

Arctic Bristletails in Juneau, Alaska



Bob Armstrong



Arctic bristletails (*Petridiobius arcticus*) are small insects without wings. They appear to be fairly common on the large rocks near and in the upper tidal zone of our seashore areas. They are most easily viewed during the hours of darkness with a headlamp.

The Arctic bristletail is found from the Aleutian Islands to the Alaska panhandle where they live in cracks of bedrock just above the high tide line and feed on lichens.

To learn more about them I asked Matt Bowser, a Fish and Wildlife Biologist on the Life history of *Petridiobius arcticus* and he said:

First instar immatures hatch from eggs in early spring, April to May in Southcentral Alaska. These grow over the summer, molting a couple of times or so (I do not know exactly) so that they are nearly mature in the fall. They overwinter in cracks of rocks or under moss and reach maturity by the end of their second summer, when eggs are laid in the moss and other material among the rocks.

Petridiobius arcticus will be out in daylight. In particular, some will be out apparently sunning on warm days. They are mostly crepuscular/nocturnal, however. If you wait around at night with a deep red light to watch them you will see many bristletails emerging from the rocks.

*There is much more to learn, though. No one has documented the mating behavior of this species, for example. We also have very little information on interactions with other species. I do not think that there is documentation of any predation on *P. arcticus*.*



I first learned about them by noticing numerous molted skins on a large beach rock in Juneau. I sent the photos to Aaron Baldwin who is one of the authors of *Intertidal Common Sea Life of Southeastern Alaska* and he identified them as Arctic bristletails.

According to *Insects Their Natural History and Diversity* by Stephen A. Marshall In order to cast a skin to enable growth they use their own feces to anchor themselves down to a solid surface, such as a rock.



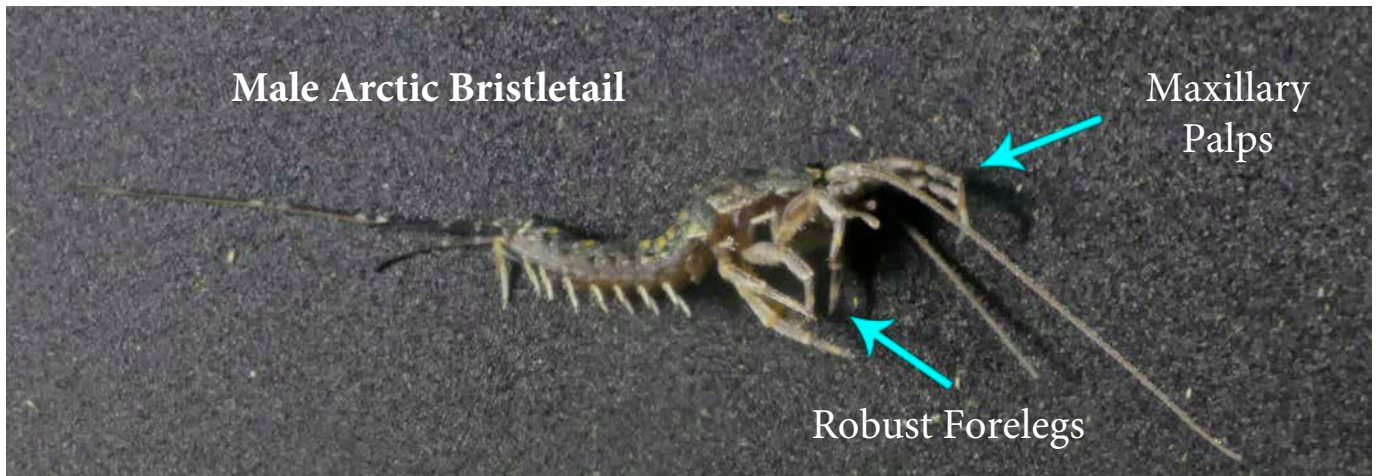


I was surprised how camouflaged these insects were. They really blended in with the rocks, lichens, and moss where they lived.



