Chapter 20

Featherwing beetles (Coleoptera: Ptiliidae) of the Atlantic Maritime Ecozone

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Abstract: The Ptiliidae (featherwing beetles) are an abundant, species-rich family found primarily in leaf litter and decaying organic materials. They have been little studied and are relatively poorly known in Canada as a whole, and in the Atlantic Maritime Ecozone in particular. In this treatment, we discuss the 29 species that are now known to occur, look at some aspects of their biology, examine the status of the systematics and taxonomy of the group, review past collecting history, and discuss their habitat and host preferences.

Résumé : L'abondante famille des Ptiliidae (coléoptères à ailes frangées ou trichoptérygidés), qui comprend de nombreuses espèces, se trouve principalement dans la couche de feuilles mortes et les matières organiques en décomposition. Elle a été peu étudiée et est relativement mal connue au Canada dans son ensemble, et dans l'écozone maritime de l'Atlantique en particulier. Dans ce document, nous présentons les 29 espèces dont la présence est connue localement, abordons certains aspects de leur biologie, examinons la systématique et la taxinomie du groupe, étudions l'historique de la collecte, et discutons des habitats et des préférences trophiques.

Introduction

The Ptiliidae are an abundant, species-rich family found worldwide, primarily in leaf litter and in various kinds of decaying organic materials. It is believed that they play an important role in the decomposition cycle in many environments. Owing to their small size, secretive habits, and difficult taxonomy the ptiliid fauna of the Atlantic Maritime Ecozone (AME), as elsewhere, is little known. Campbell (1991) wrote, "Ptiliidae is probably the most poorly known family of beetles in North America. Undoubtedly, when the family is revised, many additional species will be found, particularly in eastern Canada."

In the AME, an area encompassing the provinces of New Brunswick, Nova Scotia, and Prince Edward Island, and Îles de la Madeleine, the Eastern Townships, and the Gaspé region of Quebec, few specimens have been collected, and very little has been written about the group. Campbell (1991) published the first compilation of ptiliid records for Canada and Alaska in which six species were recorded for the AME. Sörensson (2003) has added 10 provincial records to the AME, 5 of which are new to the Canadian fauna. Majka and Sörensson (2007) added 29 provincial records and 14 species to faunal inventory of the Maritime Provinces. In the current chapter we summarize the state of knowledge of the 29 species of Ptiliidae recorded in the AME.

Collection and preservation techniques

Owing to their very small size and the environments in which they live, special attention is required in order to collect Ptiliidae. Adults of many species can be collected using a Berlese funnel (a.k.a. Tullgren funnel) apparatus in which decaying organic material is placed on a screen over a funnel below which is situated above a container of preservative. A heat source (commonly an electric light bulb) is situated above the apparatus in such a way as to heat and dry the upper layers, causing organisms within it to migrate down and fall into the preservative. They can be collected in various types of traps, such as window traps, flight intercept traps, light traps, and pitfall traps. Careful attention is required in sorting to see them amongst larger material. They can also be collected by sifting material over a white cloth or by handpicking (with moistened forceps or brush, causing them to adhere and thence be transferred to a preservative). Members of the Nanosellini can be collected from polypores using moistened forceps or brush. A

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hand lens or other magnification is often of great assistance in seeing ptiliids in the field.

Dybas and Dybas (1990) and Hall (2001) recommend that they be cleared (in KOH), rinsed, passed through progressions of ETOH, and mounted on microscope slides in order to correctly observe morphological characters. Sörensson (2003), however, employed dry-mounts or specimens preserved in ETOH, facilitating the examination of genitalia and concluded, "Whole slide mounts proved unnecessary for proper species identification". Ptiliids that are dry-mounted should be placed on points attached along their lateral margins, and not with the ventral surface glued to a card.

