Malaise trap, 7.viii.1965 (1 ♀, CNC). **Colorado:** Gunnison-Chaffee Counties, Monarch Pass, Information Center, 11 312', dead on window sill, 17.viii.1983, P.H. Arnaud, Jr. (1 ♀, CAS); Mt. Evans, Echo L., 10 600', 24.viii.1961, C.H. Mann (3 ♂, 1 ♀, CNC); Floral Park, on *Pedicularis bracteosa*, 14.viii.1973, J.R. Vockeroth (1 ♀, CNC) (Fig. 17).

Diagnosis. *Arctopiophila variefrontis* is very close to *A. nigritellus* but differs since fronto-orbital plates are mainly or completely yellow, thorax dull on scutum (especially on sides), setulae present between dorsocentral setae almost reaching scutellum and abdomen covered with longer hairs than *A. nigritellus*. **Description.** Body length 2.7–3.2 mm; wing length 3.2–3.5 mm. Body glossy black with yellow on head and legs, and with greyish microtomentum on portions of thorax. **Head:** Head as high as long, yellow with black on ocellar triangle and part of occiput; fronto-orbital plates usually yellow, but some specimens with brown in posterior section (never exceeding posterior fronto-orbital seta); eyes oval, slightly wider than high; height of eye 2.4–3.3 times genal height; 0–2 setae along gena; 1 strong reclinate posterior fronto-orbital seta, and one weaker anterior fronto-orbital seta; inner and outer vertical setae usually of equal length, but in some specimens the inner is 1.2 times longer than outer; ocellar setae as long as vertical setae; postocellar setae 1.2 times longer than inner vertical and ocellar setae; first flagellomere round, sometimes shaded black on lateral mid sections; arista about 2.5 times length of first flagellomere; arista blackish/brown, sometimes with yellowish tint at base. **Thorax:** Mainly

glossy black; postpronotum dull yellow; greyish microtomentum present from anterior of prescutellum, ventral lateral margin of postpronotum to anterior postsutural dorsocentral setae; greyish microtomentum on upper margin of anepisternum, upper and posterior margin of anepimeron and on anterior and posterior margin of meron; 2 postsutural dorsocentral setae; acrostichal setulae in 9–10 rows; setulae present between dorsocentral setae, almost reaching scutellum, unlike *A. nigritellus*; katepisternum with 2 setae on upper margin. **Wing:** Veins brown, sometimes slightly yellowish. **Legs:** Same as in *A. nigritellus*. **Abdomen:** Same as *A. nigritellus* except the short scattered hairs are longer. **Male genitalia** (Fig. 18)**:** Epandrium with a row of 6–7 short setae along posterior margin; surstylus rectangular with rounded ends and lobes folded downwards; surstylus with short setae; postgonites small, with one circular lobe and one small rounded lobe at preapical dorsal margin; pregonite greatly reduced into one subtriangular lobe; distiphallus bare, short, membranous; cerci separated from epandrium, small, oval and slightly setulose. **Female genitalia:** Cerci 2.5 times as long as wide, with 1 strong pair of seta dorsally, 1 pair of seta ventrally and with short setae on remaining surface; 2 spermathecae weakly sclerotised but distinguishable in some specimens, cylindrical, short and narrow.

Etymology: This species name is composed of the Latin word varius (different) and frontis (fore part of anything) in reference to the variable frons colour which varies from completely yellow to partly brown.

Arctopiophila vulgaris (Fallén 1820)

(Figure 19)

Piophila vulgaris Fallén 1820: 9 (type locality: not given (Sweden)), **new combination**.

Parapiophila vulgaris; McAlpine 1977: 48.

Allopiophila vulgaris; Ozerov 2004a: 606.

Piophila pygmaea Zetterstedt 1838: 772 (type locality: Sweden: "Lapponia Umensi, in paroecia Fredrica") synonym in Duda 1924.

Piophila setosa Melander & Spuler 1917: 64 (type locality: United States of America Alaska, Douglas) synonym in McAlpine 1977: 1.

Piophila oriens Melander & Spuler 1917: 63 synonym in Steyskal 1964: 180.

Piophila anomala Malloch 1923: 219 (type locality: United States of America, Alaska, Pribilof Island) synonym in McAlpine 1977: 2.

Piophila hortulana Meigen in Séguy 1934:88. Unavailable name.

Type material examined. 1 ♂ holotype of *Piophila vulgaris*. St George Id, Bering Sea, 4.vii.1914, G Dallas Hanna Collector, GDH Lot No.52, Type No. 26456, (USNM). 3 ♂, 1 ♀ paratypes of *Piophila vulgaris*. St George, Bering Sea; St Paul (USNM). 1 ♂ lectotype of *Piophila setosa*. **UNITED STATES OF AMERICA. Alaska:** Douglas, Alaska, 1.viii.1901, Eldred Jenne, Type *Piophila setosa* M.-S., A.L. Melander Collection 1961, Lectotype *Piophila setosa* Steyskal 1984, Lectotype *Piophila setosa* Melander Spuler, 1917: 64, A. Ozerov 2002 (USNM). 3 ♂, 1 ♀ paralectotypes of *Piophila setosa*. **UNITED STATES OF AMERICA. Alaska:** Douglas, Alaska (USNM). 1 ♂ lectotype of *Piophila oriens*. **New York:** Ithaca, NY, 31.v.1914, Type *Piophila oriens* M.-S., A.L. Melander Collection 1961, Lectotype *Piophila oriens*, Melander, Spuler 1917:63, by Steyskal 1964:180, Det. A. Ozerov 2002 (USNM). 1 ♂, 2 ♀ paralectotypes of *Piophila oriens*. **Massachusetts:** Greenfield. **New York:** Geneva; Ithaca (USNM).

Other material examined. 581 ♂, 586 ♀, 7 ? from the following Nearctic localities: **CANADA. Alberta:** Banff, Sulfer Mt; Bilby; Slave Lake. **British Columbia:** 32 mi Southwest of Terrace; Atlin; Bowen Island; Brooks Peninsula, Cape Cook Lagoon; Duncan; King Salmon Lake; Lisadele Lake; Moose Lake; Penticton, Apex Mt; Pete Lake; Queen Charlotte Islands (Graham Island; Laskeek Bay, Lost Island; Laskeek Bay, West Limestone Island; Queen Moresby Island, Mount Moresby); St. Elias Mts, Tats Lake, Tats Creek; Skidgate; Terrace; Vancouver, Point Grey. **Manitoba:** 11 km South Churchill, Goose Creek; Churchill; Churchill, 23 km East on Launch Road; Fort Churchill; Hudson Bay Railway mi 500; Twin Lakes, 22 km Swouthest Churchill. **Newfoundland and Labrador:** 10 mi up Saglek Fjord; Bell Island; Cartwright; Foxtrap; Funk Island; Hebron; Nutak; Okak Bay; Portugal Cove; St. Antony; St. John's; St. Vincents; Silutalik Island, Cutthroat Harb. **Northwest Territories:** Aklavik; Barlow Lake outlet; Ford Lake; Fort McPherson; Hay River; Inuvik; Muskox Lake; Padley; Reindeer Depot, Mackenzie Delta; Salmita Mines; Yellowknife. **Nova Scotia:** Cape Breton Island, South Harbour; Lockport. **Nunavut:** Baker Lake; Bathurst Inlet; Chesterfield; Coppermine; Eskimo Point; few km North of Arviat; Kugluktuk. **Ontario:** Algonquin Park (Scott Lake; Wildlife

Research Station); Arkell; Dundas, Royal Botanical Gardens; Fergus; Guelph; Hepworth; Hilton Beach; Maynooth; Midland; Neys Provincial Park; Oakville; Parasite Laboratory Belleville; Prescott; Prince-Edouard Co., Sandbanks; Prospect; Rockport; Sault Ste. Marie; Simcoe Co., Washago; Toronto Island; Wallaceburg; Wellington Co., Fergus. **Prince Edward Island:** Red Point. **Quebec:** Baie Comeau; Cottage Beaulieu; Cross Point; Duschesnay; Fort Chimo; Gaspé; Gaspé, Corte-Real, Rivière Darmouth; Gatineau Park, Harrington Lake; Great Whale River; Harrington Harbour; Hull; Iles Razade N.; Indian House Lake; Knob Lake; La Ferme; Laurentide Park, Lac-Sept-iles; Mistassini; Montreal; near Schefferville; Payne Bay; Point Harrison; St. Rémi; Ste. Annes; Schefferville, McGill Subarctic Research Station; Ungava Bay, H.B.T.; Wakefield. **Yukon Territory:** Base Camp, Erebia Creek; British Mts., Firth River; Dawson; Dempster Highway (km 72, Tombstone Campground; km128; km 141; km 141, Blackstone Rim; mi 87; Tombstone Mtn. Camp); Erebia Creek; Firth River; Hershel Island; Kluane; North Richardson Mts., Erebia Creek. **UNITED STATES OF AMERICA. Alaska:** Alaska Eng Comm, Camp 327; Anchorage; Cape Thompson; Cold Bay; Deering; Douglas; Elliot Highway mi 27.8, White Mtn. Trail; Fairbanks; Katmai; Kenai, Skilak Lake; King Salmon, Naknek River; Matanuska; Naknek; Ninilchits; Nome; Nome, Kougarok Road mi 55; Nunivak Island; Reindeer Camp, Golovin; Richardson Highway (km 206; mi 206, Isabel Pass); St. Matthew Island; St. Paul Island; Salt Island; Savonoski, Naknek Lake; Sealers Island; Seward; Teller; Umiat; Unalakleet; Unalaska Island; Valdez; Wrangell. **Colorado:** 36 km West, Fort Collins. **District of Columbia:** Eastern Branch near Bennings. **Indiana:** Lafayette. **Maryland:** Colesville; Montgomery Co., Bethesda. **Massachusetts:** Forest Hills; Middlesex Co. (Belmont; Lincoln). **Michigan:** Detroit. **New Hampshire:** Mt. Washington. **New York:** Buffalo; Ithaca; New York; Sodus Point. **Pennsylvania:** Corry. **Utah:** Uinta Mts, Hole in Rock Can. **Virginia:** Alexandria Co., Maywood; Fairfax Co., near Annandale. **Washington:** Olympia. **West Virginia:** Pendleton Co., Spruce Knob. **Wisconsin:** Polk Co. **Wyoming:** Yellowstone Lake; Yellowstone Park, Canyon Camp. **GREENLAND.** Greenland; Sondrestrom Air Base (BIO, CAS, CNC, DEBU, LEM, ORUM, RBCM, UBCZ, USNM) (Fig. 19).

60 ♂, 49 ♀ from the following Palaearctic localities: **AUSTRIA.** Raxalpe; Tirol (Igls; Obergurgl). **DENMARK.** Sjaelland, Susenup Skov. **ENGLAND.** Calne Wilts; Devon (Paignton; Torguay); Durham; Gloucestershire, Gloucester; London; London (Brunetti; Wimbledon);

Nottingham; Oxford; Suffolk; Surrey, Coulsdon. **FINLAND.** Rovaniemi. **GERMANY.** Ingelheim am Rhein. **GREECE.** Struma Vall. Macedonis. **HOLLAND.** Diemerbrug. **NORWAY.** Beverdal to Leirvassbu Rd. O.; Boden; Sandnes Vassvick. **SPAIN.** Bilbao, Vizcaya. **SWEDEN.** Akaro; Are; Lapland (Abisko; Abisko Ntl. Pk., W. bank of Abiskojakka delta; Jebrenjokk; Karesuando; Maunu; Riksgransen); Muodoslompolo; Nb., Pajala; Ostersund; Pr. Jemtland, Aare; Varmland., Eksharad. **CZECH REPUBLIC.** Jeseník, jatky lgt. **UNITED KINGDOM.** Bonhill, Dumbartonshire; Herefordshire, Craswall near R. Monnow. **USSR.** Altai; Cherskiy; Siberia, Altai Region (50 km SE. of Teletskoya Lake; Teletskoya Lake); Siberia, Novosibirsk (CAS, CNC, DEBU, LEM, UASM, USNM).

1 ♂ from the following Neotropical locality: **COSTA RICA.** Cartago Prv., La Georgina Villa Milla (USNM).

Additional distribution information: *Arctopiophila vulgaris* is also known in the Nearctic from Pribilof Island in Alaska under the synonym *Piophila anomala* (McAlpine 1977) and from the Palaearctic: Andorra, Czech Republic, Faroe Island, Finland, France, Germany, Hungary, Iceland, Norway, Poland, Russia, Slovakia, Sweden, Switzerland, The Netherlands and Ukraine (Merz 1996, Ozerov 2004b, Carles-Tolra & Pujade-Villar 2003, Misiachna & Korneyev 2015).

Notes on capture: This species was captured in the Nearctic from April to November with sweep nets, mushroom vacuum, dung pits, and pitfall, pan, Malaise, light, carrion pan, dung, and rotary traps. This species has been collected on moose antlers and on carrion (fish, squirrel, snails, grouse). It has been collected in an open air lavatory, on vegetation and garbage, on dry grass, flowers of various plants (*Heracleum*, *Veratrum*, grassviaceous plant, *Salix*), in forest (swampy wood, *Acer-Betula*, *Populus-Picea*, *Betula nana*), on *Arceuthobium cyanocarpum*, in meadow, on dung, on gravel river flats, sheltered willow pond, in fen, sneezeweed, on conifer duff, in sand dunes, tundra near a pond, near a stream, in vegetation, mesic area, tundra, on dung, in earth ditch, on rotten mushrooms, at shrubby edge, on *Equisetum*, grass/sedge meadow, along a creek and from owl pellet.

Diagnosis. This species exhibits colour variation and is similar to *A. kugluktuk* and to *Borealicola pseudovulgaris* (Rochefort & Wheeler 2015). The most reliable way to distinguish it is with the 2 strongly sclerotised pointed projections in middle of posterior margin of sternite 6 and by comparing male genitalia. **Description.** Body length 2.4–3.4 mm; wing length 2.5–3.3

mm. Head mainly yellow with black on parts of gena, on ocellar triangle and posterior fronto-orbital plates. Thorax black with yellow sometimes present on proepisternum. Abdomen black. Legs greatly variable, from mainly yellow to mostly black. **Head:** Head yellow except for black on lower margin of gena (can also be entirely yellow), ocellar triangle and posterior fronto-orbital plates; frons usually yellow, but in some specimens, sections between the ocellar triangle and posterior fronto-orbital plates are black; palps usually yellow but may have black shading; vertical height of eye about 3.4–4.1 times genal height; row of very short setae along gena; aberrations in chaetotaxy of the head is common (additional pair of vibrissae and/or verticals); 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); first flagellomere round and usually yellow, but sometimes shaded black or mostly black; arista about 2.5–3 times length of first flagellomere; arista brown, sometimes base paler. **Thorax:** Glossy black; yellow on proepisternum may be present in front of anterior spiracle and/or around spiracle (these specimens will often have mainly yellow legs); proepisternum and meron with silvery-white microtomentum; thoracic setae all strong; acrostichal setulae in 12 rows. **Wing:** Length of C between Sc and R_1 at costa 1.5 length of crossvein h. **Legs:** Fore coxa yellow, sometimes partly black; mid and hind coxae usually black, but may be partly yellow; femora black, sometimes with yellow distally and proximally or in some specimens entirely yellow; tibiae vary in color from entirely yellow to mostly black; fore tarsus black, in some specimens tarsal segment 1 partly or entirely yellow; mid and hind tarsi black with tarsal segment 1 and 2 yellow. **Abdomen:** Same as genus description. **Male genitalia:** Sternite 6 with 2 strongly sclerotised pointed projections medially on posterior margin; epandrium with several short setae; surtylus well-developed, oval with rounded projection posterio-dorsally; surstylus with many short setae; postgonite well sclerotised, elongated and narrow with 2 pointed projections at apex; pregonite well sclerotised, with a curved lobe, rounded distally; hypandrium with well sclerotised projections laterally close to gonites, with a ventral squared projection (with several short setae) and a dorsal short and narrow finger-like projection; distiphallus membranous, bare, short and narrow; cerci weakly sclerotised, oval with 1 long and 6 short setae. **Female genitalia:** Cerci 3 times as long as wide, with 2 pairs of dorsal setae and 1 pair of ventral setae, with few small setae; spermathecae short and cylindrical.

Arctopiophila xanthopoda (Melander & Spuler 1917)

(Figure 20)

Piophila xanthopoda Melander & Spuler 1917: 59, 63 (Type locality United States of America, Montana, Lake MacDonald, Glacier Park), **new combination**.

Parapiophila xanthopoda; McAlpine 1977: 48.

Allopiophila xanthopoda; Ozerov 2004a: 606.

Type material examined. 1 ♀ Lectotype. **UNITED STATES OF AMERICA. Montana:** Lake MacDonald, Glacier Park, 14.viii.1916, Mont, A.L. Melander, Type *Piophila xanthopoda* M.-S., A.L. Melander Collection 1961, Lectotype *Piophila xanthopoda* Melander, Spuler 1917: 59, 63 A. Ozerov 2002 (USNM). 1 ♂, 2 ♀ paralectotypes. **UNITED STATES OF AMERICA. Idaho:** Troy. **Montana:** Lake McDonald, Glacier Park (USNM).

Other material examined. 11 ♂, 16 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff. **British Columbia:** Atlin; Clinton; Duncan; Kokanee Mtn; Lisadele Lake; Penticton, Apex Mt; Princeton; Robson. **Manitoba:** Churchill; Fort Churchill. **Northwest Territories:** Yellowknife. **UNITED STATES OF AMERICA. Alaska:** Mt. Fairplay, Taylor Highway mi 32. **Colorado:** Loveland Pass. **Idaho:** Moscow Mt. **Montana:** Missoula. **Washington:** Lake Chelan, Lucerne; Lake Crescent, Piedmont; Mt. Rainier (Hansen Camp; Paradise Park). **Wyoming:** Yellowstone Park, Riverside (CNC, USNM) (Fig. 20).

Notes on capture: This species was captured from June to August. It has been collected on flowers of *Veratrum*.

Diagnosis. *Arctopiophila xanthopoda* varies from other *Arctopiophila* species by its mainly black head with yellow on face, lunule, antennae, gena and the anterior portion of frons, its mainly yellow legs with black usually only on tarsus and by the male genitalia. **Description.** Body length 2.1–2.7 mm; wing length 2.6–3.5 mm. Head black with yellow on face, lunule, antennae, gena and portion of frons. Thorax and abdomen black. Legs entirely yellow with black only on tarsus. **Head:** Head glossy black with yellow on face, lunule, antennae, gena and anterior portion of frons; in some specimens lower margin of gena black; posterior fronto-orbital plates and ocellar triangle always black, usually with black between both sections; vertical height of eye about 4.5 times genal height; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); postocellar setae 1.3 times length of ocellar setae; first flagellomere round with

sometimes black shading; arista about 2.5–3 times length of first flagellomere; arista brown. **Thorax:** Glossy black; proepisternum and meron with silvery-white microtomentum; thoracic setae all strong; acrostichal setulae in 12 rows. **Wing:** Length of C between Sc and R_1 at costa slightly more than 1 times length of crossvein h. **Legs:** Coxae yellow, mid and hind coxae sometimes darkened; femora and tibia yellow; in some specimens, fore femur darkened on posterior side; fore tarsus black with yellow tarsal segment 1; mid and hind tarsi yellow with black tarsal segment 4 and 5. **Abdomen:** Same as genus description. **Male genitalia:** Epandrium with 1 long posterio-dorsal seta; surstylus well developed, rectangular (longer than wide) and with many short setae across surface; postgonite strongly sclerotised distally, widest at base and narrowest at apex, about 5 times longer than wide; pregonite less sclerotised than postgonite and with one elongated and narrow lobe; distiphallus membranous, short and narrow and with very fine and short hairs; cerci weakly sclerotised with 2 long and several short setae. **Female genitalia:** Cerci about 3 times as long as wide; cerci with 2 pairs of dorsal setae and 2 shorter pairs of ventral setae, with few small additional setae; spermathecae short and cylindrical.

BOREALICOLA Rochefort **n. genus**

(Figures 21–24)

Type, *Piophila fulviceps* Holmgren 1883

Diagnosis. This genus is close to *Arctopiophila* but mainly differ by the absence of the intrapostalar setae (present but weak in *B. fulviceps*) and in male genitalic character: distiphallus inflated, folded or slightly curved at 2/3 of length and ornamented with either spines at distal end or strong and long hairs strongest towards mid section to apex. **Description.** Body length 2.6–4.7 mm; wing length 2.7–4.2 mm. Head partly yellow or orange, and black. Thorax vary from entirely glossy black, to covered with silvery-white microtomentum, to yellow or orange covering margins of scutum and side thoracic plates, and scutellum. Legs vary from partly yellow to black. Abdomen glossy black with silvery-white microtomentum in *B. skevingtoni*. **Head:** Head yellow or orange with glossy black ocellar triangle, posterior fronto-orbital plates (except for *B. madaros*), and in some species palps and parts of gena (*B. fulviceps, B. madaros*). In *B. skevingtoni*, black portions are covered with silvery-white microtomentum; short hairs

scattered on occiput, between inner and outer vertical setae, from postocellar setae to anterior end of ocellar triangle, on frons, fronto-orbital plates and gena; ocellar setae as long as vertical setae; postocellar setae 1.5 length of ocellar setae; arista pubescent; palpus with short setulae. **Thorax:** Thorax glossy black but in *B. fulviceps* and *B. madaros* with yellow or orange on margins of scutum and margins of thoracic plates, and sometimes scutellum (yellow or orange quantities variable between specimens), and in *B. skevingtoni* with silvery-white microtomentum covering black portions; katatergite, anatergite and metapleuron with silvery-white microtomentum; 1 posterior postpronotal, 1 presutural intra-alar (absent in *B. madaros*), 1 supra-alar, 1 post-alar, 1 postsutural dorsocentral setae; intrapostalar absent (present but weak in *B. fulviceps*), acrostichal setulae in 10–12 rows; 1 proepisternal seta; prosternum bare; anepisternum bare; anepimeron bare; scutellum with 2 pairs of marginal setae. **Wing:** Hyaline, but with brown tinge in *B. fulviceps* and *B. madaros*; calypter white; fringe white (black in *B. fulviceps*, and in some *B. pseudovulgaris* specimens it is pale brown); length of crossvein dm-cu 3–5 times length of crossvein r-m; length of C between Sc and R_1 2 times length of crossvein h; length of M_1 between crossveins r-m and dm-cu 2 times length of dm-cu. Halter white (black shading in *B. fulviceps*). **Legs:** Varies from mainly yellow to mainly black; claws yellow proximally and black distally. **Abdomen:** Glossy black, except in *B. skevingtoni* covered with silvery-white microtomentum; dull reflections on tergites; short hairs scattered and more developed on lateral margins of tergite 3. **Male genitalia:** Sternite 6 and 7 stongly sclerotised along anterior margin; sternite 8 round and convex with several short setae; epandrium in lateral view higher than wide, anterior and ventral margin straight, posterior margin curved; epandrium with 1 to a row of outstanding setae on posterior margin with several short setae on remaining surface; surstylus not fused with epandrium and rectangular; postgonite with 1 lobe; pregonite with 1–2 lobes; distiphallus membranous and inflated, folded or slightly curved towards 2/3 of length; cerci not fused with epandrium, oval or triangular and with setae. **Female genitalia:** Sternite and tergite 7 and 8 with strong setae laterally and several shorter ones; 2 sclerotised spermathecae; spermathecae cylindrical and elongated, with wrinkled surface. Female unknown in *B. madaros* and *B. skevingtoni*.

Etymology: This genus name is from the Latin words Borealis- (northern) and –cola (inhabitant). This is in reference to the northern distribution of species belonging to this genus.

There are four species in *Borealicola*, all present in the Nearctic: *B. fulviceps* (Holmgren 1883), *B. madaros* Rochefort n. sp., *B. pseudovulgaris* (Ozerov 1989) and *B. skevingtoni* Rochefort n. sp.

Borealicola fulviceps (Holmgren 1883)

(Figure 21)

Piophila fulviceps Holmgren 1883: 177 (type locality: USSR, Northern Russia, khabarov Bay), **new combination**.

Parapiophila fulviceps; McAlpine 1977: 48.

Allopiophila fulviceps; Ozerov 2004a: 606.

Piophila picea Becker 1897: 404 (type locality: USSR, Novaya Zemlya) synonym in Hennig 1943.

Piophila borealis Malloch 1919: 84C (type locality: United States of America, Alska, Camden Bay) synonym in Sabrosky 1958: 174.

fulvifrons, error

Material examined. 178 ♂, 101 ♀, 2 ? from the following Nearctic localities: **CANADA. Manitoba:** Churchill. **Northwest Territories:** 21mi East Tuktoyaktuk; Banks Island (Aulavik National park; Masik River); Holman; Muskox Lake; Padley. **Nunavut:** Axel Heiberg Island; Baffin Island, Clyde; Bathurst Inlet; Cambridge Bay; Chesterfield; Ellesmere Island (Fosheim Peninsula, Hot Weather Creek; Hazen Camp); Ellesmere Lake; Eskimo Point; Kugluktuk; Lady Melville Lake; Repulse Bay; Southampton Island, Coral Harbour; Spence Bay; Victoria Island. **Quebec:** Payne Bay; Point Harrison; Schefferville, McGill Subarctic Research Station; Sugluk. **Yukon Territory:** Dawson; Dempster Highway mi 51; Hershel Island; North Fork Crossing mi 42, Peel Plt. Td. **UNITED STATES OF AMERICA. Alaska:** Cape Thompson; King Salmon, Naknek; Point Barrow; St. Paul Island; Wiol Kongeagewik (Cambdin Bay). **GREENLAND.** Nedre Midsommer Sö (CNC, DEBU, LEM, USNM) (Fig. 21).

Additional distribution information: *Arctopiophila fulviceps* is also present in the Palaearctic in the USSR (Novaya Zemlya; Khabarov Bay) (McAlpine 1977).

Notes on capture: This species has been captured in the Nearctic from June to August with sweep nets, and pan, Malaise and Morgan traps. This species has been collected in mesic sites, in the tundra, on a hilltop, on an owl perch, in fox burrows, on *Salix*, on the margin of a lake, in grasses, pond and fen.

Diagnosis. This species can be differentiated by its first flagellomere which is black, round and elarged, by an either entirely black thorax with yellow on postpronotum, scutellum, margins of scutum and margins of side thoracic plates, cell bm absent or incomplete and the presence of spines on distiphallus (the new species *B. madaros* also has those spines). **Description.** Body length 2.6–3.9 mm; wing length 2.7–4.1 mm. Head mainly yellow with black on ocellar triangle, posterior fronto-orbital plates, parts of gena, first flagellomere and palps. Thorax color entirely black to partly yellow (much variable, but the yellow color is more dominant in females). Legs mainly black and partly yellow. Abdomen black. **Head:** Head higher than long, mainly glossy yellow with black ocellar triangle, posterior fronto-orbital plates, gena ventrally, first flagellomere and palps; pedicel and scape sometimes shaded black; height of eye 2.3–2.6 times genal height; 2 lateroreclinate posterior fronto-orbitals (upper slightly stronger than lower); first flagellomere round and enlarged; arista about 2 times length of first flagellomere; arista black. **Thorax:** Glossy black with yellow on postpronotum, scutellum, margins of scutum and margins of side thoracic plates; quantity of yellow coloration is variable and more dominant in females (males sometimes with thorax entirely glossy black); proepisternum with silvery-white microtomentum; setae strong except for postpronotal, presutural intra-alar and intrapostalar setae which are weak; acrostichal setulae in 10–11 rows; scutellum bare in some specimens and covered with several hairs in others. **Wing:** Hyaline but shaded black at proximal section of wing and at cell c and bc; veins black; fringe black; cell bm absent or incomplete. Halter white with black shading. **Legs:** Coxae and femora black; coxae with silvery-white microtomentum on anterior; femora with some yellow at distal tip; tibiae yellow and black (quantity of both colors variable); fore tarsus black; mid and hind tarsi entirely black or with tarsal segment 1 and 2 yellow. **Abdomen:** Same as genus description. **Male genitalia:** Epandrium with 1 long setae posterio-dorsally; surstylus developed, rectangular with slightly rounded posterior edge; surstylus with several short setae; postgonite well sclerotised, elongated subtriangle with curved apex; pregonite with a well sclerotised finger-like elongated projection; distiphallus

membranous, narrow from base to midpoint, than wider (inflated); distiphallus with several strong spines at distal end; distiphallus length reaches anterior end of sternite 4; cerci sclerotised, oval, with 1 strong setae and several shorter setae. **Female genitalia:** Cerci short, with 1 pair of dorsal and 1 pair of ventral setae, with few smaller setae; spermathecae cylindrical and elongated, with wrinkled surface.

Borealicola madaros Rochefort n. sp.

(Figures 21–23)

1 ♂ holotype. Herschel Is., Y.T., 5.vii.1953, J.S. Waterhouse (CNC) (Fig. 21).

Diagnosis. This species is very close to *B. fulviceps* but differs as it has no vibrissae, setae are reduced (especially postsutural dorsocentral setae) and it has a black pattern on scutum.

Description. Body length 4.7 mm; wing length 4.2 mm. Head and thorax mainly orange with black on ocellar triangle, antennae, palps and occiput on head, and on postpronotum, scutellum and margins of scutum dorsally and laterally on thorax. Abdomen black. Legs partly yellow and black. Hair and setae black, but seem golden in certain angles. **Head:** Head higher than long, orange except for black ocellar triangle, antennae, palps and occiput; height of eye about 1.3 times genal height; vibrissae absent; 1 lateroclinate posterior fronto-orbital seta; inner and outer vertical setae reduced and of equal length; first flagellomere round; arista about 2.2 times length of first flagellomere; arista black; palpus with 2-3 slightly longer setulae, remaining of surface with short setulae. **Thorax:** Mainly glossy black, particular black pattern on scutum: postpronotum, scutellum and posterior margin of anepisternum and anterior margin of anepimeron orange, as well as lateral, anterior and posterior margin of scutum and prescutum; presutural intra-alar absent; intrapostalar absent; postsutural dorsocentral setae weak; acrostichal setulae in 12 rows; katepisternum with 4 setae on upper margin. **Wing:** Hyaline with brownish pale tinge; costal vein brown with remaining of veins yellowish-brown; length of crossvein dm-cu 4 times length of crossvein r-m; length of C between Sc and R_1 at costa about same length as crossvein h; length of M_1 between crossveins r-m and dm-cu 1.75 times length of dm-cu. **Legs:** Coxae black; femora black with yellow distally; tibiae yellow; fore tarsus black; mid and hind tarsi yellow with tarsal segment 4 and 5 shaded black. **Abdomen:** Sternites with row of short setae along posterior margin. **Male genitalia** (Fig. 22, 23)**:** Epandrium with 2 setae along

posterior margin and with shorter setae behind these; surstylus rectangular (slightly 2 times wider than high) with rounded edges, convex and with short setae; postgonite strongly sclerotised, elongated, narrow with rounded tip; pregonite with one large oval lobe with a small rounded projection dorsally and a second small rounded lobe at base (the second lobe at base is strongly sclerotised as its dorsal margin); pregonite with several short setae on oval upper lobe; distiphallus membranous, inflated most towards middle, bare but with 10 strong brown spines at distal end; distiphallus reaching anterior margin of sternite 5; cerci not fused with epandrium but ventrally fused with surstylus; cerci linear, with 3 long setae and several small setae. **Female:** unknown

Etymology: This species name is from the Greek word madaros (bare). This is in reference to the absence of vibrissae in this species, which is unusual for this family (although greatly reduced in the Palaearctic species *Allopiophila pappi* Ozerov 2004a).

Additional notes: A female from Herschel Island (Yukon, Herschel Is., (69°34'N, 138°52'W), over dry tundra stream, Malaise trap, 21.vii.1983, R.A. Cannings (UBCZ)) was found and might be a new species or the associated female to *B. madaros*. However, there is too much variation between the two specimens to confirm its identity. **Variation.** Body and wing length 3.6 mm. **Head:** Posterior fronto-orbital plate black; height of eye about 1.5 times genal height; vibrissae present; 2 lateroclinate; inner and outer vertical setae not reduced; ocellar setae shorter than postocellar setae, postocellar 2.2 times length of ocellar; inner and outer vertical 1.4 times length of ocellar setae; arista about 2 times length of first flagellomere. **Thorax:** Presutural intra-alar and intrapostalar present but reduced. **Wing:** Length between crossveins r-m and dm-cu 2 times length of dm-cu. **Legs:** Tibiae yellow, with brownish tint distally. **Female genitalia:** Sternite and tergite 7 and 8 with several setae laterally and several setulae; epiproct round and bare; hypoproct small and linear; cerci about 1.5 times as long as wide, with 1 pair of seta ventrally and 1 dorsally; two sclerotised spermathecae; spermathecae cylindrical, elongate, and indented at tip, with wrinkled surface.