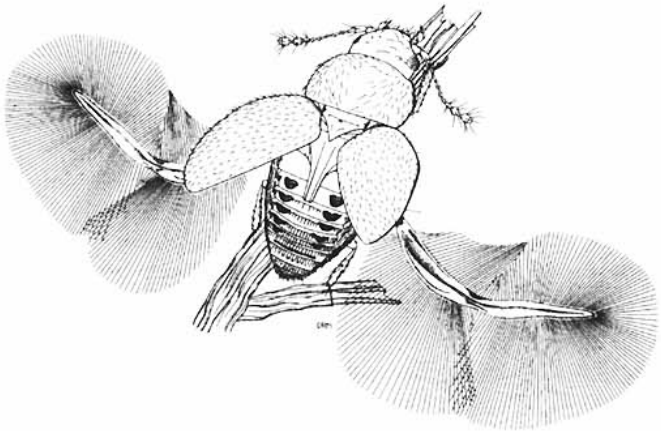
Biology of the Ptiliidae

The following account is based largely on excellent discussions by Dybas and Dybas (1990) and Hall (2001). Members of the Ptiliidae are small, easily overlooked beetles. They range in size from 0.3 to 4.0 mm, with the majority being less than 1.00 in length. The tribe Nanosellini include the smallest beetles in the world.

The common name "featherwing beetles" refers to the unusual shape of the wings, which though reduced in size are densely fringed with very long setae, giving them a "feather-like" appearance (Fig. 1). It has been suggested that the beetles move through passive flotation in the manner of dandelion seeds (Pringle 1957), however, this is an erroneous notion. One can easily observe directed flight behavior in various situations, for instance, in directed searching for ephemeral breeding sites such as dung, compost, and decomposing fungi.

There are some 600 species of Ptiliidae in 80 genera and three subfamilies in the world. Hall (2001) reported that 27 genera and some 120 species have been described in North America. Sörensson (2003) reported 29 genera and some 110 valid species (and about 135 nominal ones) that have been described. He estimated that the actual number of species on the continent may be two- or even three-fold this number. In the AME, representatives of two of the subfamilies, the Ptiliinae and Acrotrichinae, are present. The Cephaloplectinae (genera *Limulodes* Matthews, 1866, and *Paralimulodes* Bruch, 1919), which are myrmecophiles, have not been discovered in this region, although *Limulodes paradoxus* Matthews does occur in Ontario and could be present in the AME. The earliest fossil records are from Oligocene amber.

Fig. 1. *Ptenidium* sp. (illustration courtesy of D. Maddison).



Certain genera (*Pteryx* Matthews, 1858; *Ptinella* Motschulsky, 1844; *Ptinellodes* Matthews, 1872) exhibit unusual morphology and developmental biology. They are dimorphic with a "normal morph", which has well-developed wings and eyes, and a "vestigial morph" with reduced (or absent) eyes, wings, and pigmentation. Both morphs are capable of reproduction. Taylor (1980, 1981) suggested that ecological circumstances are responsible for the development of these morphs. The vestigial morphs occupy niches in decomposing wood, and if environmental circumstances become unfavourable, normal morphs are produced in greater numbers (under normal circumstances the vestigial morphs make up 90+% of the population in some species). This allows the species to disperse to new, more favourable locations.

Members of the Ptiliini and Acrotrichinae are found in a variety of moist, decomposing habitats such as in rotten wood, mammal dung, on decomposing fungi, in decaying seaweed, in forest litter, and in decaying organic matter. They are principally mycetophagous, feeding on fungal hyphae and spores and other associated organic matter. Adults and larvae feed on identical food sources and are often found together inhabiting the same niche in the same environment.

Members of the Nanosellini generally inhabit living bracket or woody fungi of the families Polyporaceae or Hydnaceae. Individuals are found on the undersurface of the fungus where they move in and out of the spore tubes, feeding on spores and fungi. In favourable circumstances, they form large colonies with scores or even hundreds of individuals inhabiting a single large polypore. They hibernate within the fungus and emerge in the spring, remaining active throughout the year until the late fall when temperatures drop sufficiently low (C.G. Majka, pers. obs.).

Most ptiliids reproduce continuously and mature and lay only a single egg at a time. The development is relatively rapid, in some species lasting 32–45 days from egg to adult. There are three larval instars. There is a high incidence of parthenogenesis in the group with some species of certain genera (*Acrotrichis* Motschulsky, 1848, amongst them) lacking males. Females produce unfertilized eggs, which develop into genetically identical female "clones." In *Ptiliopycna moerens* (Matthews), males have been found in only a few locations. Most populations of a number of species are exclusively female (Dybas 1966, 1978*a*, *b*).

Status of classification of genera known to occur in the AME

The North American ptiliid fauna contains many undescribed species and many genera that are very poorly known

and in need of revisions. The higher level classification is also in need of revision. The following genera are known to occur in the AME:

- *Ptenidium* Erichson, 1845: [12 described species in North America] is comparatively well known.
- *Pteryx* Matthews, 1858: [4 described species in North America] contains many undescribed species and is in serious need of revision.
- *Ptiliola* Haldeman, 1848: [3 species described in North America] the genus is in need of revision.
- *Ptiliolum* Flach, 1888: [4 described species in North America] contains many undescribed species and is in serious need of revision.
- *Cylindroselloides* Hall, 1999: [1 described species in North America] is well known.
- *Acrotrichis* Motschulsky, 1848: [circa 25 species in North America] with possibly an equal number of undescribed species. Sörensson is currently revising the Nearctic fauna, however, much work remains to be done, and no adequate keys to the genus exist.
- *Nephanes* Thomson, 1859: [6 described species in North America] contains undescribed species and is in need of revision.

Thus, considerable primary systematic work remains to be done before the North American fauna, and hence the species found in the AME, can be properly understood. Ecological, behavioural, and physiological research are, of course, dependent on a sound taxonomic understanding of the group.

Previous studies

There has been little specific fieldwork particularly devoted to Ptiliidae in the AME. Most specimens have been collected incidentally as part of other studies. Campbell (1991) summarized Canadian records reported to date. He listed records for five species from New Brunswick, one from Nova Scotia, and none from Prince Edward Island.

In New Brunswick, D.H. Murray, S.J. Miller, and D. Maddison collected a few ptiliids in the 1970s (the first records date from 1972). C.G. Majka has collected ptiliids in Albert County, and in 2004, R.P. Webster collected a number of species in the central part of the province. In Nova Scotia, commencing in 1965, B. Wright collected ptiliids in various locations around the province. Moseley (1997, 2007) explored cave faunas in Nova Scotia and found some ptiliids in the course of his research. Dollin et al. (2008) and Bishop (2009) collected some ptiliids in separate studies on saproxylic beetle communities. Dollin searched for *Cylindroselloides dybasi* Hall and found them at many of the 11 forest stands included in her study (Dollin et al. 2008). D.B. McCorquodale has collected some specimens on Cape Breton Island, and T. Rossolimo and C.G. Majka have collected large numbers in a study of forest floor arthropods of Kejimkujik National Park.

On Prince Edward Island, the first Ptiliidae recorded for the province were collected in 2001 by C.G. Majka in a study of forest beetles at St. Patrick's, Queens County.

Laplante et al. (1991) listed 11 species of Ptiliidae from Quebec, but no localities are indicated for species records. Sörensson (2003) examined 1942 specimens from Canada from 14 major collections of Ptiliidae, and none of the material in his study originates from the Gaspé or other portions of Quebec in the AME.