Borealicola pseudovulgaris (Ozerov 1989)

(Figure 21)

Parapiophila pseudovulgaris Ozerov 1989: 846 (type locality: Russia, Amurskaya Oblast, town Zeya), **new combination**.

Allopiophila pseudovulgaris; Ozerov 2005: 135.

paravulgaris error *in* Ozerov 2004a: 602.

Type material examined. 1 ♂, 1 ♀ paratypes. **RUSSIA:** Amurskaya Oblast, G. Vaya, 14.viii.1981, A.Ozerov; same except A. Shatalkin (CNC).

Other material examined. 10 ♂, 26 ♀ from the following Nearctic localities: **CANADA. Northwest Territories:** Aklavik. **Yukon Territory:** 14 mi East Dawson; Dempster Highway (km 141, Blackstone River; km 72, Tombstone Campground; km128; km140; Richardson Mts. km 409); Ogilvie Mts., Mt. Klotz. **UNITED STATES OF AMERICA. Alaska:** Nome, mi 17 Kougarok road (CNC, DEBU, LEM, UBCZ, USNM) (Fig. 21).

Additional distribution information: *Borealicola pseudovulgaris* is also known from Russia in the Palaearctic according to the type locality (Ozerov 1989).

Notes on capture: This species has been captured in the Nearctic from June to August with sweep nets, and Malaise and mushroom traps. It has been collected on Aspen, mushrooms, in the tundra, pond, along a path in forest, on snow field and on *Sphagnum*.

Diagnosis. This species can be differentiated from *B. fulviceps* and *B. madaros* by having strong setae on scutum with only the intrapostalar absent and a distiphallus with long strong hairs. It can be differentiated from *B. skevingtoni* by having a mainly yellow head and glossy black thorax and abdomen without silvery-white microtomentum. This species is also very similar to *Arctopiophila vulgaris* (Ozerov 1989, Rochefort & Wheeler 2015). **Description.** Body length 2.6–3.4 mm; wing length 2.7–3.6 mm. Head yellow with black on ocellar triangle and posterior fronto-orbital plates. Thorax and abdomen glossy black. Legs mainly yellow with black portions. **Head:** Head as long as high, yellow except for black ocellar triangle and posterior fronto-orbital plates; vertical height of eye 4.4–4.8 times genal height; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); first flagellomere round and may be shaded black; arista 2.5–3 times length of first flagellomere; arista entirely brown or with yellow base. **Thorax:** Glossy black; proepisternum and meron with silvery-white microtomentum; instrapostalar seta absent; setae on thorax all strong; acrostichal setulae in 11–12 rows. **Wing:** Hyaline; veins yellow; fringe pale brown (in some specimens may seem yellow or white); length of C between

Sc and R_1 at costa slightly more than 1 time length of crossvein h. **Legs:** Fore coxa yellow; mid and hind coxae black; fore femur black with up to1/3 yellow proximally; mid and hind femora yellow with a black portion in middle of segment; in some specimens the mid femur is entirely yellow; tibiae yellow; fore tarsus black; mid and hind tarsi yellow except for tarsal segment 3 to 5 which may be shaded black. **Abdomen:** Same as genus description. **Male genitalia:** Epandrium with row of long setae along posterior margin; surstylus rectangular, with 1 stout setae at dorso-posterior end, and several other finer setae posteriorly; postgonite well sclerotised, elongated, narrowest at base, widest preapically, and with a short pointed lobe dorso-posteriorly; pregonite well sclerotised, a -90° "C" shape with a ventrally curved pointed tip; distiphallus membranous, inflated, folded and with many hairs; distiphallus hairs thick and long dorsally up to 2/3 of length, distal end with short hairs; distiphallus with asymmetrical distal end; distiphallus about length of abdomen; cerci triangular with 3–4 setae. **Female genitalia:** Cerci 2 times as long as wide, with 2 pairs of dorsal setae and 1 pair of ventral setae and with few small setae; spermathecae elongated, cylindrical and asymmetric.

Borealicola skevingtoni Rochefort n. sp.

(Figures 21, 24)

1 ♂ holotype. USA. Alaska: Nome Area km 27 of Kougarok Road, 64°42'22"N, 165°17'50"W, 21-23.vi.2005, Malaise trap, J & R Skevington, CNC DIPTERA #11511 (CNC) (Fig. 21). **Diagnosis.** This species is very close to *B. pseudovulgaris* but can be differentiated by a body covered with silvery-white microtomentum. **Description.** Body 3.8 mm; wing 3.5 mm. Head yellow with black posterior fronto-orbital plates, ocellar triangle and occiput which are covered with silvery-white microtomentum. Thorax and abdomen brown with silvery-white microtomentum. Legs many yellow with some black sections. **Head:** Head slightly longer than wide, head yellow with black posterior fronto-orbital plates, ocellar triangle and occiput; black sections covered with silvery-white microtomentum; vertical height of eye 4 times genal height; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); first flagellomere round with some black shading; arista about 2 times length of first flagellomere; arista brown slightly yellowish at base. **Thorax:** Brown with silvery-white microtomentum, only scutellum mainly glossy; setae on thorax all strong; intrapostalar seta absent; acrostichal setulae

in 10 rows. **Wing:** Same as genus description with hyaline wing and yellow veins. **Legs:** Coxae yellow; fore femur brown with yellow proximally and distally; fore tibia yellow; fore tarsus with first tarsal segment yellow and brown with remaining of tarsus brown; mid and hind leg yellow with brown distal spot on femora and with black tarsal segment 4 and 5. **Abdomen:** Glossy black with some silvery-white microtomentum. **Male genitalia** (Fig. 24)**:** Same as *B. pseudovulgaris*. **Female:** unknown.

Etymology: This species is named after J. Skevington who collected the holotype. This species is also named after him for his support, constructive feedback and implication in my research.

LASIOPIOPHILA Duda 1924

(Figure 25)

Lasiopiophila (as subgenus of *Piophila*) Duda 1924: 109, type species *Lasiopiophila pilosa* Staeger 1845: 368, by monotypy.

Diagnosis. This genus differs by having two wart-like tubercles on posterior margin of scutellum and an extensively hairy body.

Lasiopiophila pilosa is the only species in this genus.

Lasiopiophila pilosa (Staeger 1845)

(Figure 25)

Piophila pilosa Staeger 1845: 368 (type locality: Greenland).

Lasiopiophila pilosa; Duda 1924: 109 (placed in subgenus *Lasiopiophila*).

Material examined. 225 ♂, 155 ♀ from the following Nearctic localities: **CANADA. Manitoba:** Churchill; Fort Churchill. **Newfoundland and Labrador:** Hebron. **Northwest Territories:** Banks Island, Aulavik National Park; Ford Lake; Holman; Muskox Island; Padley; Richards Island, Kidluit Bay; Spence Bay; Victoria Island, Holman. **Nunavut:** Axel Heiberg Island; Axel Heiberg Island, Wolf River; Baffin Island (Frobisher Bay; Pond Inlet); Baker Lake; Bathurst Inlet; Cambridge Bay; Chesterfield; Coral Harbour; Ellesmere Island (Alert; Eureka; Fosheim Peninsula, Hot Weather Creek; Hazen Camp; Hazen Lake; Tranquary Fjord); Eskimo Point; Frobisher Bay; Kugluktuk; Southampton Island, Coral Harbour; Victoria Island. **Quebec:** Indian House Lake; Payne Bay; Port Harrison; Sugluk. **Yukon Territory:** Firth River; Herschel Island.

UNITED STATES OF AMERICA. Alaska: Golovin, Reindeer Camp; Umiat. **GREENLAND.** Kusufjord; Nedre Midsommer Sö; Sondrestrom Air Base; Sukkertoppen (CAS, CNC, DEBU, LEM, UASM, USNM) (Fig. 25).

1 ♂, 1 ♀ from the following Palaearctic locality: **RUSSIA.** Tyumenskaya Obl., 150 km No. Sale., Kharda.P.Basikhin, 11.viii.1983 (CNC).

Notes on capture: This species has been captured in the Nearctic from June to August with Malaise and pan traps, and sweep nets. This species was found on beef carcass, in mesic tundra, at a garbage dump and on the flowering plant *Epilobium latifolium* and *Dryas* sp. *Lasiopiophila pilosa* has also been seen feeding on *Dryas* nectar.

Diagnosis. This species can be differentiated from other Piophilidae species by the 2 wart-like tubercles present at posterior margin of scutellum, by its extensive hairy body and the presence of silvery-white microtomentum on most body parts. **Description.** Body length 2.7–4.8 mm; wing length 3.2–4.4 mm. Body mainly glossy black with yellow on parts of head and legs. Silvery-white microtomentum present on black areas. Body very hairy. Setae and hairs black.

Head: Head as high as long, glossy black with yellow on anterior portion of frons face and part of gena along eye margin; palps yellow proximally and black distally; gena posteriorly, occiput and part of posterior fronto-orbital plates silvery-white microtomentum; eyes round; height of eye about 3.3 times genal height; gena covered with many setae; dense hair on occiput, between inner and outer vertical setae, from postocellar setae to anterior end of ocellar triangle, on frons and fronto-orbital plates; subvibrissa present in some males; 1 reclinate posterior fronto-orbital; length of setae varies with specimens; inner and outer vertical setae either of equal length or the inner is shorter than the outer vertical seta; ocellar setae and postocellar setae either of equal length or postocellar slightly shorter than ocellar setae; first flagellomere round; arista pubescent; arista about 2 times length of first flagellomere; arista black; palpus with long setulae along surface. **Thorax:** Glossy black especially on prescutum and scutum, remaining of thorax with silvery-white microtomentum; thorax with long and dense hair; setae strong; 1 posterior postpronotal, 1 supra-alar, 1 postalar, 1 intrapostalar, 1 postsutural dorsocentral setae; presutural intra-alar absent; acrostichal setulae in 11 rows; usually with 2 proepisternal setae; prosternum bare; anepisternum setulose; anepimeron bare; katepisternum with usually 3 strong setae on upper margin; scutellum convex and with long hairs (some specimens can be bare), with 2 pairs

of marginal setae; 2 wart-like tubercles present at posterior margin of scutellum (on each side of subapical seta); some specimen with 3rd wart-like tubercle between the subapical setae. **Wing:** Hyaline; veins yellowish brown; calypter and fringe whitish/yellow; length of crossvein dm-cu 3 times length of crossvein r-m; length of C between Sc and R_1 about 2 times length of crossvein h; length between crossveins r-m and dm-cu almost 2 times length of dm-cu. Halter whitish/yellow. **Legs:** Coxae black, with mid coxa yellow in some specimens; femora black with yellow distally; tibiae black with yellow proximally; black tarsi; legs with silvery-white microtomentum on black sections; claws brownish proximally and black distally. **Abdomen:** Black with sliver-white microtomentum; long and dense setae, longest laterally and along posterior margin of sternites and tergites. **Male genitalia:** Sternite 3, 4 and 5 medially depressed and weakly sclerotised from anterior to posterior margin causing both sides to be rectangular (longer than wide) and slightly convex; sternite 6 and 7 strongly sclerotised along anterior margin; sternite 7 with 1 strongly sclerotised narrow projection, rounded at apex; sternite 8 round and convex with many setae; epandrium on lateral view slightly higher than wide, anterior and ventral margin straight, with posterior margin forming a rounded edge; epandrium with 1 pair of strong seta posterio-ventrally and 1 pair posterio-dorsally, and with several shorter setae behind these; surstylus not fused with epandrium, short and asymmetrical, slightly wider than long with several long setae posteriorly along margin and 2 dorsally; surstylus with several shorter additional setae; postgonite forming one strongly sclerotised short rectangle (longer than high) with a dorsally pointed lobe and a longer rectangular (higher than wide) base projecting dorsally (not as strongly sclerotised); pregonite with two sclerotised rounded lobes; distiphallus membranous, with many hairs and spinules; distiphallus with orange blunt forming two ventro-lateral lines at base and 1 at apex; distiphallus inflated and long, at least length of abdomen; cerci weakly sclerotised, crescent shape, with 2 setae. **Female genitalia:** Sternite and tergite 7 and 8 with strong setae laterally and several shorter ones; cerci narrow and long with 1 pair of seta dorsally and one ventrally; 2 sclerotised spermathecae; spermathecae elongate, and knob-like, smooth surface but wrinkled proximally.

LIOPIOPHILA Duda 1924

(Figure 26)

Liopiophila (as subgenus of *Piophila*) Duda 1924: 109, type species *Piophila varipes* Meigen 1830: 384, by designation of Hennig 1943: 29.

Diagnosis. This genus differs by the patch of setulose present in middle of anepimeron. *Liopiophila varipes* is the only species in this genus.

Liopiophila varipes (Meigen 1830)

(Figure 26)

Piophila varipes Meigen 1830: 384 (type locality not given).

Piophila laevigata Meigen 1838: 361 (type locality: Germany, "Hiesige Gegend") synonym in Duda 1924.

Piophila vicina Meigen 1838: 362 (type locality: Germany, "Hiesige Gegend") synonym in Duda 1924.

Piophila affinis var. *nigrifrons* Strobl 1910: 197 (type locality: Austria, "Um Admont bis auf die Hochalpen") synonym in Duda 1924.

Piophila halterata var. *affins* Melander and Spuler 1917: 62 (type locality: United States of America, Washington) synonym in McAlpine 1977: 62.

Piophila oldenbergi as var. of *P. varipes* Duda 1924: 111 (type localities: Germany: Pichelsberg and Berlin, Schildhorn; Austria, "Tirol Obladis") synonym in Hennig 1943.

Prochyliza varipes; Ozerov 2004a: 606.

Type material examined. 1 ♂ holotype. Tacoma Wash., 27.viii.1911, Type *Piophila halterata* M.-S., A.L. Melander Collection 1961, Holotype *Piophila halterata*, Melander, Spuler 1917: 62, det. A. Ozerov, 2002 (USNM).

Other material examined. 842 ♂, 464 ♀, 4 ? from the following Nearctic localities: **CANADA. Alberta:** Cadomin Base Prospect Mtn.; Jasper National Park, Mt. Edith, Cavell Glacier. **British Columbia:** 10 mi West Hope Jones Creek; Alaska Highway (mi 392, Summit Lake; Testa River); Atlin; Brooks Peninsula, Cape Cook Lagoon; Craigellachie, "The Last Spike"; Kamloops; King Salmon Lake; Kitimat; Lisadele Lake; North of Vancouver, 7 mi North Lions Bay; Prince George; Robson; Squamish, Diamond Head Trail; Terrace; Vancouver; Vancouver, Point Grey; Zymagotitz River, 6 mi West Terrace. **Manitoba:** Brandon; Churchill; Fort Churchill. **New Brunswick:** Fredericton; Kouchibouguac National Park; St. Andrews; St.

Andrews, Gibson Lake. **Newfoundland and Labrador:** Cartwright; Foxtrap; Goose Bay; Pinware River Provincial Park; Port aux Basques; Portugal Cove; St. John's; Stephenville. **Northwest Territories:** Aklavik; Barlow Lake Outlet; Ford Lake; Fort McPherson; Grant Lake; Muskox Lake; Padley; Salmita Mines; Tuktoyaktuk. **Nova Scotia:** Annapolis; Cape Breton Highlands National Park (Fishing Cove Trail; French Lake; Lone Shieling; North Mt; Jordan Falls); Kentville; Lockeport; Pictou Co., Melmerby Beech. **Nunavut:** Bathurst Inlet; near Beechey Lake; Eskimo Point; Kugluktuk; McConnell River; few km North of Arviat. **Ontario:** 6 mi West Richmond; Algoma District Park T.W.P; Algonquin Park; Algonquin Park (Dump; Scott Lake; Wildlife Research Station); Arkell; Bouck's Hill; Bruce Co., West Crane Road; Guelph; Hiks; Hog's Bark; Kearney; Lake Abitibi; Lambton Co., Port Franks; London; LowBush, Marmora; Maynooth; Midland; Ogoki; Ottawa; Ottawa (Dunbar Bridge; Ottawa River); Petawawa; Point Pelee; Prescott; Simcoe Co., Washago; Trenton, Evans. **Quebec:** Berthierville; Cascapedia; Cottage Beaulieu; Gaspé; Gaspé, Cort-Real Rivière Darmouth; Gaspesie, Mt. Albert; Gatineau Park, Harrington Lake; Ile de Montreal; Ile Perrot; Johnville Bog & Forest Park; La Ferme; La Trappe; Lac Phillipe; Laniel; Lauzon; Mistassini; Montreal; Natashquan; Old Chelsea; Quebec; Région du Lac Albanel Nord; Rigaud; Roberval; Saguenay (La Baie), Hameau, Saint-Louis-de-Bagot; St. Ann-Parade; Ste-Anne-de-Bellevue; Schefferville, McGill Subarctic Research Station; Sherbrooke, Bishop's University Campus; Val d'espoir; Wakefield. **Yukon Territory:** Alaska Highway, Koidern River; British Mts., Firth River; Dawson; Dawson City; Dempster Highway (Blackstone Rim; km 47, km 72, km 128; km 141, km 155; km 161; km 165, Sulfur Spring, Engineer creek; km 172; km 594.4, Frog Creek; Scoutcar Creek; Tombstone Campground; Tombstone Mtns. Camp); Erable Creek; Erebia Creek (Base Camp, North Richardsons; West base camp); Firth River; Klondike Highway (km 300; Meadow Creek, 24 km South Dempster Corners); Klondike Loop, Tackhini Hot Springs; North Fork crossing, mi 43 Peel Pt. Road; Ogilvie; Ogilvie Mts., North Fork Pass; Old Crow; Otter Lake; Rampart House; Whitehorse, Wolf Creek Campground. **UNITED STATES OF AMERICA. Alaska:** Alsk En Comm; Alaska Highway (12 mi North Tok Jct; Moon Lake); Anchorage; Big Delta; Deering; Elliot Highway mi 27.8, White Mtn. Trail; Fairbanks; Georges Parks Highway, Honolulu Creek; Gulkana River; Healy; Kenai, Skilak Lake; King Salmon, Naknek River; Kotzebue; Livengood; Matanuska; Mt. McKinley National Park; Ninilchik;

Richardson Highway (28 mi South Delta Jct.; Isabel Pass, mi 206); St. Paul Island; Savanoski; Savanoski, Naknek Lake; Taylor Highway, Klondike, Walker Fork Campground; Tunnel Sta.; Umiat; Upper Colville River; Valdez. **Connecticut:** Stamford. **Maine:** Matinicus Island; Mt. Katahdin; White Mountains. **Massachusetts:** Boston; Greenfield; Middlesex Co., Lincoln; Petersham; Waquoit; Woods Hole. **Michigan:** Detroit. **New Hampshire:** Franconia Notch; White Mt. National Forest. **New Jersey:** Morristown. **New Mexico:** Sandoval Co., Bernalillo. **New York:** Colden; Hamburg; Oswego. **Pennsylvania:** Centre Co., Pine Grove Mills. **Washington:** Bellingham; Olympia; Seattle; Vashon (BIO, CAS, CNC, DEBU, IMQC, LEM, ORUM, RBCM, UBCZ, USNM) (Fig. 26).

30 ♂, 46 ♀ from the following Palaearctic localities: **AUSTRIA.** Igls; Raxalpe; Tirol, Obergurgl. **ENGLAND.** Devon, Paignton; Durham; London; Norfolk, Fakenham; Oxford; Staffs., Newcastle-u-Lyme; Sussex (Alfiston; Sheffield Park). **FINLAND.** Li., Kevo near Utsjoki, Könkäänpahta. **GERMANY.** Ingelheim am Rhein. **SWEDEN.** 1 km SE. Lapp Museum; Are; Eksharad; Lapland (Abisko; Abisko National Park; Jebrenjokk; Riksgransen); Ostersund; Pr. Jemtland, Are; Varmland, Eksharad. **UNITED KINGDOM.** Dumbartonshire, Bonhill. **USSR.** Siberia, Altal (ca. 50 km SE. of Teletskoya Lake; Gorno Altal, Altal Station; Teletskoya Lake) (CNC, DEBU, LEM, USNM).

2 ♂ from the following Oriental locality: **PAKISTAN.** Punk, Prov., Murree (USNM).

Additional distribution information: *Liopiophila varipes* is also found in the following Palaearctic countries: Austria, Corsica, Czech Republic, Danish mainland, Finland, France, Germany, Hungary, Iceland, Italy, Japan, Norway, Poland, Russia (Central, North, Northwest, South), Slovakia, Sweden, Switzerland and The Netherlands (Ozerov 1989, Merz 1996, Iwasa 1998, Ozerov 2004b, Roháček & Ševčík 2009).

Notes on capture: This species was captured in the Nearctic from May to October with pan (non-baited, baited with dung or mushroom), carrion (pitfall, box), Malaise, flight intercept and rotary traps, as well as sweeps/pooter, mushroom vacuum and sweep nets. It has been collected on carrion (cat, seagull, robin, lemming, moose, turtle, fish, rabbit, squirrel, pig, wolf, grouse), moose antler and bones. *Liopiophila varipes* has also been found in forest (maple-beech hemlock, damp hillside mixed forest, poplar/spruce, swampy balsam/popar wood), shaded damp earth ditch, mesic, Alder thicket, garden, bog, tundra, marshy river shore, sedge, brine and in

grasses. This species was also found on *Salix*, *Carex* and *Equisetum* beside lake, flower pots, dung, mushrooms, shale, limestone scree, along a stream, around camping vegetation and garbage, near a pond, at bleeding Elm stump, at a light source and near a creek.

Diagnosis. *Liopiophila varipes* resembles *Prochyliza brevicornis* but differs from other piophilids by a setulose patch on middle of anepimeron, male genitalia with an enlarged sternite 8, sternites 1–4 with strong and dense setae and with a well sclerotised claw-like epiphallus.

Description. Body length 2.3–4.4 mm; wing length 2.7–3.8 mm. Body glossy black with yellow on parts of head and legs. Setae and hairs black. **Head:** Head as high as long, head black except for face, part of gena along eye margin and anterior portion of frons which are yellow; palps also yellow, sometimes shaded black; silvery-white microtomentum posteriorly on margin and extending behind eye; eyes round; height of eye 6–7.8 times genal height; row of short setae along gena; short hairs scattered on occiput, between inner and outer vertical setae, from postocellar setae to anterior end of ocellar triangle, on frons and fronto-orbital plates; 2 short lateroclinate posterior fronto-orbitals (the upper slightly stronger than the lower); inner and outer vertical setae of equal length; ocellar setae as long as vertical setae; postocellar setae slightly longer than vertical and ocellar setae; first flagellomere round, either entirely black, or yellow and slightly shaded black; arista bare; arista 2.5–3 times length of first flagellomere; arista brown; palpus with several setulae along surface. **Thorax:** Glossy black; proepisternum, meron, katatergite, anatergite and metapleuron with silvery-white microtomentum; postpronotal and presutural intra-alar absent; 1 supra-alar, 1 postalar, 1 intrapostalar, 1 postsutural dorsocentral setae; acrostichal setulae in 12 rows; 1 proepisternal seta; prosternum bare; anepisternum setulose; anepimeron with patch of setulose in middle (sometimes with only 2-3 setulae); katepisternum with fine hairs and sometimes 1–2 setae on upper margin; scutellum convex and bare, with 2 pairs of marginal setae. **Wing:** Hyaline; wing veins mostly yellow; veins R_{4+5}, M_{1+2} (from crossvein dm-cu to wing margin) and M_{3+4} brown; calypter and fringe white; length of crossvein dm-cu 4 times length of crossvein r-m; length of C between Sc and R_1 2 times length of crossvein h; length of M_1 between crossvein r-m and dm-cu slightly more than 2 times length of dm-cu. Halter white. **Legs:** Fore coxae black dorsally and yellow ventrally; mid and hind coxae black; femora black, except for mid femur which has a small portion of yellow distally; fore and hind tibiae mostly black with some yellow proximally; mid tibia varies from mostly

black to mostly yellow; fore tarsus black; mid and hind tarsi yellow with tarsal segments 4 and/or 5 black; claws yellow proximally and black distally. **Abdomen:** Glossy black; dull reflections present on some tergites; covered with short setae, except for males which have longer setae on sternites. **Male genitalia:** Sternite 3, 4 and 5 medially depressed and weakly sclerotised from anterior to posterior margin causing both sides to be rectangular (longer than wide) and slightly convex; sternite 6 and 7 strongly sclerotised along anterior margin; sternite 7 with 1 strongly sclerotised narrow projection, rounded at apex and leaning laterally; sternite 8 round and convex with several short setae; epandrium on lateral view narrow, wider ventrally, forming a 90° triangle; epandrium with a row of 5 strong lateral setae with many shorter setae on remaining surface; surstylus not fused with epandrium, subtriangular with flat base connected to membrane and distally elongated and more strongly sclerotised; surstylus covered with many short setae; postgonite strongly sclerotised, rectangular with several bumps at apex; postgonite about 2 times longer than high; pregonite short with rounded apex, with 1 setulae at apex; distiphallus membranous, spinulose and hairy (hairs longer laterally); distiphallus with 2 orange blunt lines both starting at base, one extending on 2/5 of the length and the other on 4/5; distiphallus curled midway, inflated and long, longer than abdomen length; cerci weakly sclerotised, oval, with 1 setae and short setulae. **Female genitalia:** Cerci about 4 times as long as wide; cerci with 2 pairs of strong setae dorsally (the anterior most being the strongest) and 1 ventrally, with several short and fine setae on surface; two sclerotised spermathecae, oval, with slightly wrinkled surface.

MYCETAULUS Loew 1845

(Figures 27, 28)

Mycetaulus Loew 1845: 37, type species *Mycetaulus hoffmeisteri* Loew (= *bipunctatus* (Fallén 1823) (by monotypy).

Neottiophilum Frauenfeld 1868: 895, type species *Neottiophilum fringillarum* Frauenfeld (= *praeustum* (Meigen 1826) (by monotypy), **new synonym**.

Diagnosis. *Mycetaulus* can be differentiated from other genera by the presence of 2 postsutural dorsocentral setae, a fumose costal cell and stigmal space, and wing with apical spot. This description regroups characters from Nearctic species of *Mycetaulus*. **Description.** Body length 2.0–4.1 mm; wing length 2.1–3.8 mm. Head yellow and black in *M. costalis* and *M. lituratus*,

brown in *M. longipennis*, and yellow in *M. polypori* and *M. subdolus*. Thorax yellow and brown in *M. costalis* and *M. longipennis*, black in *M. lituratus*, yellow in *M. polypori* and *M. subdolus*. Abdomen glossy black or brown, except for syntergite 1+2 and sometimes tergite 3 yellow in *M. subdolus*. Legs mainly yellow with some black sections especially on tarsal segments (*M. subdolus* entirely yellow). Setae and hairs black. **Head:** Head higher than long, except as high as long in *M. lituratus* and *M. subdolus*; head mainly yellow with black on occiput, ocellar triangle and posterior fronto-orbital plate and gena in *M. costalis* and *M. lituratus*, entirely brownish-yellow in *M. longipennis*, and entirely yellow in *M. polypori* and *M. subdolus*; eyes round; hairs scattered on occiput, between inner and outer vertical setae on ocellar triangle, between ocellar triangle and postocellars and along anterior fronto-orbital plates and anterior portion of frons; lunule bare (setulose in *M. lituratus*); inner and outer vertical setae of equal length; arista pubescent; base of arista yellow with rest brown (in *M. polypori* can be entirely brown); palps with 1 long preapical ventral setulae (absent in *M. polypori* and *M. subdolus*) and several scattered setulae over all surface. **Thorax:** Thorax yellow and brown in *M. costalis* and *M. longipennis*, black in *M. lituratus*, yellow in *M. polypori* and *M. subdolus*; 1 posterior postpronotal, 1 presutural intra-alar; 1 supra-alar, 1 postalar, 1 intrapostalar (absent in *M. costalis* and *M. longipennis*), 2 postsutural dorsocentral setae (3 in *M. subdolus*); acrostichal setulae in 10 rows (except 9 in *M. subdolus*); 1 proepisternal seta; prosternum bare; anepisternum bare; anepimeron bare; scutellum convex and bare (with hairs in *M. lituratus*), with 2 pairs of marginal setae. **Wing:** Hyaline; stigmal space fumose; wing shaded black at apex of wing; veins yellow, but brown on area with apical spot; length of crossvein dm-cu usually 4 times length of crossvein r-m; length of C between Sc and R_1 usually 2 times length of crossvein h; length of M_1 between crossveins r-m and dm-cu 1.5–2 times length of dm-cu. Halter white. **Legs:** Legs mainly yellow with some black sections (entirely yellow in *M. subdolus*); claws yellow proximally and black distally (usually entirely black in *M. lituratus*). **Abdomen:** Abdomen glossy black or brown, except for syntergite 1+2 and sometimes tergite 3 yellow in *M. subdolus*; dull reflections present on some tergites; short hairs scattered (strong in *M. polypori*). **Male genitalia:** Sternite 6 and 7 strongly sclerotised along anterior margin; sternite 8 round and convex, with several short setae (bare in *M. subdolus*); surstylus not fused to epandrium; postgonite and pregonite with 1 or 2 lobes; distiphallus membranous, with weak hairs; cerci weakly sclerotised, separated from

epandrium; cerci crescent-shape or oval with several setae. **Female genitalia:** Sternite and tergite 7 and 8 with row of setae along posterior margin and fine setulae on rest of surface; two sclerotised spermathecae (weakly scelrotised in *M. lituratus*); spermathecae cylindrical and elongated (short in *M. longipennis*) with wrinkled surface.

There are ten described species of *Mycetaulus*. *Mycetaulus costalis, M. polypori, M. lituratus, M. longipennis* and *M. subdolus* are the only described species present in the Nearctic region. Several undescribed species of *Mycetaulus* in the Nearctic are present (McAlpine 1977). These new species all key out to couplet 8 in McAlpine's *Mycetaulus* key. A revision of the *Mycetaulus bipunctatus* group is needed to describe these species since they vary mainly only by male and female genitalic characters. Couplet 8 also needs closer attention in McAlpine's (1977) key since characters used to differentiate *M. bipunctatus* and *M. longipennis* are variable and sometimes the limits of each character is ambiguous. There is in fact a variation in the costal cell fumosity, and the setulae border between acrostichal and the dorsocentral area and setae is ambiguous in many specimens.

Mycetaulus bipunctatus is known from the Palaearctic (McAlpine 1977, Ozerov 2004b) but many specimens have been identified as being from the Nearctic in several museums. However, since a revision of the *M. bipunctatus* group is needed to verify if *M. bipunctatus* is found in the Nearctic or if it is rather several new species, this present work will not consider *M. bipunctatus* as being part of the Nearctic.

The *Mycetaulus bipunctatus* grous is not revised in this thesis for the following reasons: 1) DNA data would be necessary to test species limits since species mainly varie by male genitalic characters and females are hard to associate and 2) Palaearctic species would need to be considered for the revision of this group, so it would be more appropriate to treat this in an Holarctic revision.

Mycetaulus costalis Melander 1924

(Figure 27)

Mycetaulus costalis Melander 1924: 79 (type locality: United States of America, Oregon, Mt. Hood).

Type material examined. 1 ♂ holotype. Mt. Hood, OR, 3000ft, 29.vii.1921, A.L. Melander, Type *Mycetaulus Costalis* Mel., A.L. Melander Collection 1961, Holotype *Mycetaulus costalis*, Melander 1924: 79, det. A Ozerov, 2002, *Mycetaulus bipunctatus* (Fallén), det. A.L. Ozerov 2002 (USNM).

Other material examined. 8 ♂, 10 ♀ from the following Nearctic localities: **CANADA. British Columbia:** Nanaimo Lakes bog. **Yukon Territory:** Dawson City. **UNITED STATES OF AMERICA. Alaska:** Elliot Highway mi 27.8, White Mtn. Trail **Arizona:** Navajo Co., 4 mi Southwest of Forestdale. **California:** Los Angeles Co., Mt. Wilson; Marin Co., Mill Valley; Modoc Co., Cedar Pass Campground; Palo Alto; Santa Clara Co., Standford University; Tuolumne Co., Lost Claism Campground. **Idaho:** Collins. **Utah:** Logan Canyon. **Washington:** Mica; Valleyford (CAS, DEBU, RBCM, USNM) (Fig. 27).

Notes on capture: *Mycetaulus costalis* has been captured from June to September in mushroom traps, on *Boletus* and in Aspen hydrocut.

Diagnosis. This species is similar to *Mycetaulus bipunctatus* but differs in the apical spot which is separated in two. The male genitalia is much like *Mycetaulus bipunctatus* but it can be used to differentiate *M. costalis* from other Nearctic species. Distiphallus with apex strongly sclerotized, covered with asymmetrical plate-like structures. **Description.** Body length 3.0–3.3 mm; wing length 2.9–3.1 mm. Head and thorax mainly yellow with some brown. Abdomen brown. Legs yellow with possible brown on mid and hind femora and tibiae. **Head:** Head yellow except for occiput, occellar triangle, posterior fronto-orbital plate, gena and palpus which are brown (some specimens light brown on frons); height of eye 4.8–5 times genal height; 2 reclinate posterior fronto-orbitals (the posterior one strong and ¾ the length of verticals); ocellar setae as long as postocellar setae, and 1.2 times longer than verticals; first flagellomere oval (¼ longer than wide), darkened along dorsal, anterior and ventral margins; arista about 3 times length of first flagellomere; **Thorax:** Glossy yellow and brown; yellow present on postpronotum (expending medially and posteriorly), on lateral sides of prescutum and scutum, on scutellum up to anterior postsutural dorsocentral setae, on dorsal margin of anepimeron, and on prosternum and anepisternum; katatergite, anatergite and posterior half of anepimeron dull; intrapostalar absent; prescutum and scutum with short hairs until posterior presutural dorsocentral seta; katepisternum with 2 setae on upper margin. **Wing:** Wing shaded black at apex of wing along vein R_{2+3} and

R_{4+5}, and along the costal vein between the two veins; calypter dusty; fringe brown; length of C between Sc and R_1 about 1 times length of crossvein h. **Legs:** Coxae and leg segments yellow; tarsal segment 4 and 5 on each legs usually shaded brown; brown may also occur on distal half of mid and hind femora (usually along ventral side), and along entire tibiae. **Abdomen:** Glossy brown. **Male genitalia:** Epandrium on lateral view slightly higher than wide, anterior and ventral margin straight, with posterior margin forming a rounded edge; epandrium with 2 outstanding setae posteriorly and with several shorter setae; surstylus oval with many setae posteriorly; postgonite long and narrow, curved at midpoint with rounded apex; postgonite with small rounded projection dorsally at preapex; pregonite strongly sclerotised towards apex, and weakly sclerotised on remaining surface; pregonite weakly sclerotised; pregonite as postgonite except slightly longer and wider than postgonite, but without a projection; distiphallus curved with length reaching anterior margin of sternite 3; distiphallus with long hairs from base to 3/5 of the length, hairs short from 3/5 of the length to preapex (this last section is inflated and asymmetrical); apex of distiphallus strongly sclerotised and covered with very small asymmetrical plate-like structures; cerci crescent shape with 2 outstanding setae and 3 shorter ones. **Female genitalia:** Cerci about 3.5 times longer than wide; cerci with 2 pairs of setae laterally on ventral side and 2 pairs laterally on dorsal, and with additional setulae.

Mycetaulus lituratus Melander & Spuler 1917

(Figure 27)

Piophila liturata Melander & Spuler 1917: 60 (type locality: United States of America, Washington, Kamiac Butte).

Mycetaulus lituratus; McAlpine 1977: 1.

Neopiophila liturata; Ozerov 2004a: 606.

Type material examined. 1 ♂ lectotype. Kamiac Butte, Wash, 25.vii.1914, Paratype *Piophila liturata* M.-S., A.L. Melander Collection 1961, Lectotype, *Piophila liturata* Melander, Spuler 1917: 60, by Ozerov 2002 (USNM). 2 ♂, 2 ♀ paralectotypes. **UNITED STATES OF AMERICA. Idaho:** Avon; Chatcolet; Potlatch (USNM).

Other material examined. 10 ♂, 13 ♀ from the following Nearctic localities: **CANADA. British Columbia:** Sproat Lake; Squamish; Tofino; Upper Carmanah Valley. **UNITED STATES OF**

AMERICA. Idaho: Lewis Co., Lawyers Canyon; Mt. Moscow; Moscow; Potlatch; Shoshone Co., Hobo Cedar Grove Bot. Area St. Joe NF; Waha. **Montana:** Mineral Co., St. Regis; Missoula; Perma. **Washington:** Clallam Co., Olympic National Park, 4.7 km North Fairholm; Mt. Constitution, Orcas Island; Mt. Rainier, Hansen Camp; Quilcene; Stehekin, Lake Chelan (CAS, CNC, DEBU, LEM, UBCZ, USNM) (Fig. 27).

Notes on capture: This species was captured from May to September in Douglas Fir Forest and at a forest stream.

Diagnosis. *Mycetaulus lituratus* differs from other Nearctic *Mycetaulus* species by having a setulose lunule and scutellum, entirely glossy black thorax and wing shaded black along costa from proximal tip of wing to vein R_{4+5}. **Description.** Body length 2.5–3.4 mm; wing length 2.5–3.1 mm. Body glossy black with yellow coloration on head and legs. **Head:** Head as high as long, yellow except for black occiput, clypeus, ocellar triangle and posterior fronto-orbital plate; height of eye 3–3.5 times genal height; dense hair on gena, occiput, frons, fronto-orbital plates and ocellar triangle; 2 reclinate posterior fronto-orbitals (upper no more than 3 times as long as lower); lunule setulose; verticals 1.2 times the length of ocellar setae; postocellar setae 1.2 times length of ocellar setae; first flagellomere round, usually shaded black along dorsal and anterior margin; arista 2–2.5 times length of first flagellomere. **Thorax:** Glossy black; katatergite, anatergite and metapleuron dull; katepisternum with 2–3 setae on upper margin; scutellum setulose. **Wing:** Wing shaded black along costa from proximal tip of wing to vein R_{4+5}; calypter and fringe white. **Legs:** Coxae and leg segments yellow, except for fore tarsus which has black tarsal segment 2–5; fore tarsus with tarsal segment 1 partly black at distal end; mid and hind tarsi with black shading on tarsal segments 4 and 5; claws black, in some specimens brown proximally. **Abdomen:** Glossy black; short hairs scattered, and more developed on lateral margins of tergite 3; row of weak setae along posterior margin of both sternites and tergites. **Male genitalia:** Epandrium twice as wide on lateral ventral margin than width of epandrium dorsally; epandrium with several oustanding setae along posterior margin, and shorter setae on remaining of surface; surstylus with one rounded lobe and one oval projection mid way inner lateral margin; surstylus with short setae; postgonite strongly sclerotised, with clawlike projection, curved dorsally, and with one subtriangular medial posterior lobe; pregonite with two subtriangular lobes with curved tips, the upper lobe being slightly longer; pregonite with short

setulae on both lobes; distiphallus bare on half distal end and weakly haired on half proximal end; distiphallus with 2 sclerotised tubes laterally on lower half; distiphallus length not exceeding anterior margin of sternite 4; cerci weakly sclerotised, crescent-shape and with 1 long seta and 2–3 shorter setae. **Female genitalia:** Cerci longer than wide with 2 pairs of setae laterally on ventral side and 1 pair laterally on dorsal side, and with additional setulae; 2 weakly sclerotised spermathecae.

Mycetaulus longipennis Loew 1869

(Figure 27)

Mycetaulus longipennis Loew 1869: 186 (type locality: Canada, Hudson Bay Territory).
Mycetaulus pulchellus Banks 1915: 145 (type locality: United States of America, Virginia), synonym in McAlpine 1977: 1.

Material examined. 62 ♂, 108 ♀, 3 ? from the following Nearctic localities: **CANADA. Alberta:** Banff, Johnston Canyon. **New Brunswick:** Kouchibouguac National Park; Pokeshaw. **Ontario:** Bells Corners; Constance Bay; Highway 129, 35 km North Jct. 556; Hilton Beach; Kirkwood Township, Algoma District; Maynooth; Mer Bleu, 5 mi East; Simcoe Co., Washago; Stonecliffe, Driftwood Provincial Park. **Quebec:** Joliette Co., St. Alphonse; Lachute. **UNITED STATES OF AMERICA. California:** Ventura Co., Wagon Road. **Georgia:** Mt. Enotah. **Maine:** Baxter State Park. **Maryland:** Prince Georges Co., Beltsville. **Michigan:** Lapeer Co., North Branch; Marquette Co. **New Hampshire:** Franconia. **Virginia:** Fairfax Co. (Dead Run; Mt. Vernon); Plummers Island (CAS, CNC, DEBU, LEM, USNM) (Fig. 27).

Additional distribution information: *Mycetaulus longipennis* is also present in the Nearctic in Canada, Hudson Bay, according to the type locality (Melander & Spuler 1917).

Notes on capture: This species has been captured from July to October with sweep net, malaise and carrion traps. It has been collected on a shoreline, under jaskespine, on rotting fungi, on feces, in pine plantation and in forest (Hardwood, *Acer-Tauga*).

Diagnosis. This species can be differentiated by having a completely brownish-yellow head, a fumose basal costal cell and scutum with short hairs scattered from anterior end but stopping between the two postsutural dorsocentral setae. **Description.** Body length 2.3–4.1 mm; wing length 2.4–3.6 mm. Head brownish-yellow and body glossy yellow with possible brown.

Abdomen black. Legs mainly yellow. **Head:** Head brownish-yellow; height of eye about 5.4 times genal height; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); verticals as long as postocellar and ocellar setae; first flagellomere almost 2 times longer than wide; arista about 3.5 times length of first flagellomere. **Thorax:** Glossy yellow, with brown on subscutellum, metapleuron, anatergite, katatergite and portions of meron and anepimeron; meron, scutellum, scutum from anterior postsutural dorsocentral setae to scutellum, katatergite, metapleuron and anatergite dull; intrapostalar absent; scutum with short hairs scattered from anterior end, but stops between the two postsutural dorsocentral setae; katepisternum with 2 setae on upper margin. **Wing:** Hyaline with basal costal cell fumose; apical spot covering veins R_{2+3} and R_{4+5}; calypter white; fringe brown. **Legs:** Coxae and leg segments yellow; tarsal segment 4 and 5 may be shaded black; mid and hind femora and tibiae sometimes with a brown tint. **Abdomen:** Short hairs scattered with outstanding row of weak setae along posterior margin of sternites and tergites. **Male genitalia:** Epandrium on lateral view slightly higher than wide, anterior and ventral margin straight, with posterior margin forming a rounded edge; epandrium with a row of 5–6 setae along posterior margin and with several shorter setae behind these; surstylus small and circular, weakly sclerotised and with short setae; postgonite with one pointed lobe (about four times as long as wide) and with a small curvature preapically; pregonite more strongly sclerotised along margins; pregonite with one lobe (base about 1.5 times its height), pointed at tip along ventral margin; pregonite with 1 small setulae dorsally; distiphallus thickest just apical to midpoint; distiphallus with short hairs along base and with spinules from middle to apex; distiphallus with distal end densally spinulose and asymmetrically inflated; distiphallus about length of abdomen; cerci small and oval with 1 seta and a few additional setulae. **Female genitalia:** Cerci about 3–3.5 times longer than wide, with 2 pairs of setae laterally, 1 pair dorsally and several additional setulae.

Mycetaulus polypori Melander 1924

(Figure 28)

Mycetaulus polypori Melander 1924: 80 (type locality: United States of America, Washington, Mt. Rainier, Longmire).

Type material examined. 1 ♂ lectotype. Mt. Rainier, Longmire, 18.vii.1922, A.L. Melander, Paratype *Mycetaulus polypori* Mel., A.L. Melander Collection 1961, Lectotype *Mycetaulus polypori* Mel, Steyskal 1982, Lectotype *Mycetaulus polypori* Melander 1924: 80, by A. Ozerov 2002 (USNM). 1 ♂ paratype, syntype. **UNITED STATES OF AMERICA. Washington:** Mt. Rainier, Longmire, 18.vii.1922, A.L. Melander (USNM). 16 ♂, 8 ♀ paralectotypes. **UNITED STATES OF AMERICA. Washington:** Mt. Rainier (Eagle Peak; Longmire; Tahoma Fork) (USNM).

Other material examined. 68 ♂, 63 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff; Banff, Sulfur Mt; Jasper National Park; Waterton Lakes National Park; Waterton Lakes National Park, Cameron Lake Road. **British Columbia:** 32 mi Southwest Terrace; Brillian; Fry Creek; Kootenay National Park, Cobb Lake Trail; Queen Charlotte City; Queen Charlotte Islands (Laskeek Bay; Moresby Island; Robson); Penticton, Apex Mt; Squamish; Vancouver. **UNITED STATES OF AMERICA. California:** Nevada Co., (Carpenter Ridge; Donner Summit). **Colorado:** 2 mi Northwest Eldora; Boulder Co., Corona Pass; Clear Creek Co., West Chicago Creek; Hoosier Pass; Loveland Pass, West slope; Mt. Evans (Doolittle Ranch; Echo Lake); Nederland, Science Lodge. **Idaho:** Avon; Blaine Co., Galena; Coolin, Priest Lake. **Oregon:** Benton Co., Marys Peak 14 mi. **Utah:** Big Brush Creek, 22 mi North of Vernal. **Washington:** King Co., Baring; Mt. Constitution; Skamania Co., Gifford Pinchot National Forest. **Wyoming:** East side Teton Pass; Sierra Madre Range, Battle Lake Road (BIO, CAS, CNC, RBCM, UBCZ, USNM) (Fig. 28).

Notes on capture: This species has been captured from May to October using sweep nets. It is found in habitats such as mixed forest, poplar wood, on the bank of steams and in a woodland path.

Diagnosis. *Mycetaulus polypori* differs by having an entirely yellow head and thorax, and a black fore tarsus. **Description.** Body length 2.8–3.3 mm; wing length 3.2–3.8 mm. Head and thorax glossy yellow. Abdomen black. Legs mainly yellow with brown variation on fore leg. Fore tarsus entirely black. **Head:** Head yellow, but some specimens with brown ocellar triangle and some also with brown on occiput; height of eye highly variable from 2–4 times genal height; several setae present along gena; 1 strong posterior and 1 weak anterior reclinate fronto-orbital setae; ocellar setae as long as postocellar setae, and 1.2 times longer than verticals; first

flagellomere round; arista 2.7–3 times length of first flagellomere; arista brown, base may have yellow in some specimens; palpus without an outstanding long setae, only with several scattered short setulae (one female was seen with longer setae on distal ventral end of palpus). **Thorax:** Glossy yellow, however 2 females from Queen Charlotte Islands, British Columbia has been seen with 3 brown strips on scutum, and with brown on meron, anepimeron and anepisternum (RBCM); meron, katatergite, metapleuron, anatergite and posterior margin of anepimeron dull; setulae present at least until posterior postsutural dorsocentral setae; katepisternum with 2 setae on upper margin. **Wing:** Apex of wing shaded black along costa and across veins R_{2+3} and R_{4+5}; calypter white; fringe brown; length of crossvein dm-cu slightly more than 3 times length of crossvein r-m; length of C between Sc and R_1 one time length of crossvein h. **Legs:** Coxae and leg segments yellow, except with variable brown on fore femur and tibia; fore tarsus black; mid and hind tarsi sometimes with black on tarsal segments 4 and 5; mid and hind femora and tibiae yellow (in some specimens hind femur and tibia with black distally, this can also occur on mid leg in darker specimens. **Abdomen:** Glossy black, in some specimens with partly yellow segments; abdomen with strong hairs; row of outstanding setae along posterior margin of both sternites and tergites. **Male genitalia:** Epandrium on lateral view slightly higher than wide, anterior and ventral margin straight, with posterior margin forming a rounded edge; epandrium with a row of 6–7 weak setae along posterior margin and with several setulae behind these; surstylus as wide as long, slightly rounded with small rounded projection on medial ventral margin; postgonite small and claw-like with a small subtriangular proximal ventral lobe; pregonite one small weakly sclerotised rounded lobe; distiphallus covered with short fine hairs, inflated and curled; cerci small and oval, with one weak setae and slightly setulose. **Female genitalia:** Cerci less than 2 times as long than wide; cerci with 1 pair of setae dorsally and ventrally, and with several additional setulae; spermathecae short and cylindrical.

Mycetaulus subdolus (Johnson 1922)

(Figure 28)

Geomyza subdola Johnson 1922: 25 (type locality: United States of America, Massachusetts, Manomet)

Material examined. 5 ♂, 6 ♀ from the following Nearctic localities: **CANADA. Ontario:** Grand Bend; Lambton Co., Port Franks, Karner Blue Sanctuary; Ottawa; Ottawa, McKay Lake. **Quebec:** Ste-Anne-de-Bellevue; Sherbrooke, Bishop's University Campus (CNC, DEBU, IMQC) (Figure 28).

Additional distribution information: *Mycetaulus subdolus* is also present in Manomet, Massachusett according to the holotype and in Auburndale and Rutland, Massachusset and Dummerston, Vermont according to the paratypes (Johnson 1922). According to McAlpine (1977), it is found from Ontario to Massachussets.

Notes on capture: This species has been captured from June to July with pan traps and sweep nets in *Poplar* wood near a pig carrion.

Diagnosis. This species varies from other Nearctic *Mycetaulus* by having an entirely yellow body, 3 postsutural dorsocentral setae and an apical spot not reaching apex of wing but covering veins R_{2+3} and R_{4+5}. **Description.** Body length 2.0–3.3 mm; wing length 2.1–3.1 mm. Body entirely yellow. **Head:** Head as high as long, yellow; gena narrow, height of eye about 8.3 times genal height; 2–3 setae along gena; 1 strong posterior and one weak anterior reclinate fronto-orbitals; ocellar and postocellar setae of equal length, and 1.2 times longer than verticals; first flagellomere round, yellow but dusty; arista 2.5 times length of first flagellomere; palps enlarge; papls without an outstanding long setulae, only several scattered short setulae. **Thorax:** Glossy yellow; anepimeron, meron, katatergite, anatergite, metapleuron dull; 3 postsutural dorsocentral setae (the anteriormost reduced); acrostichal setulae in 9 rows; setulae extending to posterior postsutural dorsocentral setae; katepisternum with 3 setae on upper margin. **Wing:** Apical spot not reaching apex of wing but covering R_{2+3} and R_{4+5}, and usually, but not always, splitting into two segments (hyaline area present between the two R veins as in *M. costalis*); calypter white; fringe brown; length of C between Sc and R_1 1 time length of crossvein h. **Legs:** Coxae and leg segments yellow. **Abdomen:** Syntergite 1+2 and sometimes tergite 3 partially to entirely yellow, tergite and sternite 4–8 black; dull reflections present on some tergites; row of outstanding setae along posterior margin of both sternites and tergites. **Male genitalia:** Sternite 8 bare; epandrium on lateral view triangular, widest ventrally; epandrium with row of 5–6 setae on both sides along posterior margin and with setulae behind these; surstylus short and circular with short and fine setae distally; postgonite with one narrow lobe about 4 times longer than wide; pregonite

strongly sclerotised along dorsal margin; pregonite with a rounded lobe and an apical, dorsal rounded projection with short setulae laterally; distiphallus long reaching anterior margin of sternite 3; distiphallus with very short hairs and 2 sclerotised tubes laterally from proximal to distal end; cerci small and oval with a few short setulae. **Female genitalia:** Cerci about 3 times as long as wide; cerci with 2 pairs of setae dorsally and 1 ventrally and several additional setulae.

PIOPHILA Fallén 1810

(Figure 29)

Piophila Fallén 1810: 20, type species *Musca casei* Linnaeus 1758: 597 (by monotypy).
Tyrophaga Kirby & Spence 1826: 78, type species *Musca casei* Linnaeus 1758: 597 (by monotypy).

Diagnosis. This genus differs by having 3 acrostichal rows of setulae and 1 spherical spermatheca in females.

Piophila includes the species *P. casei* (Linnaeus 1758) and *P. megastigmata* McAlpine 1978. Only *P. casei* is present in the Nearctic.

Piophila casei (Linnaeus 1758)

(Figure 29)

Musca casei Linnaeus 1758: 597 (as *putris* var.) (type locality: Europe).
Musca atrata Fabricius 1781: 333 (type locality: Germany).
Piophila pusilla Meigen 1838: 360 (type locality: Germany, "Hiesige Gegend") synonym in Duda 1924.
Piophila petasionis Dufour 1844: 369 (type locality: France, Saint Sever) synonym in Duda 1924.
Piophila melanocera Rondani 1874: 249 (type locality: Italy, Parma) synonym in Duda 1924 and Hennig 1943.
Piophila smithii Hutton 1901: 89 (type locality: New Zealand) synonym in Miller 1950.
Piophila dichaeta Hendel 1913: 85 (type locality: Taiwan, Formosa) synonym in Duda 1924.
Piophila meridionalis Hendel 1933: 219 (type locality: Paraguay, Santa Trinidad) synonym in Steyskal 1967.

Piophila flavifacies Brunetti 1909: 367 (type locality: India) synonym in McAlpine 1977: 1.

Material examined. 208 ♂, 105 ♀, 2 ? from the following Nearctic localities: **CANADA. Alberta:** Edmonton; Medicine Hat. **British Columbia:** Oliver; Vancouver. **Manitoba:** Glenlea Research Station; Winnipeg. **New Brunswick:** Grand Manan Island, Seal Cove; Kouchibouguac National Park. **Nova Scotia:** Halifax. **Ontario:** Ancaster; Beamsville; Guelph; Ottawa; Toronto. **Quebec:** La Trappe; Lauzon; Levis; Montebello; Montreal; Outremont; Scotstown. **Saskatchewan:** Grant East; Grant East, Grasslands National Park; Indian Head. **UNITED STATES OF AMERICA. Alabama:** Florence. **Arizona:** 25 mi North Flagstaff, Wupatki National Monument. **California:** Coachella; Imperial Co., Glamis; Larkspur; Los Angeles Co; Pacific Grove; Pasadena; San Jose; San Mateo Co., Sharp Park; Sonoma Co. **District of Columbia:** Washington. **Florida:** Alachua Co.; Bradenton; Lakeland; White Springs. **Georgia:** Thomasville. **Hawaii:** Oahu (Honolulu; Kaneohe). **Kansas:** Lawrence. **Louisiana:** New Orleans, via Mexico Island; Opelousas. **Maine:** Matinicus Island. **Maryland:** Blythedale; Cabin John; Colesville; Hagerstown; Patuxent Ref Bowie; Plummers Island. **Massachusetts:** Beverly; Boston; Cambridge; Falmouth Heights; Woods Hole. **Michigan:** Detroit. **Mississippi:** Oxford; Pass Christian. **New Mexico:** Lincoln Co., Gallinas Park, 10 mi. West Corona; Santa Fe Co., Santa Fe Baldy. **New York:** Buffalo; Hoboken; Staten Island. **Oregon:** Malheur Co., Jordan Valley. **Pennsylvania:** Lehigh Gap; Philadelphia. **South Dakota:** Aberdeen; Brookings. **Texas:** 45 mi West of Alpine; Austin; Dallas; Kerrville; Kimble Co., 7 mi Southwest London; Mission; Victoria. **Utah:** Daggett Co., Dutch John; Emery Co., Wild Horse Creek, 1.5 mi West Wild Horse Butte; Grand Co., Moab; Kane, Smokey Mt. Road. **Virginia:** Alexandria Co., Maywood; Arlington; Falls Church. **Washington:** Pullman; Tacoma; Union Flat; Wenatchee. **Wyoming:** Old Faithful, Yellowstone Park; Teton Co., Moran Jct; Unita Co., 8 mi Southeast Evanston; Vinta Co. (6 mi East Mt. View; Lonetree) (CAS, CNC, DEBU, LEM, ORUM, RBCZ, UASM, UBCZ, USNM) (Fig. 29).

6 ♂, 5 ♀ from the following Palaearctic localities: **EGYPT.** Cairo; Desert near Cairo Egypt. **FRANCE.** France. **GERMANY.** Blankenfelde. **GREECE.** Macedonia, Struma. **ISRAEL.** Akko; Avdat. **ITALY.** Italy; Sarranus Sardinia, Monte Acuto. **SWITZERLAND:** Zurich, Mt. Uetliberg. **TURKEY.** Smyrna (USNM).

28 ♂, 23 ♀ from the following Neotropical localities: **ARGENTINA.** Bs. Aires, San Isidro (Delta); Chubut Prov., Puerto Madryn; Entre Rios Pronunciamiento. **BARBADOS.** Holatown. **BRAZIL.** Alto Yacuhy, Rio Grande; Santos Sao Paulo. **CHILE.** BioBio, 5 km W. of Tucapel; Dos Lagunas, Magallanes; Easter Island, Hanga; Isla de Pascua, Hanga-roa; Linares, Fundo Malcho; Magallanes, Punta Arenas; Ultima Esperanza Dos Lagn. Magalla. **COLOMBIA.** Cundinamarca. **COSTA RICA.** Cartago; Cartago, Tres Rios. **CUBA.** Pinar del Rio Prov., Soroa. **GUATEMALA.** Guatemala city. **JAMAICA.** Kingston; Manchester L., Mandeville; Yalluhs at Yalluhs River. **MEXICO.** 10 mi. W. El Salto; BajaCal. Norte, Isla de Guadalupe; Veracruz. **PARAGUAY.** Molinascue; Villarica. **PANAMA.** Chiriqui David, Doleguita. **PERU.** Lima, Verrugas Canyon (CNC, DEBU, USNM).

19 ♂, 9 ♀ from the following Afrotropical localities: **BENGAL.** Bengal. **DEMOCRATIC REPUBLIC OF THE CONGO.** Zaire, Mbau, N. Kivu. **UGANDA.** Ankole, Kichwanba; Kigezi Dist., Kayonza forest. **SOUTH AFRICA.** Kruger Nat. Pk., Parfuri, Transvaal (CNC, USNM).

5 ♂, 6 ♀ from the following Oriental localities: **CAMBODIA.** 40 km WSW. Khong. **CHINA.** Suifu Szechuer. **HONG KONG.** Hong Kong. **INDIA.** Assam, Misamari; Punjab, Amritsar; Punjab, Amritsar, Jhabbal Road. **INDONESIA.** Sumatra, Berastagi. **SRI LANKA.** Col. Dist., Colombo. **THAILAND:** Bangkok, Plukchit (CNC, DEBU, USNM).

23 ♂, 10 ♀, 4 ? from the following Australasian localities: **AUSTRALIA.** Kholo, S. E. Old; Macquarie Island; New South Wales (Botany; Illawarra; Quorrobolong). **FRENCH POLYNESIA.** Marquesas, Nuku Hiva, Toovii. **NEW CALEDONIA.** Mt. Koghis. **NEW ZEALAND.** Whakamaru (CNC, DEBU, USNM).

Additional distribution information: *Piophila casei* is also present in the following Nearctic localities: Colorado, Idaho (Moscow), Tennessee and Wisconsin (Polk County) (Melander & Spuler 1917, Reed 1958, de Jong & Chadwick 1999) and in the following Palaearctic localities: Croatia, Czech Republic, England, Finland, Jamaica, Japan, Portugal, Russia (Central, North, Northwest, South), Slovakia and Ukraine (Melander & Spuler 1917, Zuska & Laštovka 1965, Iwasa 1998, Ozerov 2004b, Padro e Castro et al. 2012, Kahanpää & Winqvist 2014, Misiachna and Korneyev 2015). It is also present in Malaysia and Thailand in the Oriental region (Kumara *et al.* 2012).

Notes on capture: This species has been captured in the Nearctic all year long (probably several were caught in the interior or bred) using sweep nets, and carrion and baited traps. It can be found on carrion (fish, herring, whale, deer), on meat bone and has been reared from hides. It has also been reared and found on various foods (cheese, ham, meat). *Piophila casei* has been collected on carrion present in grass, sage and shrubs at a river. It has also been found near compost heap, at light, on stinking *Arum*, on wood pulp, in spruce-fir-tundra, from leaves of cottonwood trees *Populus* sp. and on sagebrush.

Diagnosis. *Piophila casei* differs from other Piophilidae by having 3 acrostichal rows of setulae, a bare arista, long pale ventral setulae on hind trochanter of males and 1 spherical spermatheca in females. **Description.** Body length 2.5–4.0 mm; wing length 2.5–3.9 mm. Head yellow with black on anterior of frons, posterior fronto-orbital plates and ocellar triangle. Thorax and abdomen glossy black. Legs partly yellow and black. Setae and hairs black. **Head:** Head slightly as high as long, yellow with black on posterior region of frons, posterior fronto-orbital plates and ocellar triangle; some darker specimens with a black first flagellomere; eyes round; height of eye about 1.8–2 times genal height; short setae along gena; short hairs scattered on occiput, from postocellar setae to anterior end of ocellar triangle, on frons and fronto-orbital plates; fronto-orbitals usually absent, at most with 1 weak reclinate seta; inner and outer vertical, ocellar and postocellar setae reduced and of equal length; first flagellomere oval and with possible black shading; arista bare; arista about 2.5 times length of first flagellomere; base of arista yellow with rest brown; palpus with short setulae, longest ventrally. **Thorax:** Glossy black; proepisternum, scutum lateral margin, meron, katatergite, anatergite and metapleuron with silvery-white microtomentum; postpronotal absent; presutural intra-alar absent, if present weak; 1 supra-alar, 1 postalar, 1 intrapostalar, 1 postsutural dorsocentral setae; 3 acrostichal rows of setulae; 1 proepisternal seta; prosternum bare; anepisternum setulose; anepimeron bare; scutellum convex and bare, with 2 pairs of marginal setae. **Wing:** Hyaline; veins whitish yellow; calypter and fringe whitish/yellow; length of crossvein dm-cu almost 4 times length of crossvein r-m; length of C between Sc and R_1 less than 1 time length of crossvein h; length of M_1 between crossveins r-m and dm-cu about 1.7 times length of dm-cu. Halter whitish/yellow. **Legs:** Fore coxa yellow; mid and hind coxae varies from yellow to black; fore and hind femora and tibiae mainly black with some yellow proximally (some specimens with entirely yellow hind femur); mid femur

yellow with a black spot in some specimens; mid tibia varies from entirely yellow to mostly black; fore tarsus black (some specimens with tarsal segment 1, 2 and 3 yellow, almost white); mid and hind tarsi yellow with black tarsal segments 4 and 5; male with long pale ventral setulae on hind trochanter; claws yellow proximally and black distally. **Abdomen:** Glossy black; dull reflections present on some tergites; covered with short setae; male with sternite and tergite 3–5 with row of long setae along posterior margin; setae also longest laterally on tergites. **Male genitalia:** Sternite 4 and 5 medially depressed and less sclerotised, dividing sternites in 2 convex bumps; sternite 6 and 7 strongly sclerotised along anterior margin; sternite 7, at anterior margin, with small elongated projection, with rounded tip; sternite 8 round and convex with several short setae; epandrium in lateral view higher than wide, anterior and ventral margin straight, posterior margin curved; epandrium with 1 long seta on posterio-ventral margin and 1 long seta on posterio-dorsal margin, remaining of surface with shorter setae; surstylus not fused with epandrium, not reduced but not extending too far from epandrium; surstylus on lateral side rectangular (higher than wide) with rounded edge posterio-ventrally from middle to ventral margin; surstylus with several setae posteriorly; postgonite well sclerotised, elongated, widest at base and most narrow distally; pregonites rectangular at base with apex extended in 2 rounded lobes of similar size, slightly folded along medial line; pregonite with several setae; distiphallus membranous, long (at least length of abdomen) and curled at midpoint; distiphallus from base to midpoint very hairy with hairs longest laterally; distiphallus from midpoint to apex very spinulose with very short hairs laterally, and with a line of orange blunt; cerci weakly sclerotised, hard to determine shape, but with 2 setae. **Female genitalia:** Sternite and tergite 7 and 8 with strong setae laterally and several shorter ones; cerci about 3 times longer than wide; cerci with 2 setae dorsally and 1 ventrally and with several short setulae; 1 sclerotised spermatheca; spermatheca spherical, with smooth surface.