The ptiliid fauna of the AME

Table 1 summarizes the current knowledge of the ptiliid fauna of the AME. The data for this are derived from Campbell (1991), Hall (1999), Sörensson (2003), and Majka and Sörensson (2007). Twenty-nine species have been recorded in the AME; 19 in New Brunswick, 3 in Prince Edward Island, 25 in Nova Scotia, and none in the Gaspé. There are 20 species of *Acrotrichis*, 3 of *Ptenidium*, 2 of *Ptiliolum*, and 1 each of *Cylindroselloides*, *Pteryx*, *Ptiliola*, *Ptiliopycna*, and *Nephanes*. The details of new records of Ptiliidae in this region were reported in Majka and Sörensson (2007). Three species of *Acrotrichis* are currently being described by Sörensson. The current state of systematic knowledge does not allow determinations to a specific level of most species of *Pteryx*, *Ptiliola*, *Ptiliolum*, or *Nephanes*. Although taxonomic work on these is ongoing (M. Sörensson) it may be some time before it is possible to determine if these records from the AME represent previously known or undescribed species.

Within Nova Scotia (where the collecting effort has been greatest), ptiliids have been found in 13 of the 18 counties of the province and in all of the five main regions (Northern Shore, Cape Breton, Eastern Shore, South Shore, and Bay of Fundy/Annapolis Valley). While the current level of systematic knowledge is still incomplete, and the number of records and collecting effort in this region are still meagre, the information reported in this chapter is nonetheless a considerable advance on Campbell (1991) in which only six species were reported from the AME. It does indicate that the ptiliid fauna of the AME is more widespread and diverse than previously known. In terms of the zoogeographic components of the fauna, 16 species are Nearctic in origin, 5 are Holarctic, 4 are Palearctic, and for 4 such information is as yet uncertain.

It is clear that human influence has affected the ptiliid fauna of the AME. At least four species (14% of the fauna) have been accidentally introduced to this area from Eurasia, presumably in association with past importations of various organic and agricultural materials.

Bionomics

A summary of the habitats from which ptiliids have been collected is given in Table 2 from which it is clear that ptiliids are found in a diverse range of environments. It is interesting to note that many species have been collected in mature and old-growth forests. For instance, *Acrotrichis cognata* (Matthews) has been found at Lone Sheiling in Cape Breton Highlands National Park in an old-growth deciduous

Table 1. Ptiliidae of the Atlantic Maritime Ecozone.

	Gaspé	NB	PEI	NS	Origin	Regional distribution[a]	Continental distribution[b]
Ptiliinae							
Ptiliini							
Ptenidium nitidum (Heer, 1841)		•		•	Palearctic	NH, QC	1
Ptenidium pusillum (Gyllenhal, 1808)		•	•	•	Palearctic	MA, ON, QC	1, 4, 5
Ptenidium speculifer Matthews, 1884				•	Nearctic	NF, NH, ON, QC	1, 2
Pteryx NEA sp. 7[c]				•	Nearctic		1
Ptiliola sp.				•	?		
Ptiliolum NEA sp. 2[c]		•		•	Nearctic		1
Ptiliolum fuscum (Erichson, 1845)				•	Holarctic	NH, ON, QC	1, 4, 5
Nanosellini							
Cylindroselloides dybasi Hall, 1999		•	•	•	Nearctic		1
Acrotrichinae							
Acrotrichis aspera (Haldeman, 1848)				•	Nearctic	MA, NF, NH, ON, QC	1–5
Acrotrichis castanea (Matthews, 1877)				•	Nearctic	NH, ON, QC	1, 3–5
Acrotrichis cognata (Matthews, 1877)		•		•	Nearctic	NH, ON, QC	1, 4, 5
Acrotrichis fascicularis (Herbst, 1793)		•		•	Palearctic		1
Acrotrichis grandicollis (Mannerheim, 1844)		•		•	?	NY, ON, QC	1, 4, 5
Acrotrichis haldemani (LeConte, 1863)		•		•	Nearctic	NY, RI	1
Acrotrichis insularis (Mäklin, 1852)		•		•	Nearctic	QC	1, 4, 5
Acrotrichis intermedia (Gillmeister, 1845)		•		•	Holarctic	ON, QC	1, 5
Acrotrichis josephi (Matthews, 1872)		•		•	Nearctic		1, 4
Acrotrichis longipennis (Casey, 1884)		•		•	Nearctic	MA, NH, NY, ON, QC, VT	1, 2, 5
Acrotrichis parva Rosskothen, 1935		•			Holarctic	ON, QC	1, 4, 5
Acrotrichis sericans (Heer, 1841)		•			Palearctic	MA, NH, NY, ON, QC	1, 3–5
Acrotrichis silvatica Rosskothen, 1935		•		•	Holarctic	MA, NH, ON, QC	1, 2, 5
Acrotrichis thoracica (Waltl, 1838)		•			?	MA, ON, QC	1
Acrotrichis volans (Motschulsky, 1845)		•		•	Holarctic	MA, NH, ON, QC, VT	1–5
Acrotrichis xanthocera (Matthews, 1877)				•	Nearctic	NH, ON, QC,	1–5
Acrotrichis undescribed species 1				•	Nearctic	NH	1
Acrotrichis undescribed species 2		•		•	Nearctic		1
Acrotrichis undescribed species 3				•	Nearctic	NH	1
Ptiliopycna moerens (Matthews, 1874)			•		Nearctic	CT, MA, NH, NY, ON, QC	1, 5
Nephanes sp.		•		•	?		
Total	0	19	3	25			