PROCHYLIZA Walker 1849

(Figures 30–32)

Prochyliza Walker 1849: 1045, type species *P. xanthostoma* Walker 1849:1045 (by monotypy).
Stearibia Lioy 1864: 1005, type species *Piophila foveolata* Meigen 1826: 396 (= *nigriceps* Meigen 1826: 397), **new synonym**

Diagnosis. *Prochyliza* is differentiated from other genera with the absence of a postpronotal seta, a setulose anepisternum (bare in *P. nigriceps*), distiphallus inflated, long and curled, and postgonite subtriangular. **Description.** Body length 2.5–4.4 mm; wing length 2.5–4.3 mm. Head yellow and black (mainly black in *P. nigriceps* and *P. xanthostoma*), with silvery-white microtomentum on gena posteriorly and extending behind eye margin (absent in *P. nigriceps* and *P. xanthostoma*). Thorax and abdomen glossy black. Body sometimes with blue metallic tinge in *P. nigriceps*. Legs yellow and black. Setae and hairs black. **Head:** Head higher than long (in *P. xanthostoma* longer than high); head mainly black with yellow on anterior fronto-orbital plates, face, antennae, gena, palps and anterior portion of frons (pale *P. nigrimana* morphs with entirely yellow frons), and with silvery-white microtomentum on gena posteriorly and extending behind eye margin (*P. nigriceps* and *P. xanthostoma* without silvery-white microtomentum); head in *P. nigriceps* differs as it is black with yellow on face, and sometimes on antennae, and *P. xanthostoma* with yellow only on face, gena and palps; eyes round; short hairs scattered on occiput, gena, from postocellar setae to anterior end of ocellar triangle, on frons and fronto-orbital plates; inner and outer vertical, ocellar and postocellars weak (postocellars being the strongest, except in *P. nigrimana*) (all head setae strong in *P. nigricoxa*); arista bare (almost bare but with short pubescence in *P. nigriceps*); palpus scattered with short setulae, longer ventrally. **Thorax:** Glossy black (with blue mellatic tinge in *P. nigriceps* specimens); katatergite, anatergite and metapleuron with silvery-white microtomentum; postpronotal absent; presutural intra-alar absent (present but weak in *P. lundbecki* and *P. nigricoxa*); 1 supra-alar, 1 postalar, 1 intrapostalar, 1 postsutural dorsocentral setae; 1 proepisternal seta; prosternum bare; anepisternum setulose (bare in *P. nigriceps*), anepimeron bare; scutellum convex (flattened dorsally in *P. nigriceps*) and bare, with 2 pairs of marginal setae. **Wing:** Hyaline; calypter and fringe white; length of C between Sc and R_1 about 1–1.5 times length of crossvein h; length of M_1 between crossveins r-m and dm-cu 1.5–2 times length of dm-cu. Halter white. **Legs:** Legs yellow and black; claws yellow proximally and black distally. **Abdomen:** Glossy black; dull reflections present on some tergites; covered with short scattered setae. **Male genitalia:** Sternite 6 and 7 strongly sclerotised along anterior margin; sternite 7 with 1–3 soft projections; sternite 8 round and convex with several short setae; epandrium on lateral view higher than wide (as high as wide in *P. nigrimana* and *P. xanthostoma*) anterior and ventral margin straight, with posterior

margin forming a rounded edge; surstylus not fused with epandrium; postgonite in one subtriangular lobe; pregonite with 2–3 lobes; distiphallus membranous with many hairs and spinule; distiphallus long and curled; cerci weakly sclerotised and with several setae. **Female genitalia:** Sternite and tergite 7 and 8 with strong setae laterally and several shorter ones; cerci long (3 to 4 times longer than wide); 2 sclerotised spermathecae; spermathecae oval and with smooth surface (*P. nigriceps* cylindrical and wrinkled).

There are nine *Prochyliza* species, five of which are present in the Nearctic: *P. brevicornis* Melander 1924, *P. lundbecki* (Duda 1924), *P. nigricoxa* (Melander & Spuler 1917), *P. nigrimana* (Meigen 1826) and *P. xanthostoma* Walker 1849.

Prochyliza brevicornis Melander 1924

(Figure 30)

Prochyliza brevicornis Melander 1924: 81 (type locality United States of America, Montana, Yellowstone Lake).

Type material examined. 1 ♂ lectotype. Yellowstone Lake, MONT, 9.viii.1918, A.L. Melander, Cotype *Prochyliza brevicornis* Mel., A.L. Melander Collection 1961, Lectotype *Prochyliza brevicornis* Steyskal 1984, Lectotype, *Prochyliza brevicornis* Melander 1924:84, by A.L. Ozerov 2002, (USNM). 4 ♂, 10 ♀ paralectotypes. **UNITED STATES OF AMERICA. Illinois:** Chicago. **Montana:** Flathead Lake. **Wyoming:** Yellowst Lake; Yellowst Park (Canyon Camp; Continent River; Madison River; Old Faithful; Riverside) (USNM).

Other material examined. 226 ♂, 210 ♀, 2 ? from the following Nearctic localities: **CANADA. Alberta:** Banff; Cluny; McMurray; Waterton Lakes National Park, Highway 6 East of Chief Mountain. **British Columbia:** Kamloops; King Salmon Lake; Lisadele Lake; Summit Lake, mi 392 Alaska Highway; Terrace. **Manitoba:** Churchill; Fort Churchill; Transoona. **Newfoundland and Labrador:** 10 mi up Saglek Fjord; Hebron; St. John's; Silutalik Island, Cutthroat Harbor; Torngat Mountains National Park, Torngat Base Camp. **Northwest Territories:** Aklavik; Barlow Lake Outlet; Cameron Bay, Great Bear Lake; Ford Lake; Kidluit Bay, Richards Island; Muskox Lake; Padley; Salmita mines. **Nunavut:** Bathurst Inlet; few km North of Arviat. **Ontario:** Arkell; Ogoki; Ottawa; Rockport. **Quebec:** Fort Chimo; Great Whale River; Indian House Lake; Mistassini Post; Payne Bay; Tasiujaq. **Yukon Territory:** Dempster Highway (km

72, Tombstone Campground; km 155); Erebia Creek; Firth River; Herschel Island; Klondike Highway, Meadow Creek, 24 km South Dempster Corners; Klondike Loop, Minto Landing Territorial Campground; Nahanni Range Road km 128; Otter Lake; Whitehorse, Wolf Creek Campground. **UNITED STATES OF AMERICA. Alaska:** Big Delta; Elliot Highway mi 27.8, White Mtn. Trail; Healy; Kenai, Skilak Lake; King Salmon, Naknek River; Richardson Highway, Squirrel Creek Campground; Umiat; Unalakleet. **Arizona:** Apache Co. (4 mi North Alpine; 25 mi West Springerville Greens Peak). **Colorado:** Gunnison Co., 3 mi North Gothic; Independence Pass Lake Co; Mt. Evans, Echo Lake. **Illinois:** Champaign. **New Mexico:** Bernalillo Co., 7 mi South Tijereas; Catron Co., 6 mi South Luna; Cloudcroft; Lincoln Co., 1 mi North Sierra Sianca Ski; San Miguel Co., Santa Fe National Forest; Santa Fe Co. (14 mi Northeast Santa Fe; Santa Fe Baldy). **North Carolina:** Highlands. **South Dakota:** Elk Point. **Utah:** Summit Co., Henrys Fork Camp. **Wyoming:** Big Horn Co., 30 mi East Lovell; Sublette Co., 5 mi North Bondurant; Teton Co., Moran Jct. (BIO, CAS, CNC, DEBU, LEM, UBCZ, USNM) (Fig. 30).

1 ♀ from the following Palaearctic locality: **USSR.** Siberia, Altal Region, Teletskoya Lake (DEBU).

28 ♂, 5 ♀ from the following Neotropical locality: **COSTA RICA:** San Jose. **MEXICO.** 10mi. W. El Salto, Dgo. (CNC, USNM).

Notes on capture: This species has been captured from May to September with sweep nets, Malaise, flight intercept, carrion baited pan and dung traps. It has been bred from pupa in carrion and is known to be attracted to meat. It has been caught on fish and deer carcass. *Prochyliza brevicornis* has also been collected on dung, sweet clover, in fir/lodgepole pine stand with aspen/birch understory, close to pine-aspen and willows along stream, around camping vegetation and garbage, on *Salix*, on the tundra, in sage, in *Acer-Betula* forest, on shale, pond, pine forest, in marshy meadow, alpine grass meadow and on Spruce and *Equisetum*.

Diagnosis. *Prochyliza brevicornis* differs from other *Prochyliza* species by having a black head with yellow on face, anterior portion of frons, anterior fronto-orbital plates, antennae, gena and palps, as *P. lundbecki*, but can be differentiated from *P. lundbecki* by having a yellow fore coxa. This species can also be differentiated by its male genitalia. **Description.** Body length 2.5–4.4 mm; wing length 2.7–3.8 mm. Body glossy black with yellow on face, anterior portion of frons,

anterior fronto-orbital plates, antennae, gena, palps and parts of legs. Silvery-white microtomentum present on gena posteriorly and extending behind eye, on meron, posterior portion of anepimeron, on katatergite, anatergite and part of metapleuron. **Head:** Head slightly higher than long, black with yellow on face, antennae, gena, palps, anterior portion of frons and anterior fronto-orbital plates; silvery-white microtomentum posteriorly on gena and extending behind eye; height of eye 1.7–2.8 times genal height; 2 lateroclinate posterior fronto-orbitals (the lower one sometimes hard to distinguish); inner and outer vertical, ocellar and postocellar setae weak (postocellars being the strongest); first flagellomere round and usually shaded black; arista about 2–2.5 times length of first flagellomere; arista brown. **Thorax:** Glossy black; meron and posterior portion of anepimeron with silvery-white microtomentum; thoracic setae weak; acrostichal setulae in 10 rows; katepisternum with short hairs. **Wing:** Veins yellow, but veins R_{4+5} and M_{3+4} may be brown; length of crossvein dm-cu slightly more than 3 times length of crossvein r-m. **Legs:** Fore coxa yellow (in some specimens with a small black portion); mid and hind coxae black; fore and hind femora black; mid femur vary from mainly yellow to mainly black; fore and hind tibiae black with yellow proximally; mid tibia yellow; fore tarsus black; mid and hind tarsi yellow, black shading may occur on tarsal segment 4 and 5. **Abdomen:** Tergite 5 with longer setae along posterior margin. **Male genitalia:** Sternite 5 medially sunken forming 2 convex bumps covered with strong outstanding setae; sternite 7 with 1 strongly sclerotised narrow incurved projection with rounded tip and 2 less sclerotised short rounded projections; epandrium with 1 strong seta posterio-dorsally and with several shorter rows of setae; surstylus reduced and oval with several short setae; postgonite subtriangular, strongly sclerotised and reduced; pregonite well developed, with 3 projections in different directions: projection on x-axis elongated, narrow, widest distally, projection on y-axis wide and circular with several setae, projection on z-axis elongated but reduced comparing to other 2 projections; pregonite with strongly scleriotised projection on z-axis and at base of the 3 projections; distiphallus membranous, with many hairs and spinules (spinules mainly on distal half); hairs on distiphallus stronger laterally; distiphallus curled at midpoint and long (at least length of abdomen); distal half of distiphallus with a line of orange blunt; distal end of distiphallus asymmetric; cerci weakly sclerotised, oval with 2 strong setae and 1 very short seta. **Female genitalia:** Tergite 5

and 6 with 2–3 strong setae posterio-laterally; cerci about 4 times as long as wide, with 2 pairs of latero-dorsal setae; spermathecae oval, with smooth surface.

Prochyliza lundbecki (Duda 1924)

(Figure 31)

Piophila lundbecki Duda 1924: 162 (type locality: Iceland, Dyrefjord).

Prochyliza lundbecki; McAlpine 1977: 45.

Material examined. 57 ♂, 26 ♀ from the following Nearctic localities: **CANADA. Northwest Territories:** Tuktoyaktuk. **Yukon Territory:** Herschel Island. **UNITED STATES OF AMERICA. Alaska:** Cape Thompson; Golovin, Reindeer Camp; St. Matthew Island; Unalakleet (CNC, USNM) (Fig. 31).

Additional distribution information: *Prochyliza lundbecki* is also present in the Palaearctic in Iceland and Norway (Ozerov 2004b).

Notes on capture: This species has been captured from June to August.

Diagnosis. *Prochyliza lundbecki* differs by having a black head with yellow on face, anterior portion of frons, anterior fronto-orbital plates, antennae, gena and palps, by having a black fore coxa, a present but weak presutural intra-alar and by male secondary sexual characters on legs.

Description. Body length 3.0–4.3 mm; wing length 3.3–4.3 mm. Body black with yellow on head and parts of legs. Dull grey portions occur on gena and some thoracic sclerites. Setae black; hairs and setulae black but white on thorax. Male with sexual dimorphic characters on legs.

Head: Head slightly higher than long, black with yellow on face, antennae (sometimes shaded balck), gena, palps and anterior portion of frons and anterior fronto-orbital plates; posterior portion of gena up to hind eye margin with silvery-white microtomentum; height of eye 2–2.4 times genal height; row of 4–5 setae along gena; 2 lateroclinate posterior fronto-orbitals (lower one sometimes hard to distinguish); inner and outer vertical, ocellar and postocellars weak (postocellars being the strongest); first flagellomere round; arista 2–2.5 times length of first flagellomere; arista brown. **Thorax:** Glossy black; propepisternum, margin of scutum, meron and anepimeron dorsally and posteriorly, silvery-white microtomentum; 1 weak presutural intra-alar; acrostichal setulae in 12 rows; katepisternum with many hairs and two weak setae on upper posterior margin. **Wing:** Veins brownish yellow; length of crossvein dm-cu 3 times length of

crossvein r-m. **Legs:** Fore coxa glossy black, with silvery-white microtomentum (some specimens with yellow ventrally and laterally); mid and hind coxae glossy black with silvery-white microtomentum; femora black with some yellow distally; tibiae black with some yellow proximally; fore tarsus black; mid and hind tarsi yellow with black tarsal segment 4 and 5; males with the following additional characters on legs: fore coxa with a round projection ventrally on posterior margin; projection on fore coxa with 3–4 long stout setae; katepisternum with ventral portion between fore and hind coxae with several long stout setae (also present in females but as regular strong setae); hind trochanter and proximal end of hind femur with row of stout setae ventrally; mid tibia with preapical patch of long blond ventral setae. **Abdomen:** Tergite 3–5 with row of long setae along posterior margin. **Male genitalia:** Sternite 4 and 5 weakly sclerotised medially; sternite 7 with one strongly sclerotised narrow projection with rounded apex and 1 less sclerotised oval projection with pointed apex; epandrium with 3 strong latero-dorsal setae, and several shorter setae along entire surface; surstylus small, subtriangular and covered with setae; postgonite well sclerotised, elongated subtriangle; pregonite short in width, with one asymmetrical projection which is wider dorsally then ventrally and has several short setae, a second small subtriangular strongly sclerotised projection and a short rounded lobe with 1 setae; distiphallus membranous, with many hairs and spinules (spinules mainly on distal half); hairs on distiphallus stronger laterally; distiphallus curled at midpoint and long (at least length of abdomen); distal end of distiphallus asymmetric; cerci weakly sclerotised, subtriangular, with 2 large setae and 2 short setae. **Female genitalia:** Cerci long and narrow; cerci with 2 pairs of dorsal and 2 pairs of ventral setae, with several short setae; spermathecae oval, with smooth surface.

Prochyliza nigriceps (Meigen 1826)

(Figure 31)

Piophila nigriceps Meigen 1826: 397 (type locality: Europe).

Piophila foveolata Meigen 1826: 396 (type locality: Europe) synonym in Duda 1924: 157.

Piophila confinis Meigen 1830: 383 (type locality: Germany) synonym in Duda 1924.

Piophila coerulescens Zetterstedt 1847: 2517 (type localities: Sweden: Areskutan, Mullfjellen, Jemtland; and near Lycksele, Lapponia Umensis; Norway, near Naes) synonym in Ozerov 2004a: 606.

Material examined. 436 ♂, 341 ♀, 2 ? from the following Nearctic localities: **CANADA. Alberta:** Brooks; Calgary; Celerchen; Edmonton; Fort McMurray; Lethbridge; Onefour. **British Columbia:** 32 mi Southwest of Terrace; Aiyansh, Nass River; Boswell; Gagnon Road, 6 mi West of Terrace; Galiano Island; Kaslo; King Salmon Lake; Nelson; Oliver; Robson; Shames, 18 mi Southwest Terrace; Terrace; Tyee, 27 mi East of Prince Rupert; White Lake. **Manitoba:** Aweme; Brandon; Ninette. **New Brunswick:** Fredericton; Kouchibouguac National Park; St. Andrews; Shippigan. **Newfoundland and Labrador:** Cartwright; Foxtrap; Portugal Cove; Terra Nova, Platter's Beach Shore/Trail. **Northwest Territories:** Aklavik. **Nova Scotia:** South Harbour. **Ontario:** 15 mi North Sioux Narrows; Algonquin; Algonquin Park (dump; Wildlife Research Station); Arkell; Bells Corners; Blackburn; Britannia; Cambridge; Chatham; Grand Bend; Guelph; Hamilton, Royal Botanical Gardens; Harris Hill; Hastings; Kearny; Lambton Co., Pinery Provincial Park; Madawaska River; Manitoulin Island; Maynooth; Osgoode; Ottawa; Point Pelee; Point Pelee National Park; Prescott; Rainy River; St. Williams; Short Hills Provincial Park, Terrace Creek; Simcoe Co., Washago; Toronto. **Quebec:** Abbots ford; Berthierville; Cottage Beaulieu; Hemmingford; Hull; Kam. Co., Parke Reserve; La Ferme; La Trappe; Laniel; Lauzon; Megantic; Mistassini; Montreal; Mt. Albert; Region du Lac Albanel North; Rigaud; Saguenay (La Baie), Hameau, Saint-Louis-de-Bagot; St. Ambroise; Ste-Anne-de-Bellevue (forest behind the Public Health Laboratory; Stoneycroft Pond); St. Laurent; Sherbrooke, Bishop's University Campus; Ville Marie. **Saskatchewan:** Grant E., Grasslands National Park; Lisieux; St. Victor; Val Marie. **Yukon Territory:** Dawson City; Klondike Highway (km 300; Meadow Creek, 24 km South, Dempster Corner). **UNITED STATES OF AMERICA. Alabama:** Baker; Kushla; Montgomery. **Alaska:** Kenai, Shilak Lake; Ladd APB, Fairbanks; Matanuska. **District of Columbia**: Washington. **Florida:** Alachua Co., Gainesville. **Georgia:** Thomasville. **Idaho:** Colburn; Elk River; Moscow; Moscow Mt. **Illinois:** Chicago. **Indiana:** La Fayette. **Iowa:** Ames. **Kansas:** Nat. Hist. Res. Lawrence. **Louisiana:** 11 mi Southwest Alexandria. **Maine:** Southwest Harbor; White Mountains. **Maryland:** Calvert Co., Lusby; College Park; Glen Echo. **Massachusetts:** Southbridge; Woods Hole. **Michigan:** Detroit;

Lapeer Co., Deerfield township; Monroe; Roscommon Co., Higgins Lake; Saginaw Co., Hemlock; Wayne Co., Grosse Ile. **New Hampshire:** Durham; Gorham. **New Jersey:** Pemberton. **New Mexico:** Questa, Red River. **New York:** Buffalo; Claverack; Ithaca. **North Carolina:** Macon Co., Wayah Gap; Raleigh. **North Dakota:** Fargo. **Ohio**: Seneca Co., 1 mi East Melmore, Honey Creek. **Pennsylvania:** West Bradford. **South Carolina:** Greenville. **South Dakota:** Aberdeen; Brookings. **Tennessee:** Knox Co., U.T. Farm. **Texas:** Tenaha. **Virginia:** Falls Church, Holmes Run; Giles Co., Bald Knob, 10 km Northwest Blacksburg. **Washington:** Kamiak Butte; Pullman, Saints Rest; Valleyford; Wawawai. **Wyoming:** Teton Co., Moran Jct. (BIO, CAS, CNC, DEBU, IMQC, LEM, ORUM, UBCZ, USNM) (Fig. 31).

16 ♂, 15 ♀ from the following Palaearctic localities: **AUSTRIA.** Igls, Tirol. **CHINA.** Harbin, Manchuria. **ENGLAND.** Devon, Paignton; Gloucestershire, Gloucester; Lake District (Blea Tarn; Dungeon Ghyll); Staffordshire, Newcastle-u-Lyme. **GERMANY.** Ingelheim am Rhein; Westphalia, Elsdorf. **ITALY.** Piedmont, Celle de Bellino. **PORTUGAL.** Porto Douro, Litoral; Praia das Macas. **UNITED KINGDOM.** Bonhill, Dumbartonshire. **SPAIN.** Santiago, deCompostelar, Coruna. **SWEDEN.** Lapland, Abisko. **USSR.** Siberia, Novosibirsk Region, Chany Lake Bio. Station (CNC, DEBU, USNM).

57 ♂, 40 ♀, 3 ? from the following Neotropical localities: **ARGENTINA.** Entre Rios Liebig, Tio Uruguay; Rio Negro, Bariloche; San Isidro Prov., BS. Aires. **BOLIVIA.** Tumupasa. **BRAZIL.** Minas Gerais, Ouro Preto; Paraná, Morretes; Petropolis; Rio de Janiero, Tijuca; Rio Grande do Sul, Alta Vacuhy. **CHILE.** BioBio, El Abanico; Cameron, S. Bahia Inutil, T. d. Fuego, Magallanes; Estero La Jaula Curico; Fundo Malcho, Linares; Magellanes (Laguna Amarga, Natales, E. of Mt. Payne, Dos Lagunas; Laguna, Armarga; M. Etcheverry, Villarica; Rio Verde); Maullin, Llanquihue; Puerto Williams, Isla. Navarino, T. del Fuego; Tierra Del Fuego, 6.9 km SE. Cameron; Valdivia Pr. 4 km W. Anticura. **COLOMBIA.** Buga, Yotoco Forest Res.; Cundina-marca, Finca Bella Vista, near Sasaima. **COSTA RICA.** Cartago; Paral sol; San Jose. **ECUADOR.** Equador. **PERU.** Lima; Madre de Dios, Avispas. **VENEZUELA.** Caracas (CAS, CNC, USNM).

Additional distribution information: *Prochyliza nigriceps* can also be found in the following Palaearctic countries: Britain Island, Corsica, Czech Republic, Finland, France, Germany, Hungary, Italy, Japan, Norway, Poland, Portugal, Romania, Russia (Central, North, Northwest,

South), Slovakia, Sweden, Switzerland and The Netherland (Ozerov 1989, Leclercq 1996, Merz 1996, Iwasa, 1998, Ozerov 2004b). It can also be found in the Oriental region in India (Sathe *et al.* 2013).

Notes on capture: This species has been captured in the Nearctic from March to October with sweep nets, sweeps/pooter, and carrion (box, pan traps), beef baited, pan, rotary, fly, Malaise and light traps. It has been found on and near carrion (horse, cat, gopher, seagull, moose, fish, squirrel, deer, shrew, pig, cow, wolf) on the skull and hoofs of a horse's skeleton, on the bones of a moose and on the skull of a rotting whale. It has also been reared on pig liver in a lab where maggots have been collected. *Prochyliza nigriceps* was, in addition, collected on flowers of *Heracleum*, Umbelliferae and parsnips, *Typha Slough* community, Goldenrods, *Ptelea trifoliate*, in mixed dry mesophytic woods, around camping vegetation and garbage, as well as on a river margin.

Diagnosis. *Prochyliza nigriceps* is different from other *Prochyliza* species by having a bare anepisternum, a body often with a metallic blue tinge, arista with short pubescence (almost bare), scutellum flattened dorsally and female with spermathecae cylindrical and wrinkled.

Description. Body length 2.5–4.1 mm; wing length 2.5–3.4 mm. Body glossy black with yellow on antennae and parts of leg segments. Blue metallic tinge often present on entire body. **Head:** Head higher than long, black except for yellow antennae; face usually black but with sometimes yellow around antennae; height of eye 3.2–4.5 times genal height; gena with several short setae; fronto-orbital setae absent; inner and outer vertical, ocellar and postocellar setae weak; postocellar stronger than vertical and ocellar setae; first flagellomere oval and usually shaded black at tip; arista with short pubescence, almost bare; arista about 3 times length of first flagellomere; base of arista yellow with rest brown. **Thorax:** Glossy black, often with bleu metallic tinge; meron with silvery-white microtomentum; all thoracic setae weak, postalar seta being the strongest; acrostichal setulae in 9 rows; anepisternum bare; katepisternum with several short setulae (one longer at posterior upper margin); scutellum flattened dorsally. **Wing:** Veins yellow; length of crossvein dm-cu 4 times length of crossvein r-m. **Legs:** Fore coxa yellow; mid and hind coxae black; femora black with yellow distally and proximally; fore tibia black with yellow proximally; mid and hind tibiae yellow; fore tarsus black; mid and hind tarsi yellow, with tarsal segment 4 and 5 slightly shaded black in some specimens. Specimens from Costa-Rica and

Honduras have been seen by Ozerov (2004a) with mid and hind femora entirely yellow. **Abdomen:** Same as genus description. **Male genitalia:** Sternite 7 with 2 weakly but sclerotised rounded projections along posterior margin; epandrium with 1 strong seta posterio-dorsally, and with several shorter rows of setae; surstylus reduced and oval but with a small proximal dorsal rounded lobe; surstylus with 2 outstanding setae on both lobe and remaining of surface with very short setae; postgonite strongly sclerotised and subtriangular; pregonite strongly sclerotised along margin, squared with a rounded lobe extending at apex basally; pregonite with several short setae; distiphallus membranous, with many hairs and spinules; hairs on distiphallus longer and stronger dorsally; distiphallus with patch of strong brown spinules ventrally on preapex; distiphallus curled at midpoint and long (at least length of abdomen); cerci weakly sclerotised, round, with 5–6 setae. **Female genitalia:** Cerci about 3 times longer than wide; cerci with 1 pair of ventral and 1 pair of dorsal strong setae with several weaker one; spermathecae elongated, cylindrical and asymmetric, with wrinkled surface.

***Prochyliza nigricoxa* (**Melander & Spuler 1917)

(Figure 31)

Piophila nigricoxa Melander & Spuler 1917: 64 (type locality: United States of America, Washington, Pullman).

Prochyliza nigricoxa; McAlpine 1977: 45.

Type material examined. 1 ♂ lectotype. Pullman Wash., Type *Piophila nigricoxa* M.-S., Lectotype, *Piophila nigricoxa* M. & S., Steyskal 1968 (USNM). 2 ♂, 5 ♀ paralectotypes. **UNITED STATES OF AMERICA. Idaho:** Moscow Mt. **Montana:** Flathead Lake. **Washington:** Pullman; Walla Walla (USNM).

Other material examined. 11 ♂, 29 ♀ from the following Nearctic localities: **CANADA. Alberta:** Banff; Banff, Sulfur Mt; Bilby; Cadomin Base Prospect Mtn; Calgary; Kananaskis Field Station; Kananaskis Forest Experimental Station, Seebe; Lake Louise; Waterton National Park, Cameron Lake. **British Columbia:** Cranbrook; Keremeos; Lumbia, 1.6 km North Glacier, Glacier National Park; Mt. Revelstoke; North Hollister, Moose Lake; Robson. **Northwest Territories:** Aklavik. **Yukon Territory:** Alaska Highway, Koidern River. **UNITED STATES OF AMERICA. California:** Marin Co. (Alpine Lake, Lily Pond; Mill Valley); Nez Perce Co.,

Zaza Road, Lake Waha & Craig Mt; Oroville; San Francisco; Santa Clara Co., Guadalupe Creek; Siskiyou Co., 21 mi Northwest of Happy Camp, Poker Flat; Sonoma Co., Santa Rosa. **Idaho:** Mt. Moscow; Moscow. **Montana:** Mineral Co., St. Regis. **Oregon:** Hood River. **Washington:** Mt. Rainier, Paradise Park; Wawawai (CAS, CNC, DEBU, LEM, UBCZ, USNM) (Fig. 31).

Notes on capture: This species has been captured from April to October (except 28.ii.1926 in San Francisco and 12.iii.1928 in Oroville, California, USA) with dung pan and Malaise traps. It has been collected in grasses, on *Salix*, roadside seeps/flowers and on flower of parsnip. It has also been found on carrion such as on a dead cow.

Diagnosis. This species is similar to *P. lundbecki* but can be differentiated by having 1 strong seta at upper posterior margin of katepisternum, entirely yellow mid and hind tibiae and anepimeron with silvery-white microtomentum on dorsal, ventral and posterior margin of anepimeron. **Description.** Body length 3.0–4.0 mm; wing length 2.8–4.0 mm. Head black and yellow. Thorax and abdomen black with silvery-white microtomentum on proepisternum, meron and on dorsal, ventral and posterior margin of anepimeron. Legs black and yellow. **Head:** Head higher than long, black with yellow on face, antennae, gena, palps, anterior portion of frons and anterior fronto-orbital plate; posterior portion of gena up to behind eye with silvery-white microtomentum; height of eye about 3.7–5 times genal height; male with long setae along gena, also present in females but weaker; 1 lateroclinate posterior fronto-orbital; unlike most other *Prochyliza* species, setae on head strong; inner and outer vertical setae of equal length; ocellar setae as long as vertical setae; postocellar setae 1.3 times the length of ocellar setae; first flagellomere round, sometimes shaded black at tip; arista 2–2.5 times length of first flagellomere; arista brown. **Thorax:** Glossy black; proepisternum, meron and anepimeron dorsally, ventrally and posteriorly with silvery-white microtomentum; thoracic setae mostly strong unlike other *Prochyliza* species; presutural intra-alar setae is present but weak; postpronotal absent but also present in several specimens seen in the CAS collection (California, British Columbia and Northwest Territories), acrostichal setulae in 12 rows; scutellum convex and bare, with 2 pairs of marginal setae. **Wing:** Veins brownish-yellow; length of crossvein dm-cu 4 times length of crossvein r-m; length of M_1 between crossvein r-m and dm-cu almost 2.5 times length of dm-cu. **Legs:** Coxae glossy black with silvery-white microtomentum; femora black with yellow distally; fore tibia black with yellow proximally; fore tarsus black, but mostly

yellow in some specimens; mid and hind tibiae and tarsi yellow; mid and hind tarsi with tarsal segment 5 shaded black in some specimens. **Abdomen:** Same as genus description. **Male genitalia:** Tergite 3–5 with row of strong setae along posterior margin; sternite 7 with one strongly sclerotised narrow projection with rounded apex and 1 less sclerotised oval projection; epandrium with several equally sized setae; surstylus reduced and oval with several setae; postgonite strongly sclerotised, elongated and subtriangular; pregonite with a first oval lobe with a well sclerotised elongated projection along it's ventral margin with additional 3 finger-like projections at apex; pregonite with second lobe oval with a strongly sclerotised projection at base; both oval projections of pregonite with short setulae; distiphallus membranous, with short hairs and spinules; distiphallus curled twice and long (at least length of abdomen); distiphallus with two lines of orange blunt; cerci weakly sclerotised, subtriangular and with 2 large setae. **Female genitalia:** Sternite and tergite 5 and 6 with 2–3 strong setae on latero-posterior margin; cerci long and narrow, with 2 pairs of dorsal and 1 pair of ventral setae, with several short setae; spermathecae oval, with smooth surface.

Prochyliza nigrimana (Meigen 1826)

(Figure 32)

Piophila nigrimana Meigen 1826: 396 (type locality: Germany).

Prochyliza nigrimana; McAlpine 1977: 44.

Piophila nigricornis Meigen 1826: 397 (type locality: Germany) synonym in Martín-Vega 2014: 288

Piophila affinis Meigen 1830: 383 (type locality: Belgium, "Aus der Lütticher Gegend") synonym in Hennig 1943.

Piophila occipitalis Melander and Spuler 1917:65 (type locality: United States of America, Illinois, Chicago) synonym in Steyskal 1968: 25.

Piophila nigrimana var. *nigrohalterata* Duda 1924: 111 (type locality: Germany) synonym in Hennig 1943.

Piophila morator Melander 1924: 85 (type locality: United States of America, Washington, Pullman) synonym in Steyskal 1968: 25.

Piophila privigna Melander 1924: 86 (type locality: United States of America, Massachusetts, Woods Hole) synonym in Steyskal 1968: 25.

nigrimama, error.

Type material examined. 1 ♂ holotype. Pullman, Wash. May, Type *Piophila morator* Mel., A.L. Melander Collection 1961, Holotype, *Piophila morator* Melander 1924:85, det. A. Ozerov 2002 (USNM). 1 ♂ lectotype of *Piophila occipitalis*. Chicago Ill., Paratype *Piophila occipitalis* M.-S., A.L. Melander Collection 1961, Lectotype *Piophila occipitalis* Melander and Spuler 1917: 65, by G. Steyskal 1968: 25, det. A.Ozerov 2002 (USNM). 1 ♂ lectotype of *Piophila privigna*. Woods Hole, Mass., 21.vii.1902, Type *Piophila privigna* Mel., A.L. Melander Collection 1961, Lectotype *Piophila privigna* Melander 1924: 86, by Steyskal 1968: 25, det. A.L. Ozerov 2002 (USNM). 3 ♂, 6 ♀ paralectotypes of *Piophila privigna*. **CANADA. British Columbia:** Nelson. **UNITED STATES OF AMERICA. Idaho:** Potlatch. **New York:** Cold Spring Harbor. **Washington:** Ilwaco; Pullman. **Wyoming:** Sheridan (USNM).

Other material examined. 63 ♂, 76 ♀ from the following Nearctic localities: **CANADA. Alberta:** Medicine Hat; Slave Lake. **British Columbia:** Robson; Terrace; Vancouver; Vancouver, Point Grey; Victoria. **Newfoundland and Labrador:** Bell Island; Fox trap; St. John's, Top Signal Hill. **Ontario:** Arkell; Grand Bend, Pinery Provincial Park; Guelph; Maynooth; Mer Bleu, 5 mi East Ottawa; Metcalfe; Oshawa; Ottawa; Simcoe; Stittsville. **Quebec:** Beaulieu; Berthierville; Great Whale River; Kazabazua; La Trappe; Montreal. **Saskatchewan:** Assiniboia. **Yukon Territory:** Whitehorse. **UNITED STATES OF AMERICA. California:** Alameda Co., Berkeley; Humboldt Co., Eureka; Merin Co., Mill Valley; Mt. Tamalpais; Oakland; San Mateo Co. (Mussel Rock; Sharp Park; South San Francisco); Santa Cruz Co., Big Basin State Park. **District of Columbia:** Washington. **Idaho:** Moscow. **Illinois:** Champaign. **Indiana:** La Fayette. **Massachusetts:** Woods Hole. **Maine:** White Mountains, Morrison. **Maryland:** Calvert Co., Scientist Cliffs; Colesville. **Michigan:** Detroit; East Lansing; Washtenaw Co., Ann Arbor; Wayne Co., Grosse Ile. **New Hampshire:** Mt. Washington, Alpine Gardens; White Mts., Morrison. **New Jersey:** Fort Lee. **New York:** Chappaqua; Long Island, Riverhead; New York; Staten Island. **North Dakota:** Minot. **Oregon:** Multnomah Co., Columbia River. **South Carolina:** Clemson. **Tennessee:** Knox Co., U.T. Farm.

Virginia: Arlington; Dead Run Fairfax Co. **Washington:** Seattle (CAS, CNC, DEBU, ORUM, UBCZ, USNM) (Fig. 32).

5 ♂, 11 ♀ from the following Palaearctic localities: **AUSTRIA.** Tirol, Obergurgl. **ENGLAND.** Durham. **GERMANY.** Ingelheim am Rhein. **GREECE.** Crete, Canea Health Center. **ISRAEL.** Herzliuua; Mount Meron. **ITALY.** Lucera Puglis Prov.. **MOROCCO.** Tangiers. **PORTUGAL.** Azores, Santa Maria, Vila do Porto; Praia das Macas. **USSR.** Siberia, Akmolinsk, Tokosha; Siberia, Novosibirsk Region, Cherny Mis. **UZBEKISTAN.** 90km NE Tashkent, Chim Gand (CNC, DEBU, USNM).

19 ♂, 9 ♀, 1 ? from the following Neotropical localities: **ARGENTINA.** Rio Negro, Bariloche; San Isidro, Prov. Bs. Aires. **CHILE.** Aconcagua, Piscicultura; Aysen, Coihaique Road, Km 50 Pto.; BioBio, El Abanico; Estero La Jaula Curico; Linares, Fundo Malcho; Llanquihue (Carelmapu; Maullin); Malleco, Liucura; Osorno Province, P.N. Puyehue; Santiago, Penalolén; Region X (Los Lagos) P.N. Vicente Pérez Rosales Volcán Osorno (CAS, CNC, LEM, USNM).

Additional distribution information: *Prochyliza nigrimana* is also present in the following Nearctic localities: Ontario (London); Massachusett (Bellingham, Boston, Greenfield, New Bedford, Tacoma) and New York (Cold Spring Harbor) (Melander & Spuler 1917). It is also present in the Palaearctic: Andorra, Azores, Belgium, Britain Islands, Canary Islands, Czech Republica, Danish Mainland, Finland, France, Germany, Greece, Hungary, Italy, Madeira, Poland, Russia (Northwest, South), Slovakia, Spain, Switzerland, The Netherlands and Ukraine (Merz 1996, Carles-Tolra & Pujade-Villar 2003, Ozerov 2004b, Martín-Vega *et al*. 2011, Misiachna & Korneyev 2015).

Notes on capture: This species has been captured in the Nearctic from March to October (caught 13.ii.1915 at Beaulieu in Quebec) with sweep nets and Malaise, pan and cheesecloth traps. It can also be found on and near carrion (molluscs, fish, ground hog, whale) and has been bred from pupa in carrion. It has also been collected on seepage on earth cliff, on carrion flower, on *Quercus durata* and in *Acer-Betula* forest.

Diagnosis. *Prochyliza nigrimana* can be identified by having entirely yellow frons (black only on ocellar triangle and posterior fronto-orbital plates) in the pale morph and with male genitalia.

Description. Body length 2.7–3.7 mm; wing length 2.6–3.4 mm. Martín-Vega & Baz (2011) noted colour variation in specimens of *Prochyliza nigrimana*. There is a dark and pale morph

where color variation in black and yellow varies on the cheeks, legs and abdomen. Silvery-white microtomentum present on gena, proepisternum, meron and lateral margin between prescutum and scutum. **Head:** Head higher than long, yellow in pale morph except for black on occiput, posterior fronto-orbital plate and ocellar triangle; in dark morph head entirely black except for frons and anterior fronto-orbital plates and sometimes lower margin of gena; posterior section of gena up to hind eye margin with silvery-white microtomentum; height of eye 2.5–2.7 times genal height; setae on gena stronger in males; gena with several short setae; 1 weak lateroclinate posterior fronto-orbital; inner and outer vertical, ocellar and postocellar setae weak; inner and outer vertical setae of equal length; ocellar setae as long as postocellar setae; vertical setae 1.5 times longer than ocellar and postocellar setae; first flagellomere round, in pale morph specimens may have black shading along dorsal margin and laterally, in dark morph antennae entirely black; arista 2–2.5 times length of first flagellomere; base of arista yellow with rest brown. **Thorax:** Glossy black; proepisternum, meron and lateral margin between prescutum and scutum with silvery-white microtomentum; thoracic setae mostly strong unlike most *Prochyliza* species; acrostichal setulae in 11–12 rows; katepisternum with several hairs. **Wing:** Veins yellow; length of crossvein dm-cu 4 times length of crossvein r-m. **Legs:** Pale morph: fore coxa yellow with silvery-white microtomentum; mid and hind coxae glossy black (brownish-yellow in some specimens) and silvery-white microtomentum; fore femur black with yellow proximally and distally; fore tibia black with yellow proximally; mid and hind legs, excluding coxae, yellow; tarsal segments 4 and 5 may be shaded black. Dark morph: fore coxa mainly black; front leg same as pale morph; mid and hind femur and tibia same as front leg; mid and hind tarsus yellow with tarsal segments 4 and 5 shaded black. **Abdomen:** Glossy black in dark morph and paler brown in pale morphs. **Male genitalia:** Sternite 5 medially depressed dividing sternite 5 in 2 convex bumps; tergite and sternite 5 and 6 with longer setae on posterior margin; sternite 7 with a strongly sclerotised elongated incurved projection beside a rounded bump (also well sclerotised); epandrium in lateral view almost as high as wide, oval shaped with straight anterior margin; epandrium with 1 strong setae posterio-dorsally and 1 strong setae posterio-ventrally, remaining of surface with shorter setae; surstylus small and rectangular (about 5 times as wide as long); surstylus with 1 strong seta and 3 strong but shorter ones; postgonite elongated strongly sclerotised subtriangle; pregonite strongly sclerotised along margin and bi-lobed; pregonite with

two rounded projection, the ventral projection slightly wider than dorsal one; pregonite similar to crab-claw (but with rounded apex) with short setae on "opening" of claw; distiphallus membranous, long hairs at base than only laterally until midpoint were distiphallus is curled; distiphallus with very short and fine hairs, and spinules, on remaining of surface; distiphallus from midpoint to preapex with line of orange blunt; distiphallus long (at least length of abdomen); cerci weakly sclerotised, crescent shape and with 3 setae. **Female genitalia:** Sternite 4–6 and tergite 5 and 6 with 1–2 long setae on posterior lateral margin; cerci about 4 times as long as wide; cerci with 2 pairs of dorsal and 1 pair of ventral setae plus several shorter setae; 2 sclerotised spermathecae; spermathecae elongated, oval, with smooth surface.

Prochyliza xanthostoma Walker 1849

(Figure 32)

Prochyliza xanthostoma Walker 1849: 1045 (type locality: Canada, Ontario).

Material examined. 292 ♂, 212 ♀, 2 ? from the following Nearctic localities: **CANADA. British Columbia:** Near Massett; Queen Charlotte Islands (Alliford Bay; Graham Island, Naikoon Provincial Park, Tow Hill); Vernon. **Manitoba:** Aweme. **New Brunswick:** Kouchibouguac, National Park. **Ontario:** 7 mi East Griffith; Algonquin Park; Algonquin Park (Scott Lake; Wildlife Research Station); Ancaster; Arkell; Bells Corners; Bruce Co., Black Creek Provincial Park; Cambridge; Carp; Chatham; Elgin Co., Fingal; Essex Co., Point Pelee National Park, Southeast Beach; Ethel; Fergus; Fort Erie; Freelton; Guelph; Hamilton Royal Botanical Gardens; Heron Bay, Pukaskwa National Park; Honey Harbor; Lambton Co., Pinery Provincial Park; LowBush, Lake Abitibi; Manitoulin Island; Maynooth; Merivale; Metcalfe; Midland; Ottawa; Peterborough; Rockwood; Short Hills Provincial Park, Terrace Creek; Simcoe Co., Washago; Wellington Co. (Guelph; Puslinch Township Concession 11). **Quebec:** Joliette; La Mauricie National Park; La Trappe; Laniel; Mont Tremblant Park; Montreal; Rigaud; Saguenay (La Baie), Hameau, Saint-Louis-de-Bagot; Ste-Anne-de-Bellevue (forest behind the Public Health Laboratory; Stoneycroft); Sherbrooke, Bishop's University Campus. **UNITED STATES OF AMERICA. Alabama:** Kushla. **Alaska:** Anchorage; Cold Bay; Douglas; King Salmon, Naknek River; Matanuska; Naknek; Revillagigedo Island, Herring Cove Reed; Seward; Valdez. **Arkansas:** Polk Co., 13 mi Northwest Mena Rich Mt. **California:** Alameda Co., Berkeley Hills:

Berkeley; Contra Costa Co., Concord; Marin Co., Mill Valley; Napa Co., Angwin; Pasedena; San Francisco, Lake Merced; San Mateo Co. (Pacifica; Sharp Park). **Colorado:** South Georgia, Morrison. **District of Columbia:** Rock Creek; Washington. **Florida:** Cary State Forest. **Georgia:** Dekalb Co., Stone Mt; Tifton. **Idaho:** Potlatch; Troy. **Illinois:** Carlinville, Roberston; Champaign. **Indiana:** La Fayette. **Iowa:** Ames; Ames, Pammel Woods. **Kansas:** Nat. Hist. Res. Lawrence; Onaga, Crevecoeur. **Louisiana:** 11 mi Southwest Alexandria; Opelousas. **Maryland:** Chesapeake Beach; Plummers Island. **Massachusetts:** New Bedford. **Michigan:** Detroit. **Minnesota:** Mankato; Olmsted Co. **Montana:** Flathead Lake; Glacier Park, Lake McDonald. **New Hampshire:** Mt. Washington. **New Jersey:** Fort Lee; Morristown; Riverton. **New Mexico:** Las Vegas Mts. **New York:** Ithaca; Tuxedo. **North Carolina:** Highlands; Macon Co., Wayah Gap; Raleigh. **North Dakota:** Linton. **Oregon:** Eagle Creek Forest Res. **Pennsylvania:** Centre Co., Pine Grove Mills; Delaware Co; Lehigh Gap; Pittsburg. **South Carolina:** Clemson; Greenville. **South Dakota:** Aberdeen. **Tennessee:** Knox Co., U.T. Farm; Smokies, Chimneys. **Texas:** Austin; Dallas; Kerville; Kimble Co., London; Victoria; Waco, Belfrage. **Virginia:** Chain Bridge; Chesterfield, Pocahontas St. Park; Fairfax Co., Dead Run; Falls Church; Giles Co. (10 km Northwest Blacksburg, Bald Knob; 10 km Northwest Blacksburg Mtn; Ripplemead).**Washington:** Blewett; Blue Mts., Rose Spring; Crescent Bay; Ilwaco; Mt. Rainier, Paradise Park; Pullman, Saints Rest; Roche Harbor; Tacoma. **Wyoming:** Yellowstone Park, Old Faithfull (BIO, CAS, CNC, DEBU, IMQC, LEM, ORUM, UASM, USNM) (Fig. 32).

Additional distribution information: *Prochyliza xanthostoma* is also present in the following Nearctic localities: Illinois (Chicago; Homer, St. Joseph), South Dakota (Brookings) and Washington (Friday Harbor, Quilcene) (Melander & Spuler 1917).

Notes on capture: This species has been captured from March to October (also in 12.ii.1949 and 18.xi.1948, Raleigh, Carolina, USA) using pooter, sweep nets, and carrion (box trap, tent), beef baited, Malaise, rotary, light, cheesecloth, flight and pan traps. It has been collected from carrion (fish, moose, ground hog, shrew, deer, pig, whale (skull), snails, squirrel, goat, fox, cat). It has also been collected in swampy wood, in *Acer – Betula* wood, from a bleeding Maple stump, at sap on *Acer* stump, in conifer forest stand (balsam fir, *Epicea glauca*, birch), on *Carex* in a peatland, on tundra, mesic oak-hickory, in willow and *Salix* thicket, from wheat, on flowers seablite and on stinkhorn fungus.

Diagnosis. *Prochyliza xanthostoma* differs from other species by having an elongated pedicel, and frons and face extending beyond anterior eye margin. **Description.** Body length 2.9–4.4 mm; wing length 2.8–3.9 mm. Mainly glossy black body with yellow on anterior margin of eye, face, palps and gena, and on legs. Silvery-white microtomentum on proepisternum, lateral margin of scutum, around wing apex and meron. **Head:** Head longer than high, black with yellow on anterior margin of eye, face, palps and gena; frons and face extending beyond anterior eye margin; height of eye 3.5–4.5 times genal height; gena without silvery-white microtomentum as in other *Prochyliza* species; pedicel elongated, at least twice as long as wide; pedicel longer in males than in females; fronto-orbitals absent; inner and outer vertical, ocellar and postocellars weak; inner vertical usually longer than outer vertical setae; first flagellomere two times as long as wide; arista about 1.5 times length of first flagellomere; arista brown. **Thorax:** Glossy black; proepisternum, meron, lateral margin of scutum and around wing apex with silvery-white microtomentum; a specimen has been seen with an additional postsutural dorsocentral seta on one side; acrostichal setulae in 9 rows; katepisternum with fine hairs and 2 weak setae on upper margin. **Wing:** Veins brownish-yellow, often veins R_{4+5} and M_{3+4} darker; length of crossvein dm-cu 3 times length of crossvein r-m. **Legs:** Fore coxa yellow; mid and hind coxae black; fore and hind femora black with yellow distally and proximally; mid femur yellow; fore tibia black with yellow proximally; mid and hind tibiae usually yellow (in some specimens the hind tibia with some brown); fore tarsus black; mid and hind tarsi yellow with tarsal segments 4 and 5 which may be shaded black. **Abdomen:** Tergite 4, 5 and 6 with outstanding setae on posterior side margins. **Male genitalia:** Sternite 5 medially sunken forming 2 convex bumps which are covered with strong outstanding setae directed medially; sternite 7 with a strongly sclerotised elongated incurved projection; epandrium in lateral view almost as high as wide, oval shaped with straight anterior margin; epandrium with 2 strong posterio-lateral setae, remaining of surface with shorter setae; surstylus short, rounded and covered with several setae; postgonite strongly sclerotised, greatly reduced, subtriangular; pregonite tri-lobe, first rounded lobe at base, second lobe long, elongated with rounded apex and with a ventral rounded projection at midpoint, third lobe elongated and rounded (longer than second lobe); pregonite with setae along dorsal margin of second lobe and on entire inner surface of first basal lobe; distiphallus hairy, with hair longer laterally until slightly past midpoint were distiphallus is curled; distiphallus with

spinules present especially at distal end; distiphallus with lateral line of orange blunt from past midpoint to apex; distiphallus long, at least length of abdomen; cerci weakly sclerotised, oval with 2 large setae. **Female genitalia:** Cerci about 5 times as long as wide; cerci with 2 pairs of dorsal 1 pair of ventral setae, with several short additional setae; spermathecae elongated and oval, with smooth surface.

PROTOPIOPHILA Duda 1924

(Figure 33)

Protopiophila (as subgenus of *Piophila*) Duda 1924: 109, type species *Piophila latipes* Meigen 1838: 360 (by designation of Harrison 1959).

Clusina Curran 1934: 449, type species *Clusina nigriventris* Curran (synonymy in McAlpine 1977: 37)

Diagnosis. The *Protopiophila* genus differs from other Piophilids by the presence of 2 postpronotal setae, 1 presutural and 3 postsutural dorsocentral setae, and flattened front tarsomere 2 to 5.

There are 12 *Protopiophila* species, two of which are present in the Nearctic: *Protopiophila latipes* (Meigen) and *Protopiophila litigata* Bonduriansky.

Protopiophila latipes (Meigen 1838)

(Figure 33)

Piophila latipes Meigen 1838: 360 (type locality: Germany, "Hiesige Gegend").

Mycetaulus hornigi Cresson 1919: 193 (type locality: United States of America, Pennsylvania, Philadelphia) synonym in Steyskal 1958: 246.

Material examined. 323 ♂, 194 ♀, 1 ? from the following Nearctic localities: **CANADA. British Columbia:** Victoria. **New Brunswick:** St. Andrews; St. Andrews, Gibson Lake. **Nova Scotia:** Dover; near Sherbrooke, Nimrod Campground. **Ontario:** 7 mi East Griffith; Algonquin; Algonquin Park (Scott Lake; Wildlife Research Station); Carleton Co., Ottawa; Grand Bend; Guelph; Hamilton; Hamilton, Royal Botanical Gardens; Kearney; Lambton Co., (Pinery Provincial Park; Port Franks, Karner Blue Sanctuary; Port Franks, Watson Property near L-lake); Manitoulin Island, Kip Fleming Tract, 8 km Southwest Gore Bay; Maynooth; Morrisburg;

Ottawa; Ottawa (McKay Lake; Montfort Hospital); Point Pelee; Pinery Provincial Park, Grand Bend; Prescott; 6 mi West Richmond; Rockport; Rondeau Provincial Park; Short Hills Provincial Park, Terrace Creek; Simcoe Co., Washago; Wellington Co., Fergus; Windsor. **Quebec:** Duncan Lake, near Rupert; Les Cedres; Old Chelsea; Perkins; Rougemont; Saguenay (La Baie), Hameau, Saint-Louis-de-Bagot; St. Ambroise; Ste-Anne-de-Bellevue; Ste-Anne-de-Bellevue, Stoneycroft Pond; Sherbrooke, Bishop's University Campus. **UNITED STATES OF AMERICA.** **Connecticut:** Stamford. **Delaware:** Rehoboth. **District of Columbia:** Chain Bridge; Washington. **Indiana:** Lawrence Co., Hoosier National Forest. **Maryland:** Cabin John; Calvert Co., Lusby; Colesville; Glen Echo; Montgomery Co., Bethesda; Prince Georges Co., Patuxent Wildlife Research Centre. **Massachusetts:** Middlesex Co., Cambridge; Woods Hole. **Michigan:** Berrien Co., St. Joseph; Detroit; Wayne Co., Grosse Ile. **Minnesota:** Clearwater Co., Itasca State Park. **New Jersey:** Morristown. **New York:** Claverack; New York. **North Carolina:** Highlands. **Pennsylvania:** Fulton Co., Cowan's Gap State Park. **Tennessee:** Knox Co., U.T. Farm. **Vermont:** Waitsfield. **Virginia:** Alexandria Co., Maywood; Falls Church, Holmes Run; Gilles Co., Ripplemead, Route 460 bridge; Glencarylyn. **Wisconsin:** Pewaukee (CAS, CNC, DEBU, IMQC, LEM, RBCM) (Fig. 33).

15 ♂, 7 ♀ from the following Palaearctic localities: **ENGLAND.** Kingslynne; Middleton-on-Sea, Sx. **GREECE.** Macedonia, Lahana Hill. **ITALY.** Marches Provo, Iesi. **SPAIN.** Coruna, Santiago de Compostela; Granada. **SWEDEN.** Stockholm (CNC, USNM).

2 ♀ from the following Oriental localities: **NEPAL.** Kathmandu. **INDIA.** Mudumalai N. P., Tamil Nadu (CNC, DEBU, USNM).

Additional distribution information: *Protopiophila latipes* is also known from the following Nearctic localities: Illinois; Pennsylvania, Philadelphia; and in Virginia, Maywood (Steyskal 1958, Harrison 1960, Johnson 1975) and the following Palaearctic localities: Andorra, Corsica, Czech Republic, France, Germany, Hungary, Japan, Poland, Portugal, Russia South, Slovakia, Switzerland and Urkraine (Harrison 1960, Zuska & Laštovka 1965, Merz 1996, Iwasa 1998, Carles-Tolra & Pujade-Villar 2003, Ozerov 2004b, Roháček & Ševčík 2009, Padro e Castro *et al.* 2012, Misiachna & Korneyev 2015). It is also present in the Oriental region: Calcutta, Celebes, Formosa, Kurseong, Philippine Islands, Sumatra, and in the Australasian region: Australia, Fiji, New Guinea (Steyskal 1958).

Notes on Capture: This species has been captured in the Nearctic from April to October using dung, beef baited, pitfall, carrion (box trap), pan, flight-intercept, light and Malaise traps, and with sweep nets. It has been captured on moose skull and bones, and on carrion (moose, fish, squirrel, turtle, deer, shrew, mouse, pig). It has also been collected on carrion flower, in grasses, earth ditch, oak savannah/alvar near a burrow, forest (old growth beech-maple-hemlock, *Acer-Betula, Poplar*) and at a light source during heavy rain. The female of this species has been seen twice in copula with a male of *Protopiophila litigata* (specimens in DEBU).

Diagnosis. This species can be differentiated from *P. litigata* by having a glossy thorax with only silvery-white microtomentum on proepisternum, and by having yellow mid and hind femora and tibiae. **Description.** Body length 2.0–3.2 mm; wing length 2.0–2.8 mm. **Head:** Head higher than long, glossy black with yellow antennae and palps (some specimens with black shading on first flagellomere and apex of palps); gena posteriorly and ventrally with silvery-white microtomentum; eyes round; height of eye 6.6–7.6 times genal height; several short setae along gena; short hairs scattered on occiput, from postocellar setae to anterior end of ocellar triangle, frons and fronto-orbital plates; 2 reclinate posterior fronto-orbitals (upper no more than twice as long as lower); inner and outer vertical setae of equal length; vertical, ocellar and postocellar setae of equal length; first flagellomere oval; arista pubescent; arista about 3 times length of first flagellomere; base of arista yellow with rest brown; palpus only with very short and fine hairs. **Thorax:** Glossy black; proepisternum with silvery-white microtomentum; sculletum, subsculletum, katatergite, anatergite and metapleuron dull; 2 postpronotal (1 anterior and 1 posterior); 1 presutural intra-alar, 1 supra-alar, 1 postalar, 1 intrapostalar, 1 presutural and 3 postsutural dorsocentral setae (the posterior most dorsocentral setae being the strongest of the four setae); acrostichal setulae in 12 rows; 1 proepisternal seta; prosternum bare; anepisternum bare; anepimeron bare; katepisternum usually with 3 large setae on upper margin; scutellum convex and bare, with 2 pairs of marginal setae. **Wing:** Hyaline; veins yellow; calypter and fringe white; length of crossvein dm-cu 3 times length of crossvein r-m; length of C between Sc and R_1 almost 1 time length of crossvein h; length of M_1 between crossveins r-m and dm-cu slightly less than 2 times length of dm-cu. Halter white. **Legs:** Coxae yellow; fore femur yellow proximally and black distally, with remaining of leg black; mid and hind leg yellow with shaded black tarsal segment 5 (some specimens, hind femur and/or mid femur with black distally); claws

yellow proximally and black distally. **Abdomen:** Glossy black; presence of dull reflections on tergites; short setae scattered, and more developed on lateral margins of tergite 3; sternites and tergites with row of longer setae along posterior margin. **Male genitalia:** Sternite 5 medially slightly depressed from anterior to posterior margin, causing both sides of sternite to be slightly convex; sternite 6 and 7 strongly sclerotised along anterior margin; sternite 7 with 3 weakly sclerotised rounded projections right from sensori seta, the furthest projection from sensori seta being the longest; sternite 8 round and convex with several short setae; epandrium on lateral view slightly higher than wide, anterior and ventral margin straight, with posterior margin forming a rounded edge; epandrium with a 1 pair of strong seta posterio-ventrally and 1 pair posterio-dorsally, and with several shorter setae behind these; surstylus not fused with epandrium, reduced to rounded lobe with 2 setae and several short setae; postgonite strongly sclerotised, narrow and elongated, 3–4 times longer than width, with pointed apex; postgonite slightly incurved laterally towards apex; pregonite more strongly sclerotised on margins, 3 reduced rounded lobes, almost all equally sized, but the ventral lobe slightly longer than others; distiphallus membranous, with fine hairs on most of its surface, ventral surface however with strong thick brown hairs, distal end finely spinulose; distiphallus inflated and curved on itself at midpoint; distiphallus long, at least length of abdomen; cerci oval with one seta and short hairs. **Female genitalia:** Sternite and tergite 7 and 8 with setae laterally and posteriorly, and with setulae; cerci 4 times as long as wide, with 2 pairs of setae dorsally; two sclerotized spermathecae; spermathecae spherical and flattened, with smooth surface.

Protopiophila litigata Bonduriansky 1995

(Figure 33)

Protopiophila litigata Bonduriansky 1995: 860 (type locality: Canada, Ontario, Wildlife Research Station, Algonquin Park).

Type material examined. 1 ♂ holotype. W.R.S., Algonquin Park, moose antler, 7.vi.1993, R. Bonduriansky, Holotype *Protopiophila litigata* Bonduriansky (CNC). 12 ♂, 7 ♀ paratypes. **CANADA. Nova Scotia:** South Harbour beach. **Ontario:** Algonquin Park Wildlife Research Station (CNC; DEBU).

Other material examined. 242 ♂, 226 ♀ from the following Nearctic localities: **CANADA. Alberta:** Waterton Lakes National Park, Red Rock Parkway. **Newfoundland and Labrador:** Terra Nova National Park, Blue Hill Road. **Ontario:** Algonquin; Algonquin Park (Scott Lake; Wildlife Research Station); James Bay Route km 398.8; Stonecliffe, Driftwood Provincial Park; Tunder Bay Distr., Neys Provincial Park, Dune Trail. **Quebec:** Forillon National Park. **Saskatchewan:** Prince Albert National Park, Narrows Penninsula Trail (BIO, CNC, DEBU, LEM) (Fig. 33).

Notes on capture: This species has been captured from May to October with sweep nets, white pan traps and carrion box trap. It has been collected on both carrion and moose antlers. It is also present in meadow, boggy black spruce, open pine plantation in sand & heath, mixed dry mesophytic woods, white spruce and poplar forest, and in forest containing old balsam fir, dog berry saplings, birch and mountain ash. The male of this species has been seen twice in copula with a female of *Protopiophila latipes* (specimens in DEBU).

Diagnosis. It can be differentiated from *P. latipes* by having silvery-white microtomentum on katepisternum, anepimeron and ventral margin of anepisternum and by having black mid and hind femora, and tibiae. **Description.** Body length 2.0–2.8 mm; wing length 1.9–2.6 mm. In Bonduriansky (1995), female body length varied from 1.9–3.1 mm and male from 1.6–2.8 mm. Same as in *P. latipes* except head with black palps; antennae varies from mostly yellow to mostly black; legs differ as fore femur is more black, mid and hind femora as well as tibiae are entirely black; anepisternum with silvery-white microtomentum at ventral margin; katepisternum and anepimeron with silvery-white microtomentum. Abdomen with setae more dense and developed. **Male genitalia:** Same as *P. latipes* except surstylus less rounded; pregonite same except the 3 lobes are more developed; distiphallus hair on dorsal side more coarse than in *P. latipes*. **Female genitalia:** Same as *P. latipes.*

Identification key to Nearctic Piophilidae

1. R_1 setulose dorsally. 3–4 fronto orbital setae. Fore and hind femora with 2 ventral rows of stout setae.....*Actenoptera,* 2

1'. R_1 bare dorsally. 1–2 fronto orbital setae. Fore and hind femora without ventral rows of stout setae.....3

2. Mid femur with 1 row of ventral stout setae. Scutellum bare with 2 pairs of marginal setae. Legs partly brown.....*Actenoptera avalona*

2'. Mid femur without row of ventral stout setae. Scutellum with several short hairs between marginal setae. Legs entirely yellow.....*Actenoptera hilarella*

3. Posterior margin of scutellum with 2 wart-like tubercles.....*Lasiopiophila pilosa*

3'. Posterior margin of scutellum without 2 wart-like tubercles.....4

4. 2 postpronotal setae. 1 presutural and 3 postsutural dorsocentral setae. Front tarsomere 2–5 flattened.....*Protopiophila*, 5

4'. 1 or no postpronotal seta. Presutural absent. 1 or 2 postsutural dorsocentral setae (3 in *Mycetaulus subdolus*). All tarsomere cylindrical (except flattened in *Prochyliza nigriceps*).....6

5. Katepisternum, anepimeron and ventral margin of anepisternum with silvery-white microtomentum. All tibiae, and mid and hind femora black.....*Protopiophila litigata*

5'. Katepisternum, anepimeron and anepisternum glossy. All tibiae, and mid and hind femora yellow..... *Protopiophila latipes*

6. Postpronotal setae absent. Anepisternum setulose (bare in *Prochyliza nigriceps*).....7

6'. 1 postpronotal setae present. Anepisternum bare.....14

7. Acrostichal setulae in 3 distinct rows. Males with long pale ventral setulae on hind trochanter. Females with 1 spermatheca.....*Piophila casei*

7'. Acrostichal setulae in 8–12 rows. Males without long pale ventral setulae on hind trochanter. Females with 2 spermathecae.....8

8. Anepimeron with patch of setulose in middle (sometimes with only 3 setulae).....
.....*Liopiophila varipes*

8'. Anepimeron bare.....*Prochyliza*, 9

9. Anepisternum bare. Body usually with metallic blue tinge. Arista almost bare but with very short pubescence. Spermathecae cylindrical and wrinkled..... *Prochyliza nigriceps*

9'. Anepisternum setulose. Body without metallic blue tinge. Arista bare. Spermathecae oval and smooth.....10

10. Pedicel elongated, at least two times as long as wide (longer in males than in females).....
.....*Prochyliza xanthostoma*

10'. Pedicel not elongated, about as long as wide.....11

11. Fore coxa yellow. Sternite 5 of male medially depressed, dividing sternite 5 into 2 convex bumps.....12

11'. Fore coxa black. Sternite 5 of male not medially depressed and divided.....13

12. Frons entirely yellow with black only on ocellar triangle and posterior fronto orbital plates, in pale morphs. In the less common dark morph, frons black. Gena yellow in pale morph and black in dark morph. Anepimeron glossy.....*Prochyliza nigrimana*

12'. Frons yellow on anterior portion of frons. Frons always black between ocellar triangular and fronto orbital plates. Gena always yellow. Anepimeron with silvery-white microtomentum at posterior margin.....*Prochyliza brevicornis*

13. Katepisternum with 2 weak setae on upper posterior margin. Katepisternum with ventral portion between fore and hind coxae with several long stout setae in males, and regular strong setae in females. Male with preapical patch of long blond ventral setae. Hind trochanter and proximal end of hind femur in males with row of stout setae ventrally.....*Prochyliza lundbecki*

13'. Katepisternum with 1 strong seta at upper posterior margin. Katepisternum between fore and hind coxae without long stout setae. Males without dimorphic characters on legs.....*Prochyliza nigricoxa*

14 (6'). Prosternum with 1 pair of setae.....*Allopiophila*, 15

14'. Prosternum without a pair of setae (in *Arctopiophila setaluna*, with many hairs only).....16

15. Postalar and intrapostalar setae weak. Head yellow with black on ocellar triangle, and occasionally on fronto-orbital plate and occipital region.....*Allopiophila luteata*

15'. Postalar and intrapostalar setae usually strong. Head entirely glossy yellow.....*Allopiophila testacea*

16. Stigmal space and costal cell fumose. Wing with apical spot (except in *Amphipogon hyperboreus*). 2 or 3 postsutural dorsocentral setae.....17

16'. Stigmal space and costal cell hyaline. Wing without apical spot. 1 postsutural dorsocentral setae (postsutural weak in *Borealicola madaros*, and 2 postsutural in *Arctopiophila nigritellus* and *A.variefrontis*).....22

17. Wing without apical spot. Head longer than high. Male with beard-like cluster of long curved brown and white setae on gena.....*Amphipogon hyperboreus*

17’. Wing with apical spot. Head higher than long or as long as wide. Male without beard-like cluster on gena..... *Mycetaulus*, 18

18. 3 postsutural dorsocentral setae (the anteriormost reduced). Apical spot not reaching apex of wing.....*Mycetaulus subdolus*

18’. 2 postsutural dorsocentral setae. Apical spot reaching apex of wing.....19

19. Lunule and scutellum setulose. Thorax black.....*Mycetaulus lituratus*

19’. Lunule and scutellum bare. Thorax at least partly yellow.....20

20. Head yellow with brown on occiput, ocellar triangle, posterior fronto orbital plates, genus and palps. Apical spot divided in two between veins R_{2+3} and R_{4+5}.....
.....*Mycetaulus costalis*

20’. Head entirely brownish-yellow or yellow. Apical spot not divided.....21

21. Head and thorax yellow. Fore tarsus black. Setulae in acrostichal area present at least until posterior dorsocentral setae.....*Mycetaulus polypori*

21’. Head brownish-yellow. Thorax at least partly brown. Fore tarsus yellow with only segments 4 and 5 black. Setulae in acrostichal area not reaching posterior-most dorsocentral setae.....
.....*Mycetaulus longipennis*

22 (16’). Intrapostalar setae absent (present but weak in *Borealicola fulviceps*). Distiphallus ornamented with spines (Fig. 22) or with strong and long hairs (Fig. 24).....
.....*Borealicola* n. gen., 23

22’. Intrapostalar setae present. Distiphallus bare or with very short hairs (Fig. 14).....
.....*Arctopiophila*, 26

23. Vibrissa absent. Postsutural dorsocentral setae present but greatly reduced. Scutum orange with 3 black connected strips.....*Borealicola madaros* n.sp.