[a] For the purposes of this treatment, northeastern North America is taken to include (in addition to NB, New Brunswick; PE, Prince Edward Island; NS, Nova Scotia) the following jurisdictions: CT, Connecticut; LB, Labrador; MA, Massachusetts; ME, Maine; NF, insular Newfoundland; NH, New Hampshire; NY, New York; ON, Ontario; PM, Saint-Pierre et Miquelon; QC, Quebec; RI, Rhode Island; VT, Vermont.

[b] Indicates distribution within North America. 1, Northeastern; 2, Southeastern; 3, Southwestern; 4, Northwestern; 5, Central.

[c] Acronym refers to undescribed species as cited in Majka and Sörensson (2007).

forest. *Pteryx* sp., *Ptiliolum* NEA sp. 2 (acronym refers to undescribed species as cited in Majka and Sörensson (2007)). *Acrotrichis longipennis* (Casey), *A. silvatica* Rosskothen, and *A. xanthocera* (Matthews) have all been found in relatively undisturbed old or mature forests. Such associations with mature and old-growth forests merit further investigation to ascertain if these species might be indicative of undisturbed forest environments. In Great Britain, 4 of the 180 species of saproxylic Coleoptera employed in calculating the Index of Ecological Continuity (an inverse of disturbance in forested habitats) are members of the Ptiliidae (Alexander 2004).

To date, in this region, *Acrotrichis castanea* (Matthews) has only been found inside caves. S. Peck has also collected this species in a cave in Illinois (Sörensson 2003). Moseley (1997) raised the possibility that it is a troglophile, although Sörensson (2003) reports it from a variety of other

Table 2. Habitat occurrences of Ptiliidae in the Atlantic Maritime Ecozone.

Species	Macro-habitat	Micro-habitat
Ptiliinae		
Ptiliini		
Ptenidium nitidum (Heer)	Mixed forest	Leaf litter
Ptenidium pusillum (Gyllenhal)	Coastal white-spruce forest	Decaying *Russula virescens*
Ptenidium speculifer Matthews	Coastal forest	
Pteryx NEA sp. 7[a]	Old-growth red spruce forest	
Ptiliola sp.	Maple/oak/birch and hemlock forests	Leaf litter and on carrion
Ptiliolum NEA sp. 2[a]	Maple/oak/birch and hemlock forests	Leaf litter
	Potato field	
Ptiliolum fuscum (Erichson)	Hemlock forest	Leaf litter
Nanosellini		
Cylindroselloides dybasi Hall	Many forested habitats with conifers, from old-growth hemlock to mixed white pine, red spruce, balsam fir, and white spruce forests	Typically on either *Hetrobasidion annosum* or *Fomitopsis pinicola*
Acrotrichinae		
Acrotrichis aspera (Haldeman)	Red spruce forest	
Acrotrichis castanea (Matthews)	Cave environments	Porcupine dung
Acrotrichis cognata (Matthews)	Small stream in coastal spruce forest	Needle litter
Acrotrichis fascicularis (Herbst)	Coniferous forest	
Acrotrichis grandicollis (Mannerheim)	Coastal white spruce forest	Decaying *Russula virescens*
	Lawn	Cut grass
Acrotrichis haldemani (LeConte)	Salt marsh	Grass litter
	Mixed forest	
Acrotrichis insularis (Mäklin)	Coastal white spruce forest	Decaying *Russula virescens*
	Mixed forest	Leaf litter
Acrotrichis intermedia (Gillmeister)	Regenerating (<30 years) mixed forest	Decomposing fungus?
Acrotrichis josephi (Matthews)	Cobble seashore	Decomposing seaweed
	Regenerating coastal forest	Compost
Acrotrichis longipennis (Casey)	Mature deciduous forest	Leaf litter
Acrotrichis parva Rosskothen	Roadside	On dead Striped Skunk
Acrotrichis sericans (Heer)		Decaying grass and vegetation
Acrotrichis silvatica Rosskothen	Old-growth red spruce/hemlock forest	
	Roadside	On dead Striped Skunk
Acrotrichis thoracica (Waltl)	Lawn	Cut grass
Acrotrichis volans (Motschulsky)	Mixed and deciduous forest	Leaf litter
Acrotrichis xanthocera (Matthews)	Mature deciduous forest	Leaf litter
Acrotrichis undescribed species 1	Hemlock forest and field	Leaf litter and on carrion
Acrotrichis undescribed species 2	Mixed forest, bog, and field	In compost and on carrion
Acrotrichis undescribed species 3	Maple/oak/birch and hemlock forests	Leaf litter
Ptiliopycna moerens (Matthews)	Along stream in mixed forest	Leaf litter
Nephanes sp.	Coastal white spruce forest	Decaying *Russula virescens*

[a]Acronym refers to undescribed species as cited in Majka and Sörensson (2007).

habitats in other areas of Canada and the United States. In Nova Scotian caves, they have repeatedly been found living in decaying Porcupine (*Erethizon dorsatum* (Linnaeus)) dung (Moseley 1997, 2007). Decaying fungi also appear to be a rich source of Ptiliidae. At Mary's Pt., New Brunswick, C.G. Majka has found four species in decaying *Russula virescens* (Shaeff. ex Zant.) (Basidiomycota: Russulaceae), while R.P. Webster has found an equal number in decaying compost at Charter's Settlement, New Brunswick.

Dybas and Dybas (1990) reported *Ptiliopycna moerens* (Matthews) from bogs in northeastern United States and Canada. The one specimen collected on Prince Edward Island was in leaf litter along the banks of a small woodland stream.

Only one species in the Nanosellini, the recently described (Hall 1999) *Cylindroselloides dybasi* Hall, is found in the AME. Preliminary observations indicate that it is very abundant and widespread. Wherever the first author has found the polypores *Heterobasidion annosum* (Fr.) Bref. or *Fomitopsis pinicola* (Fr.) Kar. (Basidiomycota: Polyporaceae) he has been able to locate *C. dybasi*. He has not found it on *Fomes fomentarius* (Fr.) Kickx or *Piptoporus betulinus* (Fr.) Kar, the two common species of polypores occurring on white birch

(*Betula papyrifera* Marsh.), although a specimen collected by D. Maddison in Doaktown, New Brunswick, was collected on *B. papyrifera*.

It is not clear if human activity can adversely affect ptiliid populations. The presence of a number of species in old-growth or mature forests raises the question of whether certain species are particularly associated with such environments, and if so, if they have been affected by the scarcity of such forested habitats in the AME. For example, in Nova Scotia, although 78% of the land base is forested, less than 1% of that land is comprised of old-growth forests (Loo and Ives 2003). Also unknown is if factors such as acid rain, climate change, ozone thinning, or other anthropogenic factors can influence ptiliid populations.

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