23’. Vibrissa present. Postsutural dorsocentral setae well developed. Thorax entirely black, or partly yellow or orange, without connected strips.....24

24. Body covered with silvery-white microtomentum.....*Borealicola skevingtoni* n.sp.

24’. Body glossy.....25

25. First flagellomere black and enlarged. Cell bm absent or incomplete. Distiphallus with spines on distal end (Fig. 22).....*Borealicola fulviceps*

25’. First flagellomere yellow and not enlarged. Cell bm present and complete. Distiphallus without spines, but with long strong hairs (Fig. 24).....*Borealicola pseudovulgaris*

26 (22’). Halter and fringe of calypter shaded black.....27

26’. Halters and fringe of calypter white.....28

27. Palps enlarged. Legs black. Mid and hind femora with stout setae ventrally, at proximal end... .....*Arctopiophila nigerrima*

27’. Palps not enlarged. Legs black with yellow proximally. Mid and hind femora without stout setae.....*Arctopiophila arctica*

28. Frons and gena black.....29

28’. Frons and gena at least partly yellow.....33

29. First tarsal segment of fore tarsus white.....*Arctopiophila atrifrons*

29’. First tarsal segment of fore tarsus black or yellow.....30

30. Ocellar setae weak. Fore tarsus with tarsal segment 5 yellow..... .....*Arctopiophila flavipes*

30’. Ocellar setae strong. Fore tarsus with tarsal segment 5 black.....31

31. Sternite 5 of male with cluster of setae posteriorly.....32

31’. Sternite 5 of male without cluster of setae.....*Arctopiophila dudai*

32. Legs black with yellow distally and proximally on tibia, and usually on tarsal segment 1. Cluster of setae on sternite 3, 4 and 5 posteriorly.....*Arctopiophila pectiniventris*

32’. Legs black with yellow on femur distally, on tibia (possible black on middle section), on tarsal segment 1 of fore tarsus and tarsal segments 1–3 in mid and hind tibia. Cluster of setae on middle of sternite 5 posteriorly. Sternite 3 and 4 with long setae posteriorly but are not regrouped into a cluster, they are more divided.....*Arctopiophila penicillata*

33 (28’). Lunule and prosternum setulose. Palps enlarged..... .....*Arctopiophila setaluna*

33’. Lunule and prosternum bare. Palps not enlarged.....34

34. Body mainly dull grey. Sternite 8 and epandrium of male with silvery-white microtomentum. Sternite 6 of male with a small sclerotised projection.....*Arctopiophila tomentosa*

34’. Body mainly glossy. Sternite 8 and epandrium of male glossy black. Stenite 6 of male without a small projection.....35

35. 2 postsutural dorsocentral setae. 1 posterior and 1 anterior fronto-orbital setae.....36

35’. 1 postsutural dorsocentral seta. 1 or 2 posterior fronto orbtial setae. Anterior fronto-orbital setae absent.....37

36. Posterior fronto orbital plates black. Acrostichal area with short setulae not exceeding posterior-most dorsocentral setae.....*Arctopiophila nigritellus*

36’. Posterior fronto orbital plates usually yellow. Acrostichal area with short setulae exceeding posterior-most dorsocentral setae, almost reaching scutellum.....*Arctopiophila variefrontis* n.sp.

37. Frons yellow anteriorly but also between posterior fronto orbital plates and ocellar triangle.....38

37’. Frons yellow on anterior portion only.....40

38. Sternite 6 of male with 2 strongly sclerotised pointed projections in middle of posterior margin.....*Arctopiophila vulgaris*

38’. Sternite 6 of male without 2 strongly sclerotised pointed projections.....39

39. Proepisternum yellow. Abdomen black. Distiphallus narrow but somewhat inflated, curled at 2/3 of length with apex asymmetrical.....*Arctopiophila mcalpinei* n. sp.

39’. Proepisternum black. Abdomen black, but in some specimens syntergite 1+2 yellow. Distiphallus narrow, and folded and symmetrical at apex.....*Arctopiophila kugluktuk*

40. First flagellomere round and enlarged. Body size ranging from 3.4–4.8 mm.....*Arctopiophila lonchaeoides*

40’. First flagellomere oval and not enlarged. Body size ranging from 2.1–3.1 mm.....41

41. Meron glossy. Surstylus boot-shaped in lateral view.....*Arctopiophila nitidissima*

41’. Meron with silvery-white microtomentum. Surstylus rectangular in lateral view.....42

42. Femora yellow with sometimes fore femur darkened on posterior side. Pregonite with one elongated and narrow lobe.....*Arctopiophila xanthopoda*

42’. Femora black with yellow distally and proximally. Pregonite oval with an elongated and rectangular projection dorso-posteriorly.....*Arctopiophila baechlii*

Revised classification of Piophilidae

Subfamily THYREOPHORINAE

Genus BOCAINAMYIA Albuquerque 1953

hagmannarum Papavero 1971

necrophila Albuquerque 1953

Genus CENTROPHLEBOMYIA Hendel 1903

Thyreolepida Sack 1939: 4, type species *T. cinerea* Sack 1939: 4.

Protothyreophora Ozerov 1984: 465, type species *P. grunini* Ozerov 1984 synonymised by Mei *et al.* 2013.

anthropophaga (Robineau-Desvoidy 1830)*

Thyreophora anthropophaga Robineau-Desvoidy 1830: 623 (type locality: France, Paris).

furcata (Fabricius 1794)

Musca furcata Fabricius 1794: 343 (type locality: "habitat in Gallia").

Thyreolepida cinerea Sack 1939: 4 (type locality: Israel, "Rehoboth bei Jaffa") synonymised in Freidberg 1981: 321.

grunini (Ozerov 1984)**

Protothyreophora grunini Ozerov 1984: 466 (type locality: Amur region, near Zeya) combination in Mei *et al.* 2013.

orientalis Hendel 1907*

cinerea Sack 1939*

Genus DASYPHLEBOMYIA Becker 1914

stylata Becker 1914

Genus PIOPHILOSOMA Hendel 1917

Chaetopiophila Malloch 1928: 309, type species *C. hyalipennis* Malloch (=Piophilosoma antipodum (Osten Sacken)).

antipodum (Osten Sacken 1881-82)*

Thyreophora antipodum Osten Sacken 1881: 35.

Chaetopiophila hyalipennis Malloch 1928: 309 synonymised by D.K. McAlpine 1989).

Chaetopiophila scutellata Malloch 1931: 293 synonymised by D.K. McAlpine 1989).

norrisi (Paramanov 1954)*

Chaetopiophila norrisi Paramonov 1954: 297, (type locality: Jervis Bay).

palpatum Hendel 1917: 37-38, (type locality: New South Wales, Mount Victoria).

Chaetopiophila palpalis Paramonov 1954: 296-297, (type locality: F.C.T., Canberra).

Genus THYREOPHORA Meigen 1803

cynophila (Panzer 1798)*

Subfamily PIOPHILINAE

Genus ACTENOPTERA Czerny 1904

Gymnomyza Strobl 1894: 85, type species *Heteromyza hilarella* Zetterstedt 1847: 2467.

avalona McAlpine 1977

hilarella (Zetterstedt 1847)

shatalkini Ozerov 2000*

New genus A

"Protopiophila" vitrea (D.K. McAlpine 1989)

Genus ALLOPIOPHILA Hendel 1917

luteata (Haliday 1883)

pappi Ozerov 2004 ***

teatacea (Melander 1924)

Genus AMPHIPOGON Wahlberg 1845

Macrochira Zetterstedt 1838: 784, type species: *Macrochira flava* Zetterstedt 1838: 784.

Ambopogon Greene 1919: 126. type species: *Ambopogon hyperboreus* Greene 1919: 126.

flavus (Zetterstedt 1838)

Amphipogon spectrum Wahlberg 1845(1844): 217 (type locality: Sweden, Lulea).

hyperboreus (Greene 1919)

Genus ARCTOPIOPHILA Duda 1924

Boreopiophila Frey 1930: 86, type species *B. tomentosa* Frey 1930: 84 **new synonym**.

Neopiophila McAlpine 1977: 33, type species *N. setaluna* McAlpine **new synonym**.

Parapiophila McAlpine 1977: 48, type species *Piophila vulgaris* Fallén 1820 **new synonym**.

arctica (Holmgren 1883)

atrifrons (Melander & Spuler 1917) **new combination**

baechlii (Merz 1996) **new combination**

dudai (Frey 1930) **new combination**

flavipes (Zetterstedt 1847) **new combination**

kugluktuk (Rochefort & Wheeler 2014) **new combination**

lonchaeoides (Zetterstedt 1838) **new combination**

mcalpinei Rochefort **new species**

nigerrima (Lundbeck 1901)

nigritellus (Melander 1924) **new combination**

nitidissima (Melander & Spuler 1917) **new combination**

pectiniventris (Duda 1924) **new combination**

penicillata (Steyskal 1964) **new combination**

setaluna (McAlpine 1977) **new combination**

tomentosa (Frey 1930) **new combination**

uralica (Ozerov 2002)* **new combination**

variefrontis Rochefort **new species**

vernicosa (Ozerov & Barták 1993)* **new combination**

vulgaris (Fallén 1820) **new combination**

xanthopoda (Melander & Spuler 1917) **new combination**

Genus BOREALICOLA Rochefort new genus

fulviceps (Holmgren 1883) **new combination**

madaros Rochefort **new species**

pseudovulgaris (Ozerov 1989) **new combination**

skevingtoni Rochefort **new species**

Genus LASIOPIOPHILA Duda 1924

pilosa (Staegar 1845)

Genus LIOPIOPHILA Duda 1924

varipes (Meigen 1830)

Genus MYCETAULUS Loew 1845

Neottiophilum Frauenfeld 1868: 895, type species *Neottiophilum fringillarum* Frauenfeld (= *praeustum* (Meigen 1826) **new synonymy**

asiaticus Gregor 1971*

bipunctatus (Fallén 1823)

Geomyza bipunctata Fallén 1823: 3.

Mycetaulus hoffmeisteri Loew 1845: 37 (type locality: Germany, "Gegend von Cassel").

confusus Soós 1977

confuses error in Ozerov 2004a: 606.

costalis Melander 1924

hispanicus Duda 1927*

latipennis Ozerov & Bartak 1993*

lituratus Melander & Spuler 1917

longipennis Loew 1869

praeustum (Meigen 1826) **new combination**

polypori Melander 1924

subdolus (Johnson 1922)

Genus PIOPHILA Fallén 1810

Tyrophaga Kirby and Spence 1826: 78, type species *Musca casei* Linnaeus 1758: 597.

casei (Linnaeus 1758)

megastigmata McAlpine 1978

Genus PROCHYLIZA Walker 1849

Stearibia Lioy 1864: 1005, type species *Piophila foveolata* Meigen 1826: 396 (= *nigriceps* Meigen 1826: 397) **new synonym**

azteca McAlpine 1977

brevicornis Melander 1924

georgekaplani Martín-Vega 2014*

inca McAlpine 1977

lundbecki (Duda 1924)

nigriceps (Meigen 1826) **new combination**

nigricoxa (Melander & Spuler 1917)

nigrimana (Meigen 1826)

xanthostoma Walker 1849

Genus PROTOPIOPHILA Duda 1924

Clusina Curran 1934: 449, type species *Clusina nigriventris* Curran, synonymy in McAlpine 1977: 37.

aethiopica (Hennig 1951)

Piophila (*Protopiophila*) *aethiopica* Hennig 1951:70 (type locality: Transvaal, Johannesburg).

atrichosa McAlpine 1977

australis Harrison 1960

caucasica Ozerov 2007*

contecta (Walker 1860)

Piophila contecta Walker 1860: 167 (type locality: Celebes, Makessar)

Piophila ruficornis Wulp 1871: 49.

latipes (Meigen 1838)

leucodactyla (Hennig 1954)*

Piophila (*Protopiophila*) *leucodactyla* Hennig 1954: 641 (type locality: East Africa, Msingi).

litigata Bonduriansky 1995

nigriventris (Curran 1934)

pallida McAlpine 1977

scutellata Harrison 1960

vikhrevi Ozerov 2007*

Genus PSEUDOSEPS Becker 1902

Pseudoceps, error.

signata (Fallén 1820)

Scatophaga signata Fallén 1820: 9 (type locality : Sweden, "Scania").

Scatophaga latipalpis Zetterstedt 1847: 2411 (type locality: Sweden, "Westrogothia, juxta urbem Gothoburgum".

Piophila punctipennis Zetterstedt 1847: 2516 (type locality: Sweden, "Ostrogothia ad Lärketorp").

Genus PYGOPIOPHILA Duda 1927

sikorae Duda 1927****

*Species not included in phylogenetic analysis

**Species included in analysis but further investigation needed to validate status

***Species not included in phylogenetic analysis. Questionable if this species is part of *Borealicola* instead of in *Allopiophila* since prosternum setae are lacking. In description, male genitalia was damaged and not extensively defined or drawn. Further investigation needed to validate status.

****Species not included in analysis and further investigation needed to validate

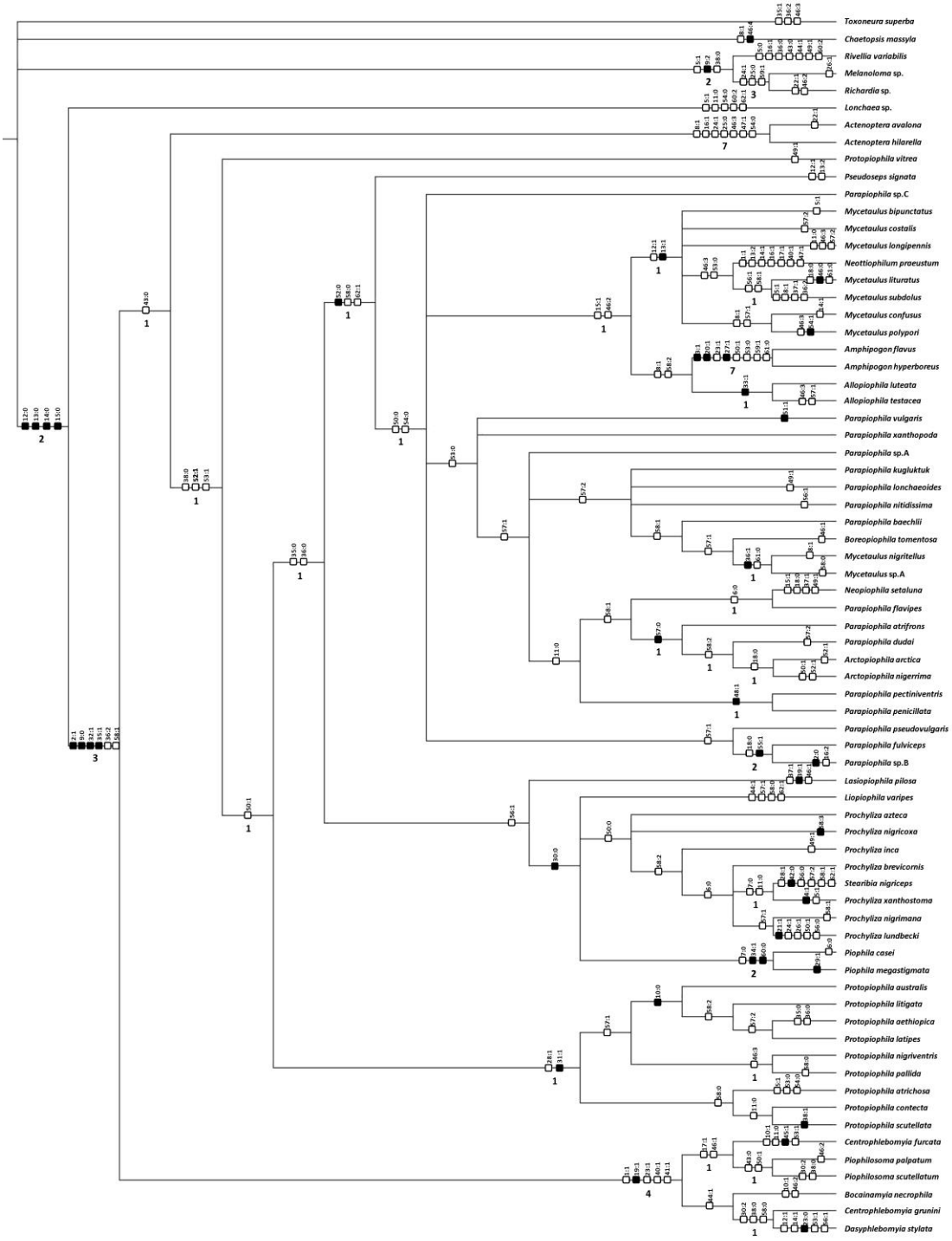


Figure 1. One of the 30 most parsimonious trees based on morphology. Species names follow literature prior to revised classification in this thesis. Dark squares = uniquely derived character states; white squares = homoplasious character states. Bremer values are shown below branches.

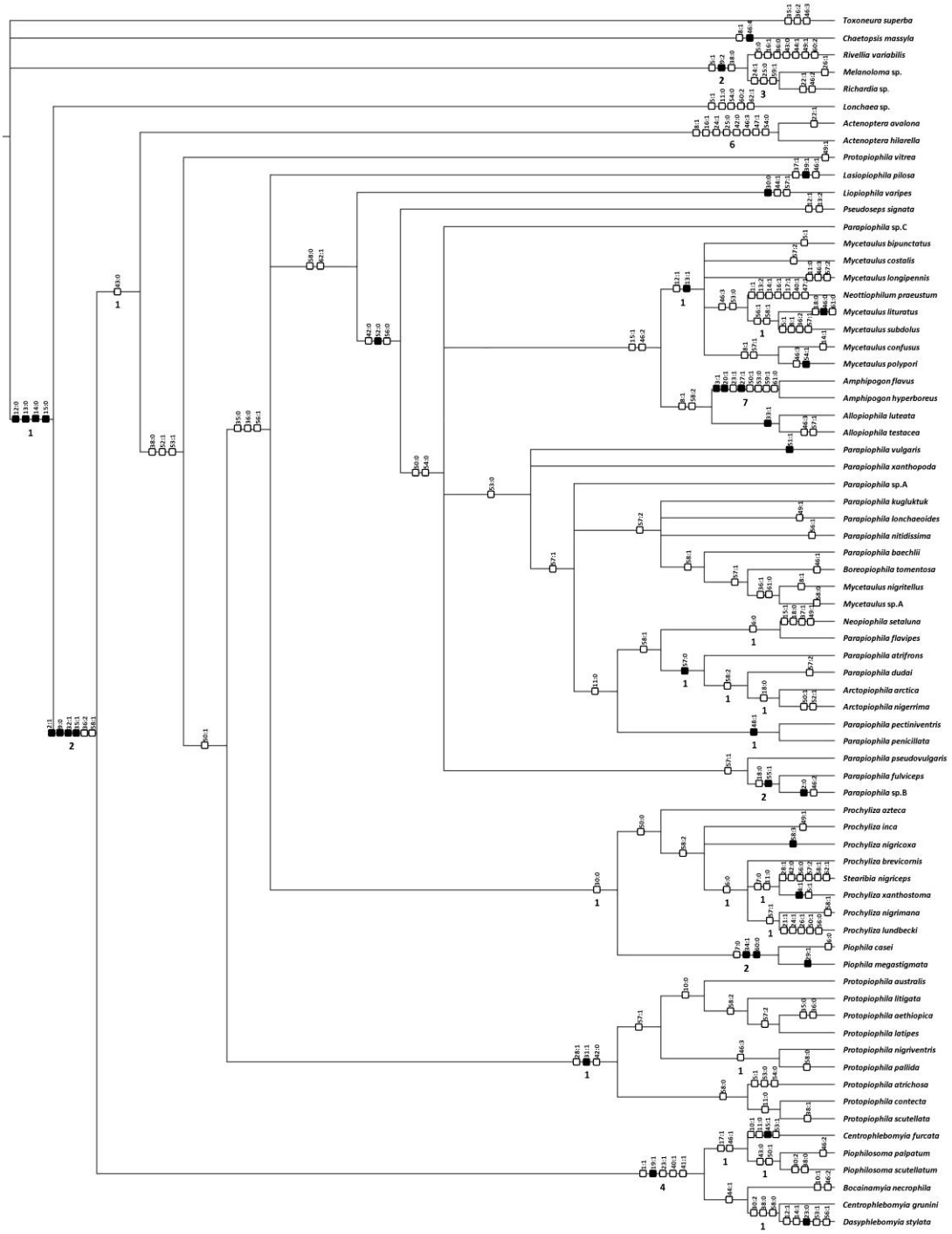


Figure 2. One of the 30 most parsimonious trees based on morphology. Species names follow literature prior to revised classification in this thesis. Dark squares = uniquely derived character states; white squares = homoplasious character states. Bremer values are shown below branches.

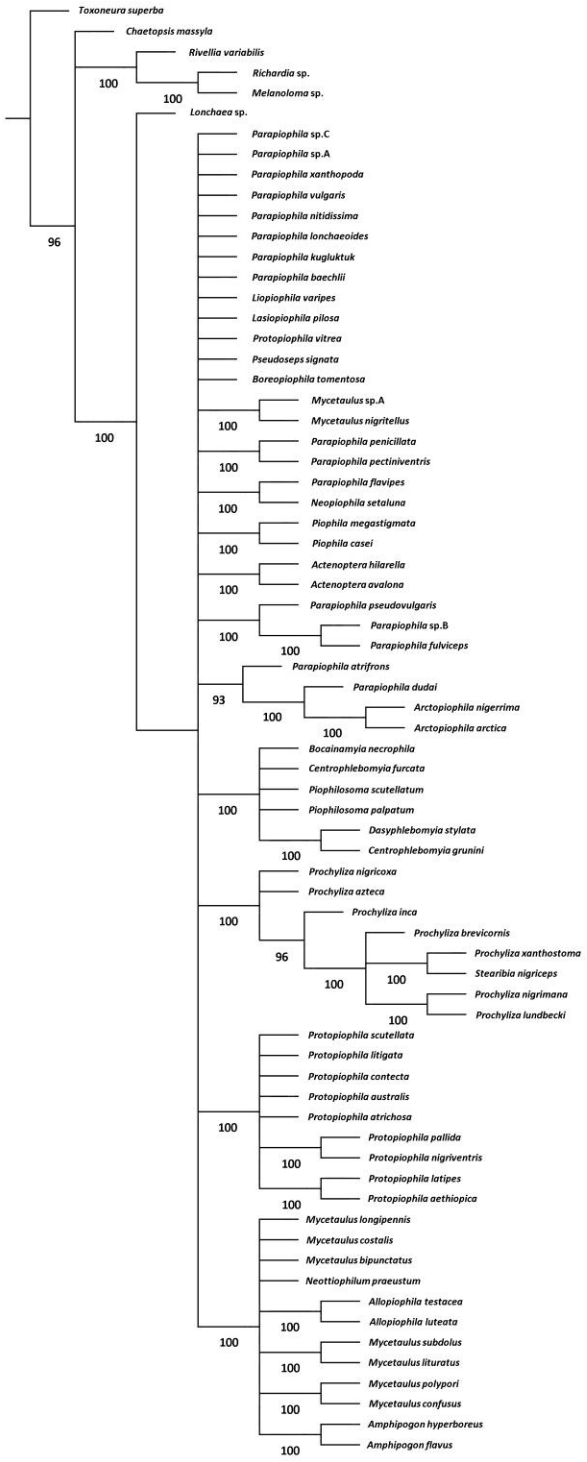


Figure 3. Majority consensus tree (70%) of 30 most parsimonious trees. Percentage frequency values are shown below branches.

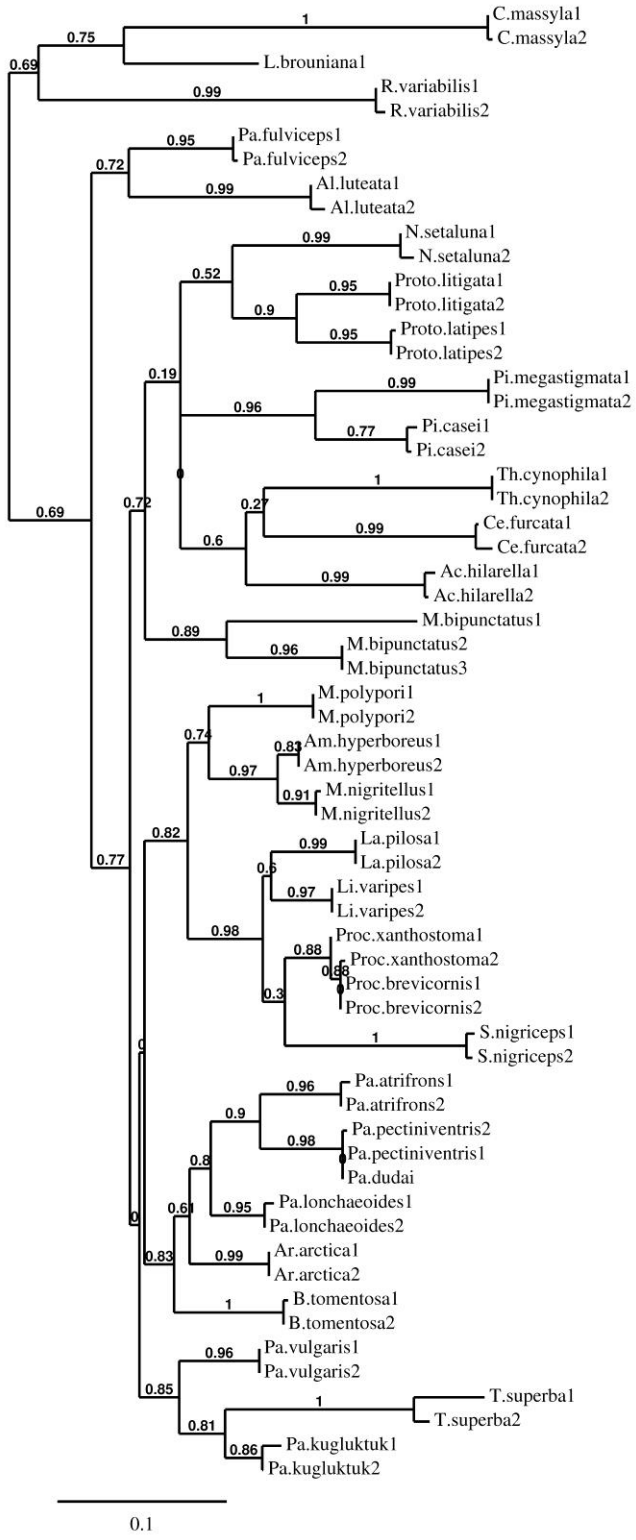


Figure 4. Maximum likelihood tree of Piophilidae exemplar species using 483 base pairs of Cytochrome Oxidase 1 (CO1). Bootstrap values above branches.

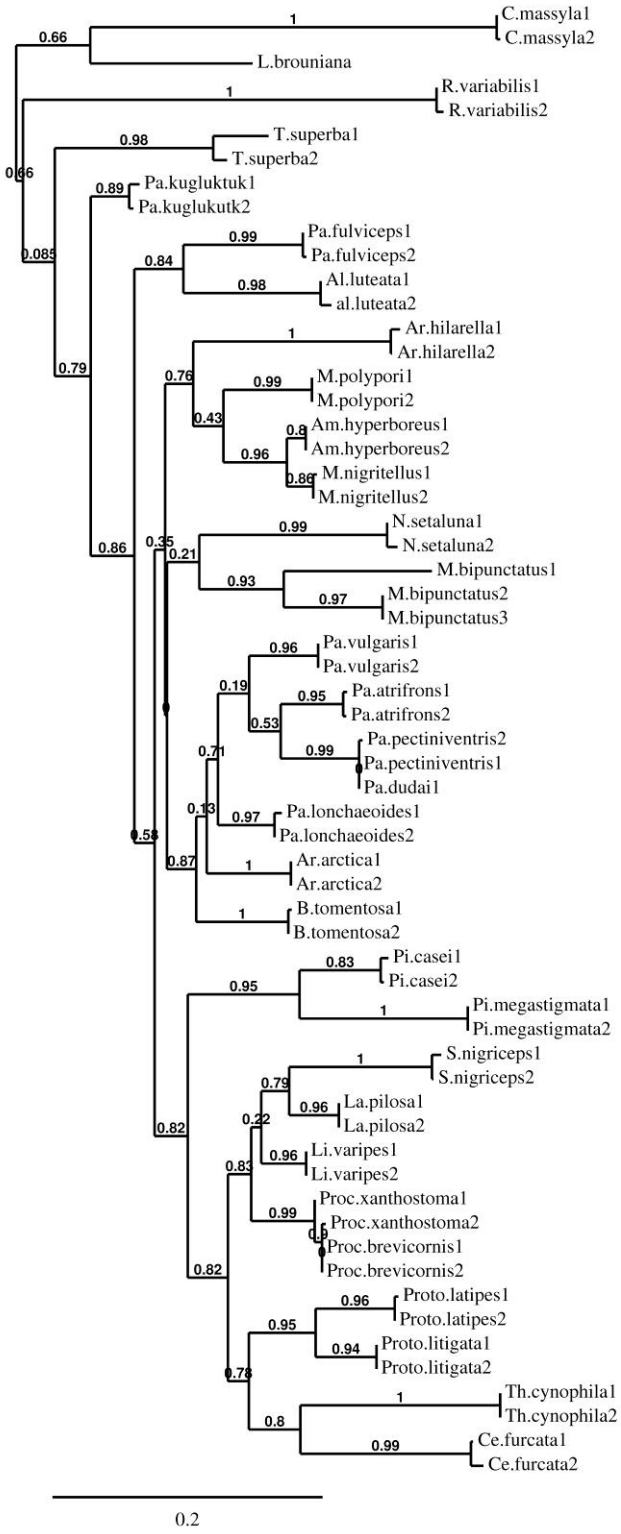


Figure 5. Maximum likelihood tree of Piophilidae exemplar species using 658 base pairs of Cytochrome Oxidase 1 (CO1). Bootstrap values above branches.

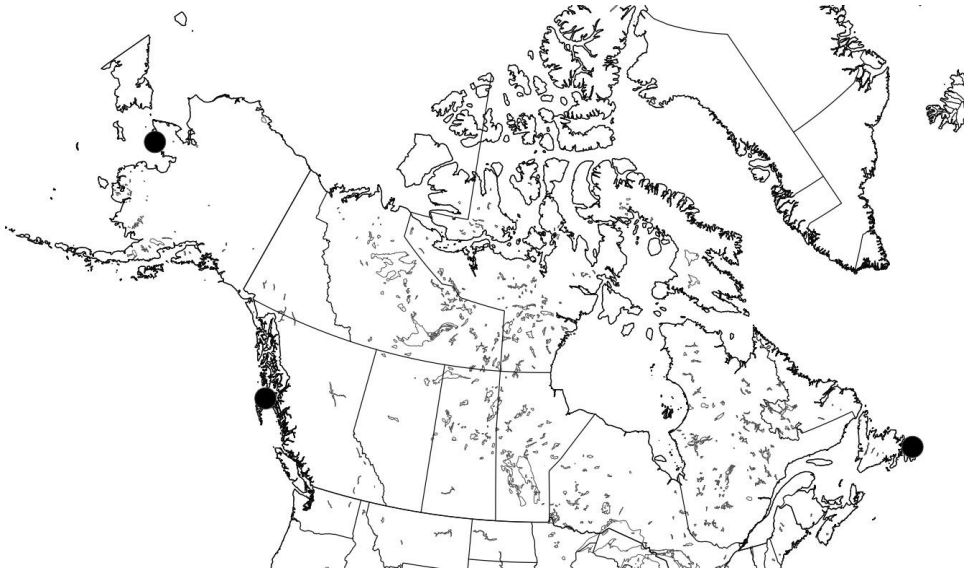


Figure 6. Nearctic distribution of *Actenoptera avalona*.

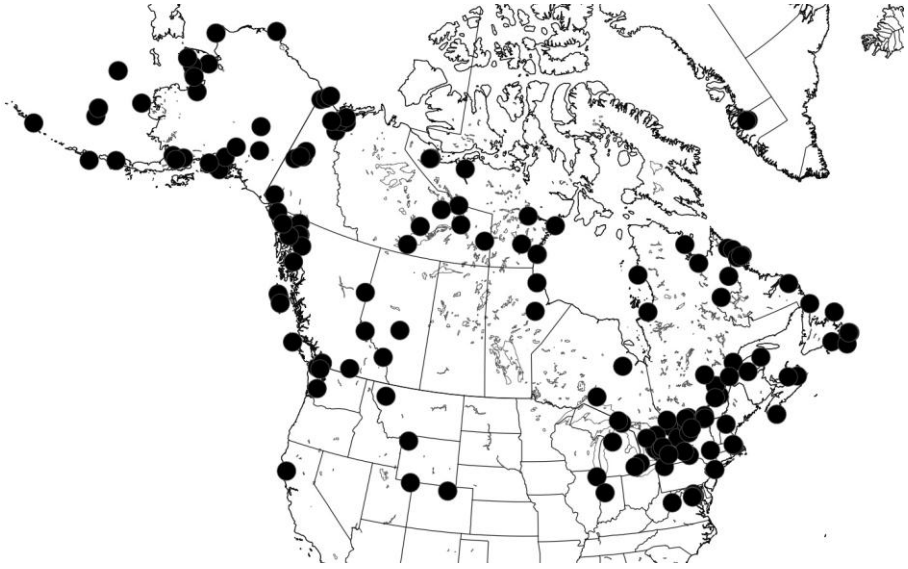


Figure 7. Nearctic distribution of *Actenoptera hilarella*.

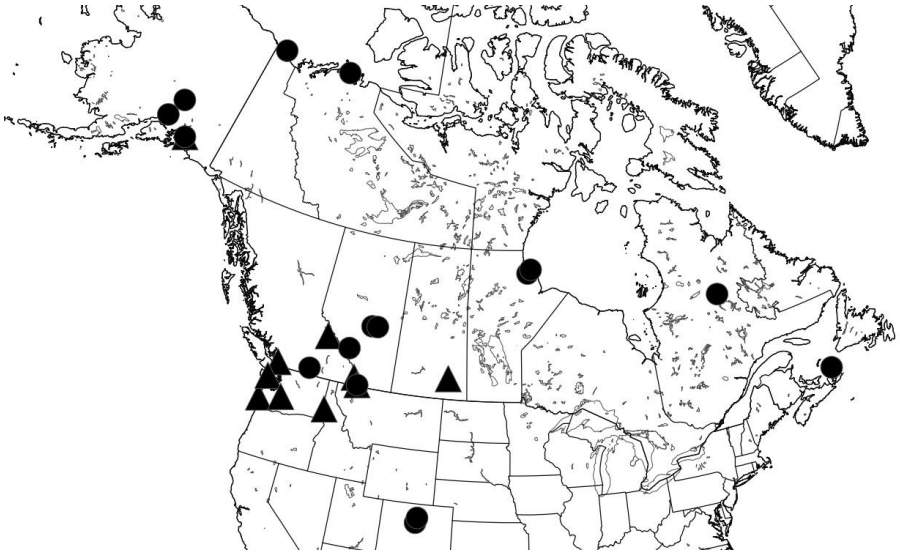


Figure 8. Nearctic distribution of *Allopiophila luteata* (circles) and *A. testacea* (triangles).

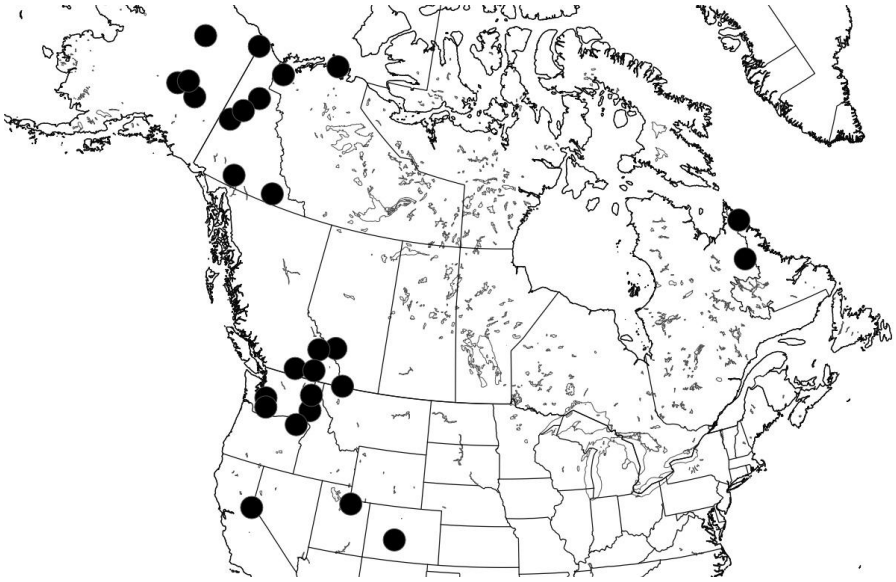


Figure 9. Nearctic distribution of *Amphipogon hyperboreus*.

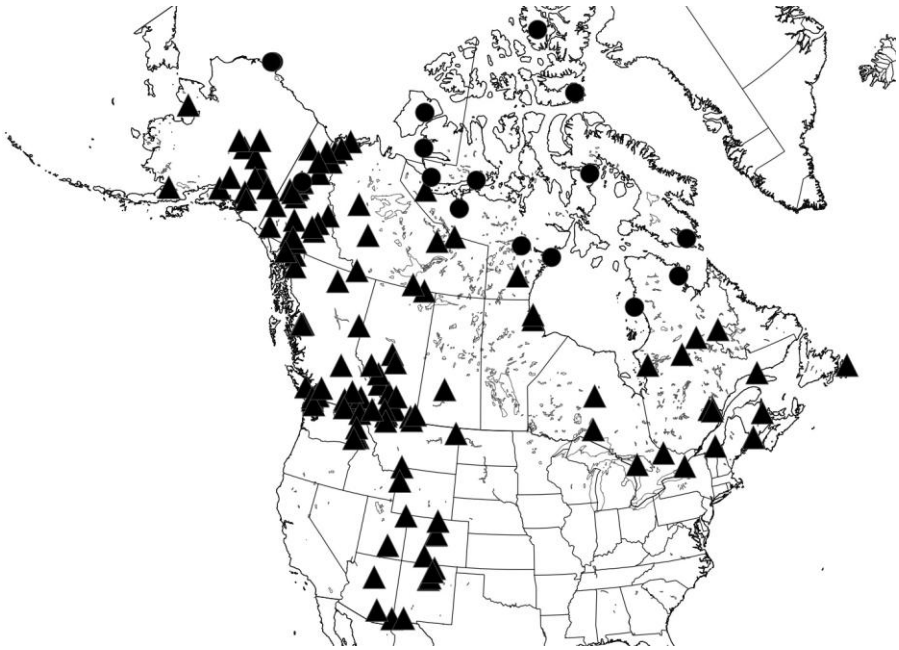


Figure 10. Nearctic distribution of *Arctopiophila arctica* (circles) and *A. atrifrons* (triangles).

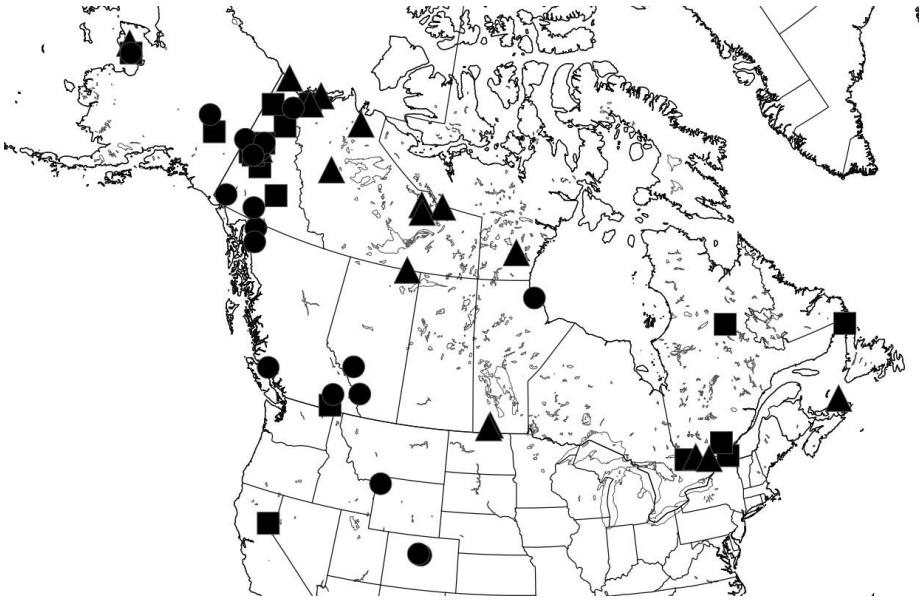


Figure 11. Nearctic distribution of *Arctopiophila baechlii* (circles), *A. dudai* (triangles) and *A. flavipes* (squares).

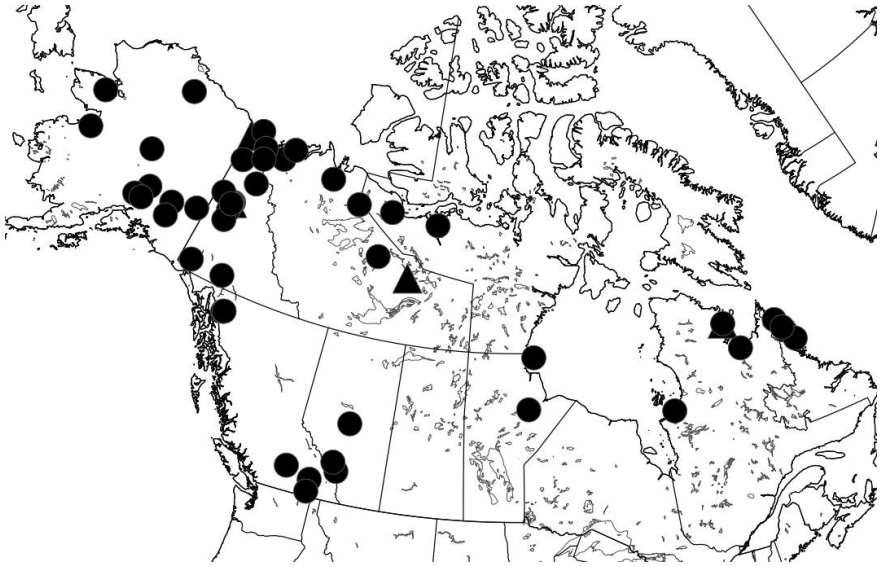


Figure 12. Nearctic distribution of *Arctopiophila kugluktuk* (circles) and *A. lonchaeoides* (triangles).

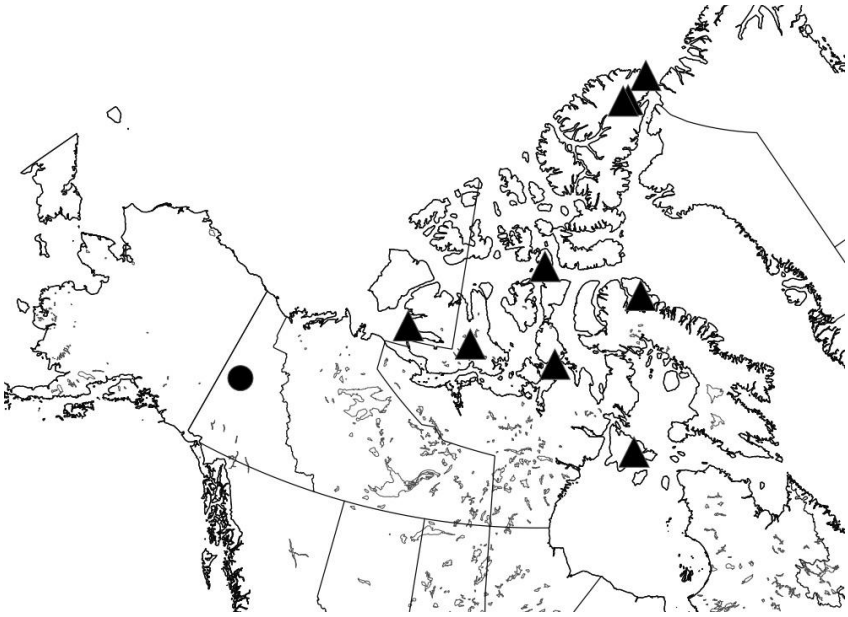


Figure 13. Nearctic distribution of *Arctopiophila mcalpinei* n. sp. (circle) and *A. nigerrima* (triangles).

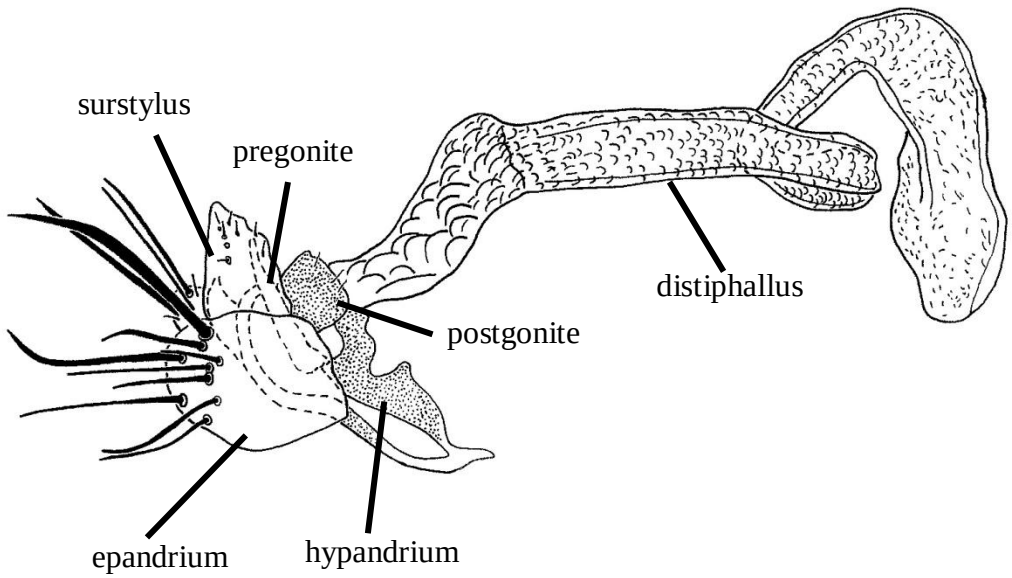


Figure 14. *Arctopiophila mcalpinei* n.sp. lateral view of male genitalia.

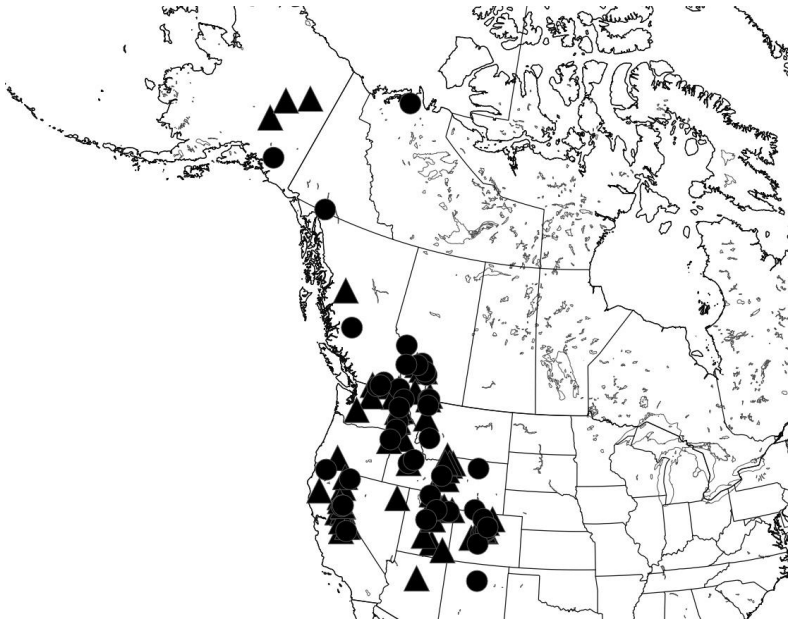


Figure 15. Nearctic distribution of *Arctopiophila nigritellus* (circles) and *A. nitidissima* (triangles)

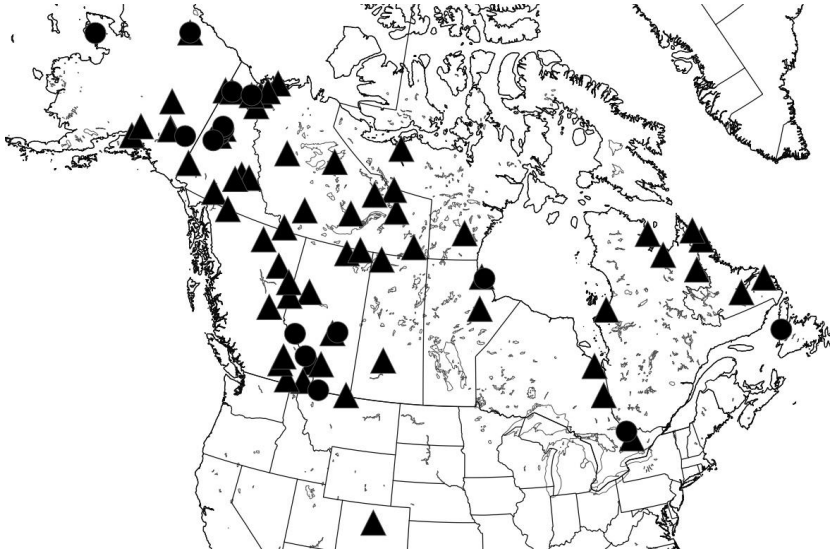


Figure 16. Nearctic distribution of *Arctopiophila pectiniventris* (circles) and *A. penicillata* (triangles).

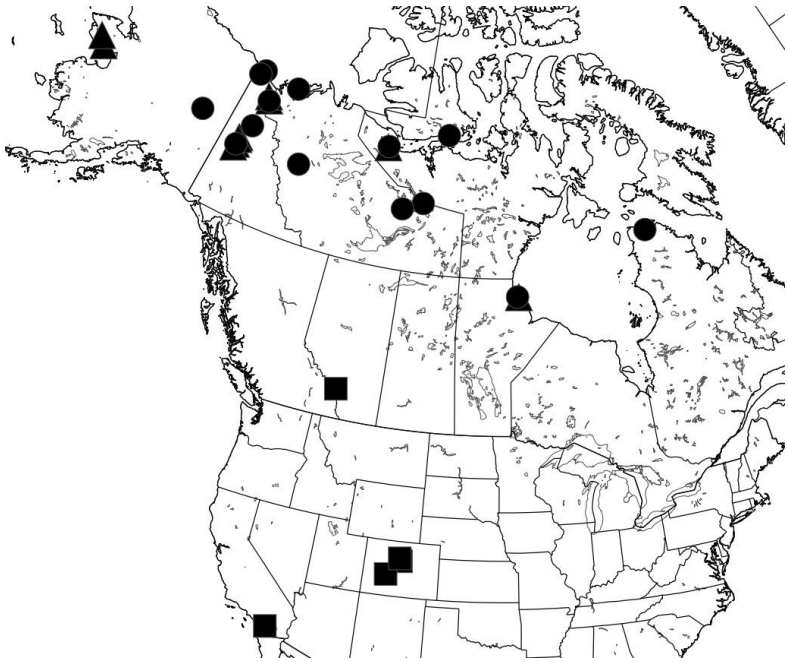


Figure 17. Nearctic distribution of *Arctopiophila setaluna* (circles), *A. tomentosa* (triangles) and *A. variefrontis* n. sp. (squares).

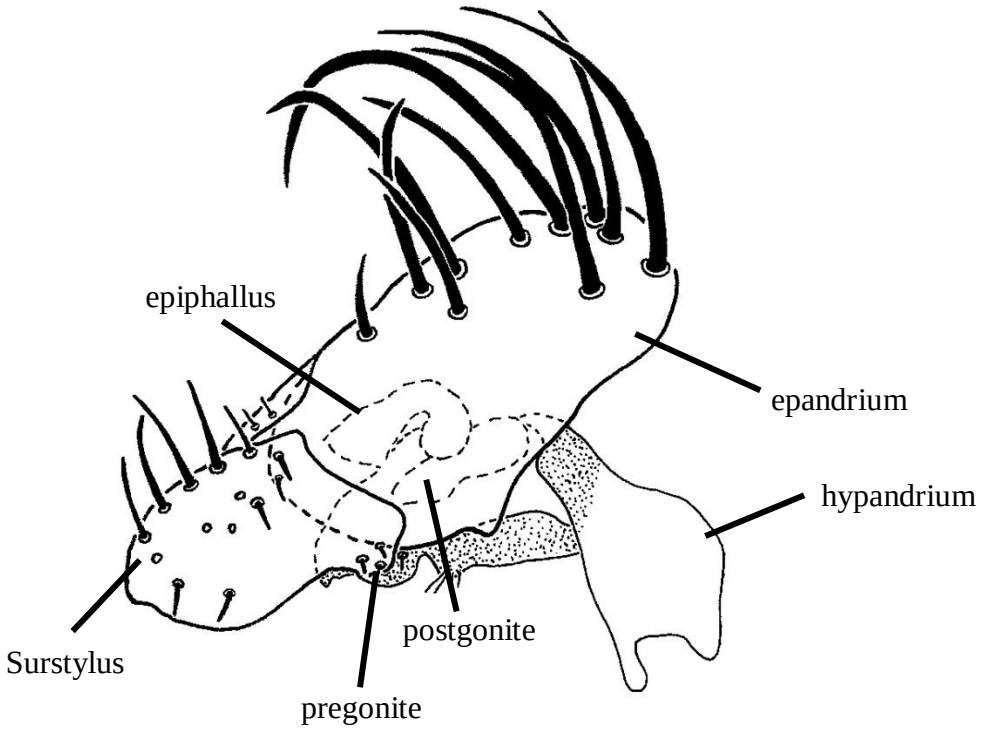


Figure 18. *Arctopiophila variefrontis* n. sp. lateral view of male genitalia.

Figure 19. Nearctic distribution of *Arctopiophila vulgaris*.

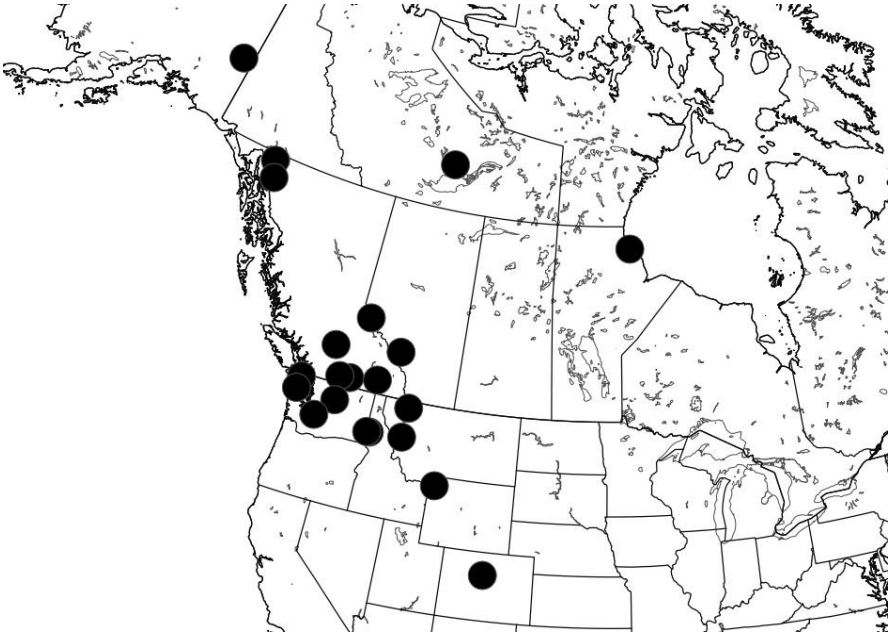


Figure 20. Nearctic distribution of *Arctopiophila xanthopoda*.

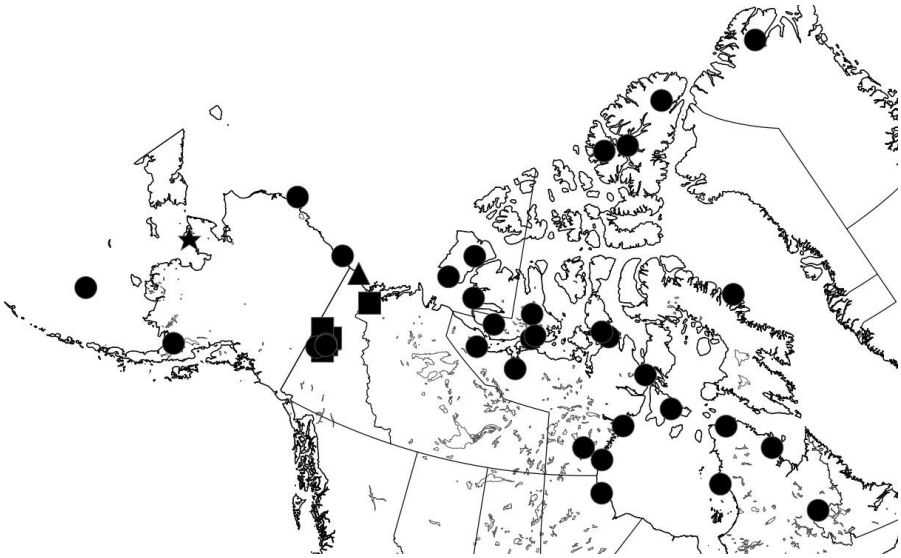
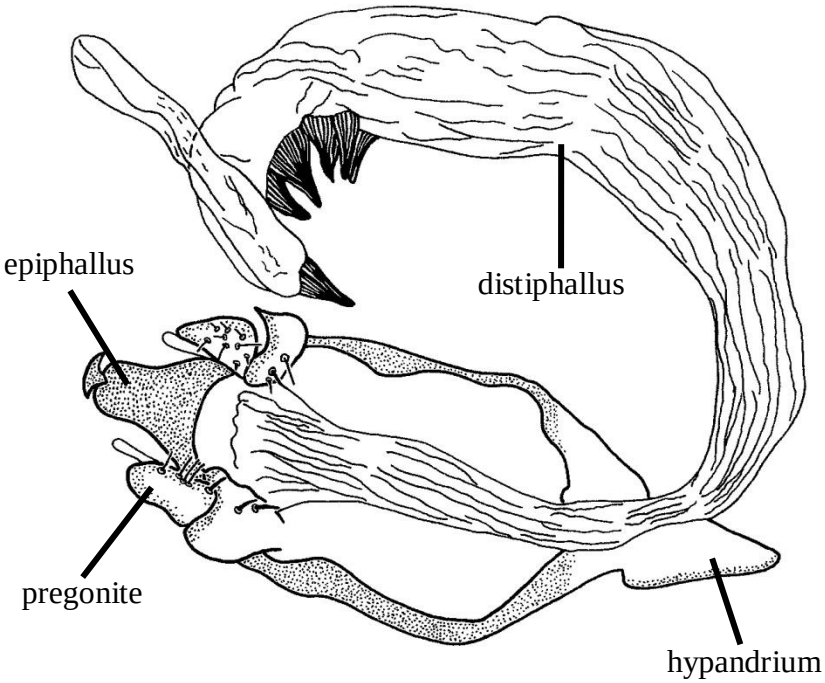
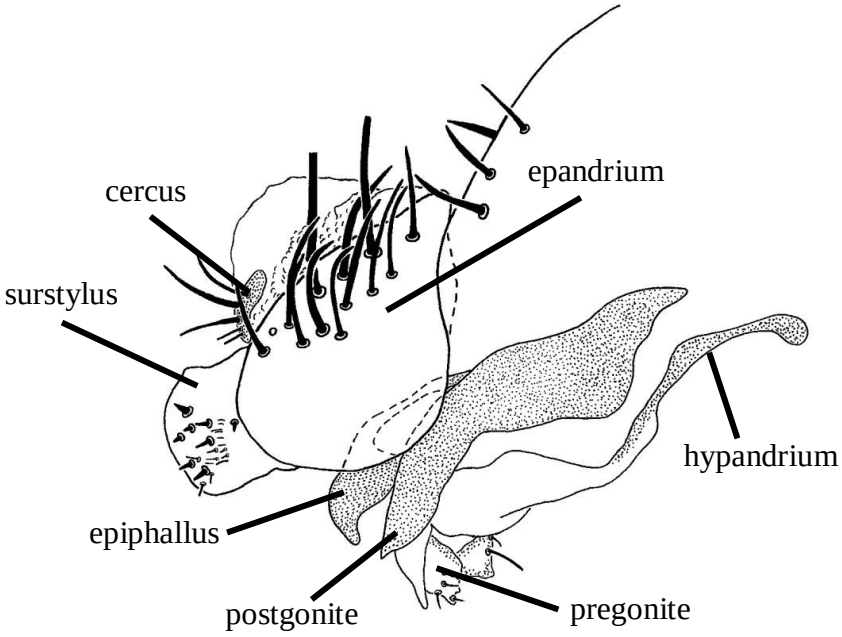


Figure 21. Nearctic distribution of *Borealicola fulviceps* (circles), *B. madaros* n. sp. (triangle), *B. pseudovulgaris* (squares) and *B. skevingtoni* n. sp. (star).





Figures 22–23. *Borealicola madaros* n. sp. ventral view (22) and lateral view (23) of male genitalia.

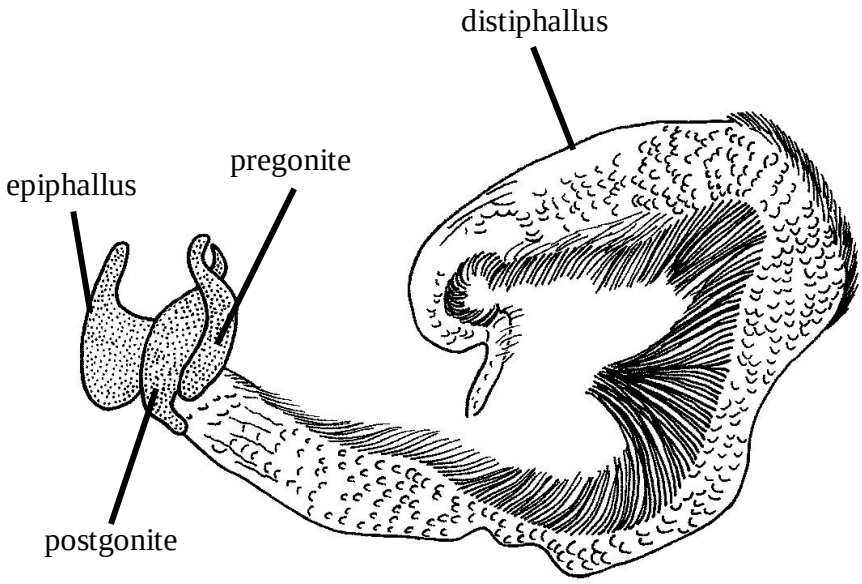


Figure 24. *Borealicola skevingtoni* n. sp. male phallic complexe.

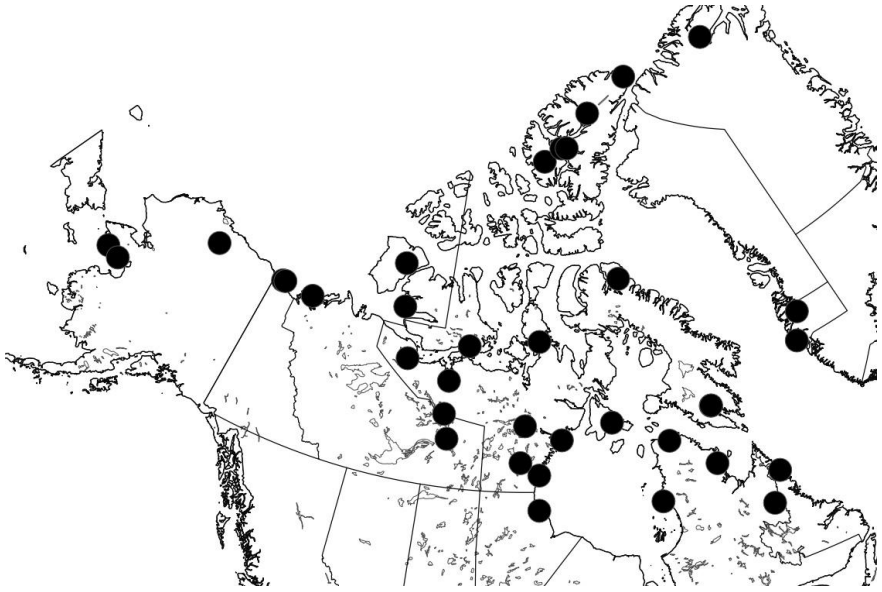


Figure 25. Nearctic distribution of *Lasiopiophila pilosa*.

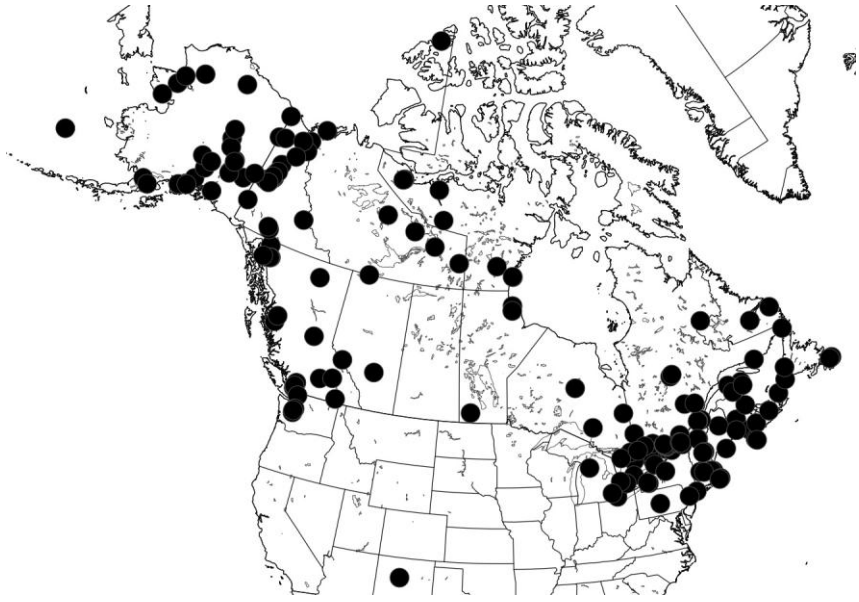


Figure 26. Nearctic distribution of *Liopiophila varipes*.

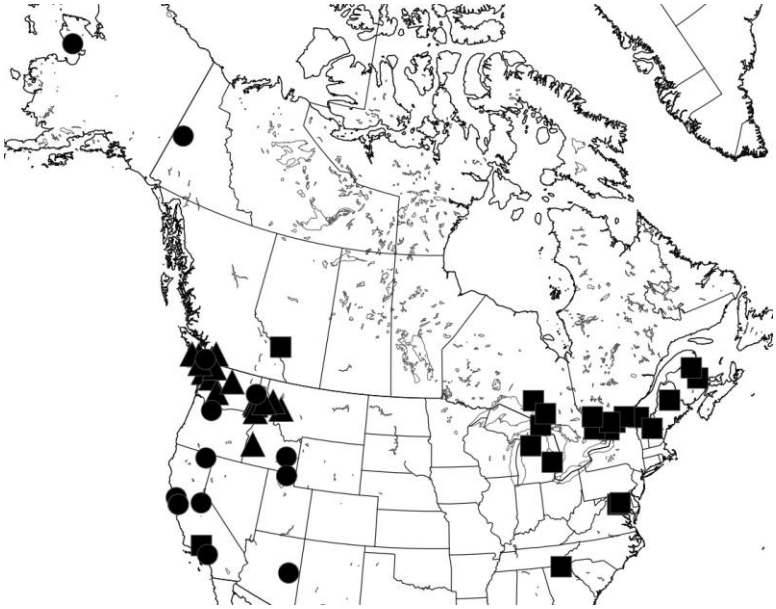


Figure 27. Nearctic distribution of *Mycetaulus costalis* (circles), *M. lituratus* (triangles) and *M. longipennis* (squares).

Figure 28. Nearctic distribution of *Mycetaulus polypori* (circles) and *M. subdolus* (triangles).

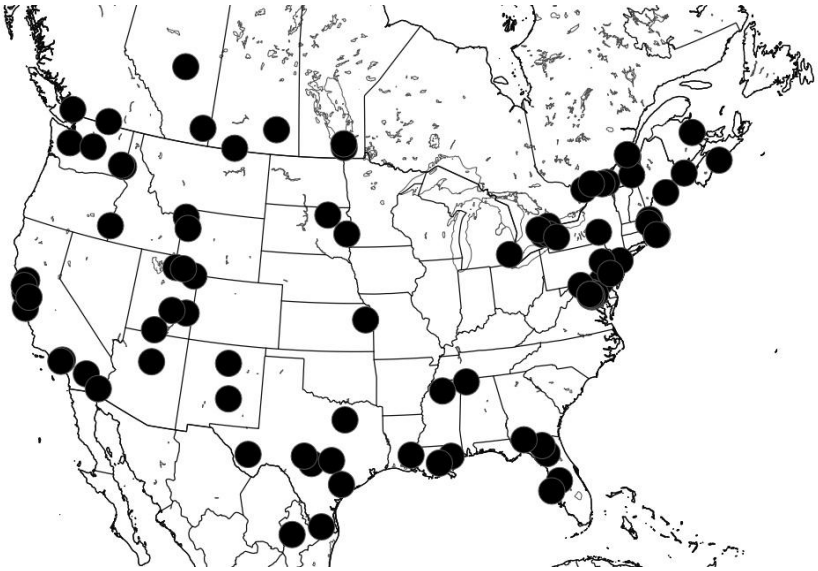


Figure 29. Nearctic distribution of *Piophila casei*.

Figure 30. Nearctic distribution of *Prochyliza brevicornis*.

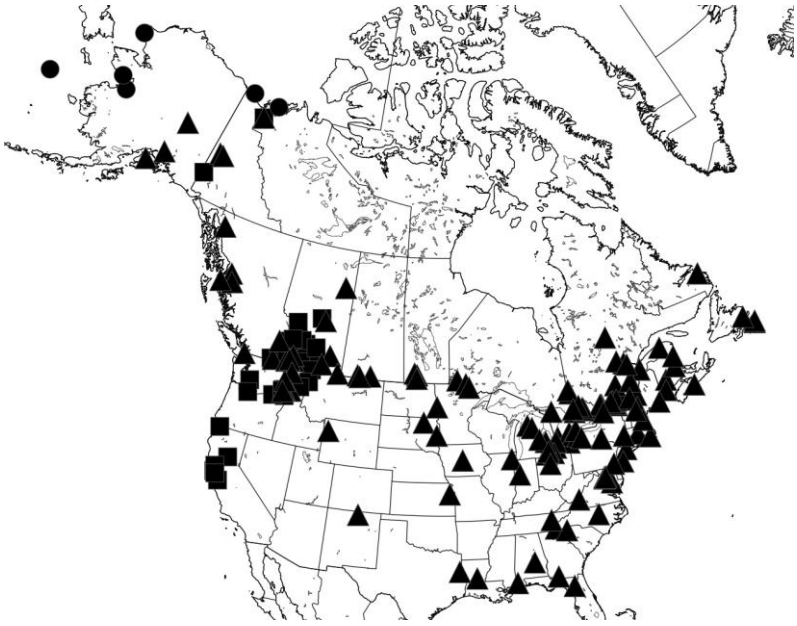


Figure 31. Nearctic distribution of *Prochyliza lundbecki* (circles), *P. nigriceps* (triangles) and *P. nigricoxa* (squares).

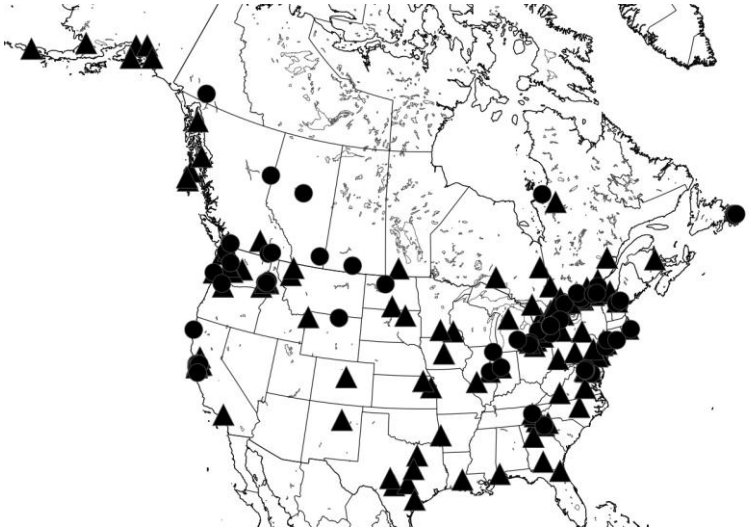


Figure 32. Nearctic distribution of *Prochyliza nigrimana* (circles) and *P. xanthostoma* (triangles).

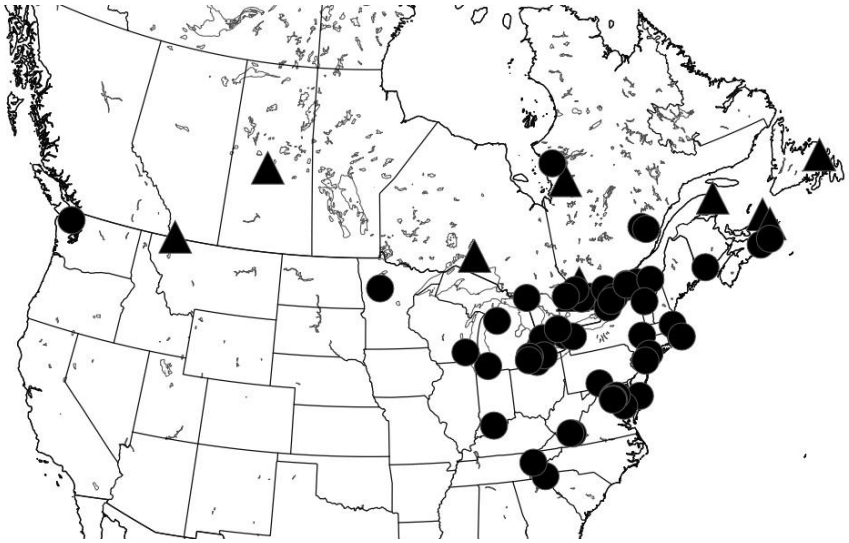


Figure 33. Nearctic distribution of *Protopiophila latipes* (circles) and *P. litigata* (triangles).

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CHAPTER 3: GENERAL CONCLUSION

Research provided in this thesis will have a major contribution to the phylogeny of worldwide Piophilidae and the taxonomy of Nearctic species. The first explicit phylogenetic analysis of Piophilidae is presented using morphological and molecular characters, as well as, a taxonomic Nearctic revision including species and genus descriptions, geographic distribution maps, notes on capture and an identification key to species.

The first section of Chapter 2 will help build and test hypotheses in ecology and evolution. It presents a new hypothesis which is different than McAlpine's (1977) and Ozerov's (2004) on the relationship of Piophilidae species. The morphological and molecular phylogenies have supported the synonymy of several genera and the creation of new combinations. In addition, 'Neottiophilidae' and 'Thyreophoridae' are proposed as monophyletic with Piophilidae, however, *Actenoptera* is now proposed as the only representative of 'Neottiophilidae' since *Neottiophilum* is considered as a junior synonym of *Mycetaulus*. Even if this study includes the first explicit phylogenetic analysis of Piophilidae, further investigation is necessary. More species need to be added to both phylogenies, especially in the Thyreophorinae subfamily. Many species were not included to the molecular phylogeny because of sequence unavailability. In addition these should be of at least 658bp. In this study, several species had 465 to 483bp, explaining the creation of two molecular analysis, one with 465bp and another with 658bp. The use of another gene than CO1 could also increase the value of the phylogenetic analysis since some species were not recognised.

The second section of Chapter 2 provides tools to simplify identification of Nearctic Piophilidae in studies. A total of 11 genera and 43 species are now present in the Nearctic, including the discovery of four new species. Species description for all 43 species is presented, including details on color and structure variations which will help differentiate and identify ambiguous species. Geographic distribution maps have also been updated by examining specimens from several insect collections in North America. The known distribution range of species have greatly expended since McAlpine (1977). In addition, a more user friendly identification key to the Nearctic species is provided. Further work could also be done on Piophilidae taxonomy by revising the *Mycetaulus bipunctatus* group which contain several undescribed species, by including male genitalic drawings for each species and by including

figures to support each character in the identification key. Such a key has been provided in Rochefort *et al.* (2015) on Nearctic piophilids of forensic interest and are essential to permit researchers from different fields to identify more accurately specimens in their studies.

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Appendix 1: Data matrix of morphological character states (? = missing data, A = polymorphic 0/1).

	1 2 3 4 5 6 7 8 9 1 0	1 1 2 3 4 5 6 7 8 9 2 0	2 2 2 2 2 2 2 2 2 3 0 1	3 3 3 3 3 3 3 3 3 4 0 1 2 3 4 5 6 7 8 9 0
Toxoneura suberba	0 0 0 0 0 1 1 0 1 0	1 1 2 1 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 0 0 0 1 2 0 1 0 0
Rivellia variabilis	0 0 0 0 1 0 1 0 2 0	1 1 2 1 1 1 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0
Chaetopsis massyla	0 0 0 0 0 1 1 1 1 0	1 1 2 1 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 1 0 1 0 0
Lonchaea sp.	0 0 0 0 1 1 1 0 1 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 1 1 1 0 0
Melanoloma sp.	0 0 0 0 1 1 1 0 2 0	1 1 2 1 1 0 0 1 0 0	0 0 0 1 0 1 0 0 0 1	0 0 0 0 0 1 0 0 0 0
Richardia sp.	0 0 0 0 1 1 1 0 2 0	1 1 2 1 1 0 0 1 0 0	0 1 0 1 0 0 0 0 0 1	0 0 0 0 0 1 0 0 0 0
Actenoptera avalona	0 1 0 0 0 1 1 1 0 0	1 0 0 0 0 1 0 1 0 0	0 1 0 1 0 0 0 0 0 1	0 1 0 0 1 2 0 1 0 0
Actenoptera hilarella	0 1 0 0 0 1 1 1 0 0	1 0 0 0 0 1 0 1 0 0	0 0 0 1 0 0 0 0 0 1	0 1 0 0 1 2 0 1 0 0
Neottiophilum praeustum	1 1 0 0 0 1 1 0 0 0	1 1 2 1 1 1 1 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 1
Amphipogon flavus	0 1 1 0 0 1 1 1 0 0	1 0 0 0 1 0 0 1 0 1	0 0 1 0 1 0 1 0 0 1	0 1 0 0 0 1 0 0 0 0
Amphipogon hyperboreus	0 1 1 0 0 1 1 1 0 0	1 0 0 0 1 0 0 1 0 1	0 0 1 0 1 0 1 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus bipunctatus	0 1 0 0 1 1 1 0 0 0	1 1 1 0 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus confusus	0 1 0 0 0 1 1 1 0 0	1 1 1 1 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus costalis	0 1 0 0 0 1 1 0 0 0	1 1 1 0 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus lituratus	0 1 0 0 0 1 1 0 0 0	1 1 1 0 1 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus longipennis	0 1 0 0 0 1 1 0 0 0	0 1 1 0 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus nigritellus	0 1 0 0 0 1 1 1 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus sp.A	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus polypori	0 1 0 0 0 1 1 1 0 0	1 1 1 0 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 1 0 0 0 0
Mycetaulus subdolus	0 1 0 0 1 1 1 1 0 0	1 1 1 0 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 2 0 0 0 0
Boreopiophila tomentosa	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Pseudoseps signata	0 1 0 0 0 1 1 0 0 0	1 1 2 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Neopiophila setaluna	0 1 0 0 0 0 1 0 0 0	0 0 0 0 1 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 1 0 0 0
Allopiophila luteata	0 1 0 0 0 1 1 1 0 0	1 0 0 0 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 1 0 0 0 0 0 0 0
Allopiophila testacea	0 1 0 0 0 1 1 1 0 0	1 0 0 0 1 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 1 0 0 0 0 0 0 0
Protopiophila aethiopica	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 0 0 0 0 0 0
Protopiophila atrichosa	0 1 0 0 1 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 0 0 0
Protopiophila australis	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 0 0 0
Protopiophila contecta	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 0 0 0
Protopiophila latipes	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 0 0 0
Protopiophila litigata	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 0 0 0
Protopiophila nigriventris	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 0 0 0
Protopiophila pallida	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 0 0 0
Protopiophila scutellata	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 ? 0 0 0 0 0 1 0 1	1 1 0 0 1 2 0 1 0 0
Protopiophila vitrea	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 1 2 0 0 0 0
Lasiopiophila pilosa	A 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 1 0 1 0
Liopiophila varipes	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0 0
Stearibia nigriceps	0 1 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 1 0 0	0 1 0 0 0 0 0 0 0 0
Prochyliza azteca	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0 0
Prochyliza brevicornis	0 1 0 0 0 0 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0 0
Prochyliza inca	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0 0
Prochyliza lundbecki	0 1 0 0 0 0 1 0 0 0	1 0 0 0 0 0 0 1 0 0	1 0 0 1 0 1 0 0 0 0	0 1 0 0 0 0 0 0 0 0
Prochyliza nigricoxa	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 A	0 1 0 0 0 0 0 0 0 0
Prochyliza nigrimana	0 1 0 0 0 0 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0 0
Prochyliza xanthostoma	0 1 0 1 1 0 0 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0	0 1 0 0 0 0 0 0 0 0
Piophila casei	0 1 0 0 0 0 0 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 0	0 1 0 1 0 0 0 0 0 0
Piophila megastigmata	0 1 0 0 0 1 0 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 1 0	0 1 0 1 0 0 0 0 0 0

Arctopiophila arctica	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 A 0 0
Arctopiophila nigerrima	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 A 0 0
Parapiophila atrifrons	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila baechlii	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila dudai	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila flavipes	0 1 0 0 0 0 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila fulviceps	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila kugluktuk	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila lonchaeoides	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila nitidissima	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila pectiniventris	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila penicillata	0 1 0 0 0 1 1 0 0 0	0 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila pseudovulgaris	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila vulgaris	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila xanthopoda	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila sp.A	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila sp.B	0 0 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Parapiophila sp.C	0 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 0 0	0 0 0 0 0 0 0 0 0 1	0 1 0 0 0 0 0 0 0 0
Piophilosoma palpatum	1 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 1 1 1 0	0 0 1 0 0 0 0 0 0 1	0 1 0 0 1 2 1 1 0 1
Piophilosoma scutellatum	1 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 1 1 1 0	0 0 1 0 0 0 0 0 0 2	0 1 0 0 1 2 1 0 0 1
Centrophlebomyia furcata	1 1 0 0 0 1 1 0 0 1	0 0 0 0 0 0 1 1 1 0	0 0 1 0 0 0 0 0 0 1	0 1 0 0 1 2 1 1 0 1
Centrophlebomyia grunini	1 1 0 0 0 1 1 0 0 0	1 0 0 0 0 0 0 1 1 0	0 0 1 0 0 0 0 0 0 2	0 1 0 0 1 2 1 0 0 1
Bocainamyia necrophila	1 1 0 0 1 1 1 0 0 1	1 0 0 0 1 0 0 1 1 0	0 0 1 0 0 0 0 0 0 1	0 1 0 0 1 2 1 1 0 1
Dasyphlebomyia stylata	1 1 0 0 1 1 1 0 0 0	1 1 0 1 1 0 0 1 1 0	0 0 0 0 0 0 0 0 0 2	0 1 0 0 1 2 1 0 0 1

	4 4 4 4 4 4 4 4 4 5	5 5 5 5 5 5 5 5 5	6 6 6
	1 2 3 4 5 6 7 8 9 0	1 2 3 4 5 6 7 8 9	0 1 2
Toxoneura suberba	0 1 1 0 0 3 0 0 0 0	0 0 0 1 0 0 0 0 0	1 1 0
Rivellia variabilis	0 1 0 1 0 0 0 0 1 0	0 0 0 ? 0 0 ? ? 0	2 1 0
Chaetopsis massyla	0 1 1 0 0 4 0 0 0 0	0 0 0 1 0 0 0 0 0	1 1 0
Lonchaea sp.	0 1 1 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0	2 1 1
Melanoloma sp.	0 1 1 0 0 0 0 0 0 0	0 0 0 1 0 0 1 0 1	1 1 0
Richardia sp.	0 1 1 0 0 2 0 0 0 0	0 0 0 1 0 0 ? 0 1	1 1 0
Actenoptera avalona	0 0 0 0 0 3 1 0 0 0	0 0 0 0 0 0 0 1 0	1 1 0
Actenoptera hilarella	0 0 0 0 0 3 1 0 0 0	0 0 0 0 0 0 0 1 0	1 1 0
Neottiophilum praeustum	0 0 0 0 0 3 1 0 0 0	0 0 0 0 0 0 0 0 0	1 1 1
Amphipogon flavus	0 0 0 0 0 2 0 0 0 1	0 0 0 0 0 0 0 2 1	1 0 1
Amphipogon hyperboreus	0 0 0 0 0 2 0 0 0 1	0 0 0 0 0 0 0 2 1	1 0 1
Mycetaulus bipunctatus	0 0 0 0 0 2 0 0 0 0	0 0 1 0 0 0 0 0 0	1 1 1
Mycetaulus confusus	0 0 0 0 0 2 0 0 0 0	0 0 1 0 0 0 1 0 0	? ? ?
Mycetaulus costalis	0 0 0 0 0 2 0 0 0 0	0 0 1 0 0 0 2 0 0	1 1 1
Mycetaulus lituratus	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 1 0 1 0	? 0 1
Mycetaulus longipennis	0 0 0 0 0 3 0 0 0 0	0 0 1 0 0 0 2 0 0	1 1 1
Mycetaulus nigritellus	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 1 0	? 0 ?
Mycetaulus sp.A	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 1 0 0	? 0 ?
Mycetaulus polypori	0 0 0 0 0 3 0 0 0 0	0 0 1 1 0 0 1 0 0	1 1 1
Mycetaulus subdolus	0 0 0 0 0 3 0 0 0 0	0 0 0 0 0 1 1 1 0	1 1 1
Boreopiophila tomentosa	0 0 0 0 0 1 0 0 0 0	0 0 0 0 0 0 1 1 0	1 1 1
Pseudoseps signata	0 0 0 0 0 0 0 0 0 1	0 0 1 1 0 0 0 0 0	1 1 1
Neopiophila setaluna	0 0 0 0 0 0 0 0 1 0	0 0 0 0 0 0 1 1 0	1 1 1

Allopiophila luteata	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	0	2	0	1	1	1
Allopiophila testacea	0	0	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	1	2	0	1	1	1
Protopiophila aethiopica	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	2	2	0	?	?	?	
Protopiophila atrichosa	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	1	1	0	
Protopiophila australis	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	1	0	1	1	0	
Protopiophila contecta	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0	0	1	1	0	
Protopiophila latipes	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	2	2	0	1	1	0	
Protopiophila litigata	0	0	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	2	0	1	1	0	
Protopiophila nigriventris	0	0	0	0	0	3	0	0	0	1	0	1	1	1	0	0	1	1	0	1	1	0	
Protopiophila pallida	0	0	0	0	0	3	0	0	0	1	0	1	1	1	0	0	1	0	0	1	1	0	
Protopiophila scutellata	0	0	0	0	0	0	0	?	?	?	?	?	?	?	?	?	?	?	?	?	1	1	0	
Protopiophila vitrea	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	0	?	?	?	
Lasiopiophila pilosa	0	1	0	0	0	1	0	0	0	1	0	1	1	1	0	1	0	1	0	1	1	A	
Liopiophila varipes	0	1	0	1	0	0	0	0	0	1	0	1	1	1	0	1	1	0	0	1	1	1	
Stearibia nigriceps	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	2	1	0	1	1	1	
Prochyliza azteca	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	1	1	0	
Prochyliza brevicornis	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	2	0	1	1	0	
Prochyliza inca	0	1	0	0	0	0	0	0	1	0	0	1	1	1	0	1	0	2	0	1	1	0	
Prochyliza lundbecki	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	0	1	2	0	1	1	0	
Prochyliza nigricoxa	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	3	0	1	1	0	
Prochyliza nigrimana	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	1	0	1	1	0	
Prochyliza xanthostoma	0	1	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	2	0	1	1	0	
Piophila casei	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	1	0	0	1	0	
Piophila megastigmata	0	1	0	0	0	0	0	0	0	1	0	1	1	1	0	1	0	1	0	0	1	0	
Arctopiophila arctica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	1	1
Arctopiophila nigerrima	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2	0	1	1	1
Parapiophila atrifrons	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1
Parapiophila baechlii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	1	1	1
Parapiophila dudai	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	1	1	1
Parapiophila flavipes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	1
Parapiophila fulviceps	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	1	1	1
Parapiophila kugluktuk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	1	1
Parapiophila lonchaeoides	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	1	1	1
Parapiophila nitidissima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	1	1
Parapiophila pectiniventris	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1
Parapiophila penicillata	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1
Parapiophila pseudovulgaris	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	1	
Parapiophila vulgaris	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	1
Parapiophila xanthopoda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Parapiophila sp.A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	?	?	?
Parapiophila sp.B	0	0	0	0	0	2	0	0	0	0	0	0	1	0	1	0	1	0	0	?	?	?	
Parapiophila sp.C	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	?	?	?	
Piophilosoma palpatum	1	1	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	1	0	?	?	?	
Piophilosoma scutellatum	1	1	0	0	0	1	0	0	0	1	0	0	0	?	0	0	1	1	0	1	1	0	
Centrophlebomyia furcata	1	1	1	0	1	1	0	0	0	0	0	0	1	1	0	0	1	1	0	1	1	0	
Centrophlebomyia grunini	1	1	1	1	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	1	1	0	
Bocainamyia necrophila	1	1	1	1	0	2	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	0	
Dasyphlebomyia stylata	1	1	1	1	0	0	0	0	0	0	0	1	1	0	1	1	0	0	1	1	0		

Appendix 2: Accession number and process ID of COI sequences of specimens used for the molecular phylogenetic analysis.

Family	Species	Database	Accession # or Process ID	Base pairs (COI)
Lonchaeidae	*Lamprolonchaea brouniana*	GenBank	HQ261237.1	658
Pallopteridae	*Toxoneura superba*	BOLD	LYMAA1357-14	658
			LYMAA1358-14	658
Platystomatidae	*Rivellia variabilis*	BOLD	LYMAA1192-14	658
			LYMAA1193-14	658
Ulidiidae	*Chaetopsis massyla*	BOLD	LYMAA1184-14	658
			LYMAA1185-14	658
Piophilidae	*Actenoptera hilarella*	BOLD	LYMAA300-14	658
			LYMAA299-14	658
	Allopiophila luteata	BOLD	CNWLF1732-12	621
			SSEID826-13	590
	Amphipogon hyperboreus	BOLD	CNTMB3070-14	549
			CNTMB2636-14	576
	Arctopiophila arctica	BOLD	LYMAA291-14	658
			LYMAA294-14	640
	Boreopiophila tomentosa	BOLD	LYMAA295-14	624
			LYMAA298-14	636
	Centrophlebomyia orientalis	GenBank	KP659083	465
			KP659084	483
	Mycetaulus bipunctatus	GenBank	KP659101	483
		BOLD	CNEID305-12	658
			JWDCJ1139-11	658
	Mycetaulus nigritellus	BOLD	SSWLD2859-13	585
			SSBAE5427-13	620
	Mycetaulus polypori	BOLD	BBDCM225-10	658
			BBDCM226-10	658
	Lasiopiophila pilosa	BOLD	LYMAA286-14	658
			LYMAA288-14	658
	Liopiophila varipes	BOLD	BBDCM321-10	658
			JWDCA579-10	658
	Neopiophila setaluna	BOLD	LYMAA305-14	658
			LYMAA306-14	658
	Parapiophila atrifrons	BOLD	CNMIE425-14	588
			CNMIE1076-14	591
	Parapiophila dudai	BOLD	LYMAA331-14	658
	Parapiophila fulviceps	BOLD	LYMAA312-14	658
			LYMAA311-14	658
	Parapiophila kugluktuk	BOLD	LYMAA337-14	658
			LYMAA338-14	658
	Parapiophila lonchaeoides	BOLD	TWDIP105-09	658
			MTDIC212-09	641
	Parapiophila pectiniventris	BOLD	CNEIA1198-12	670
			CNJAA352-12	670
	Piophila casei	GenBank	KP659178	483
			KP659179	483
	Piophila megastigmata	GenBank	KP659129	470
			KP659130	483

Prochyliza brevicornis	BOLD	PHDIP491-11	658
		SMTPB9864-13	576
Prochyliza xanthostoma	BOLD	CNTMC344-14	591
		CNTMC1367-14	555
Protopiophila latipes	BOLD	LYMAA351-14	658
		LYMAA350-14	658
Protopiophila litigata	BOLD	CNFNS509-14	576
		CNFNF1117-14	590
Stearibia nigriceps	BOLD	BBDEC478-09	658
		LYMAA355-14	658
Thyreophora cynophila	GenBank	KP659178	483
		KP659179	483