The photo above shows one in the moss and the lower photo shows one in a combination of moss and lichens.





The male Arctic bristletail is fairly easy to tell from a female by its robust forelegs and maxillary palps.

The total length of this one is about 3.5 cm or 1.4 inches from the tip of its tail to the end of its antennae. Its main body length is about 1 cm or .4 inches in length.



This male was collected on October 5, 2020. It would be nearly or completely mature but may overwinter and mate next fall.

Female Arctic Bristletail

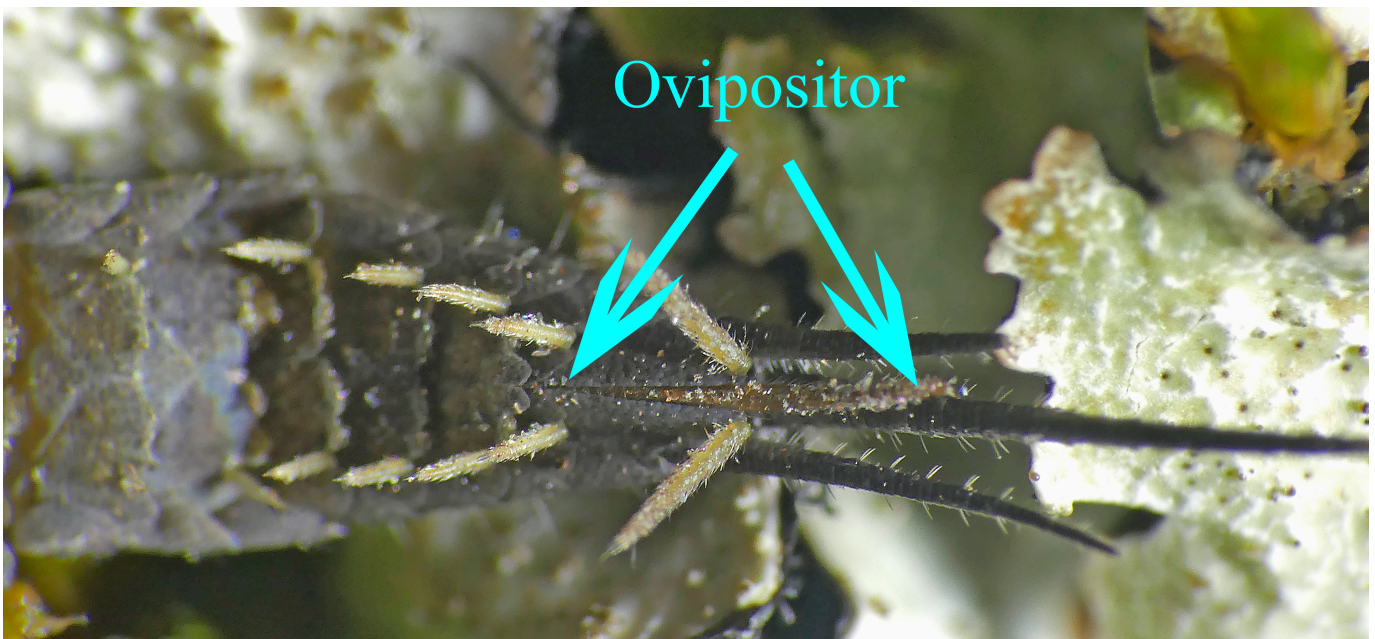


Females can be told from males by their less robust forelegs. This is not very obvious in nature but with practice you can begin to notice the difference.



The presence of an ovipositor sticking out their hind end is the best way, I think, to determine it is a female.

Notice the reddish thing coming out her rear end. That is her ovipositor which is used to deposit eggs in amongst the moss and cracks in the rock.





Bristletails have three "tails" the middle one is termed a median filament and the outer two are called cercus.

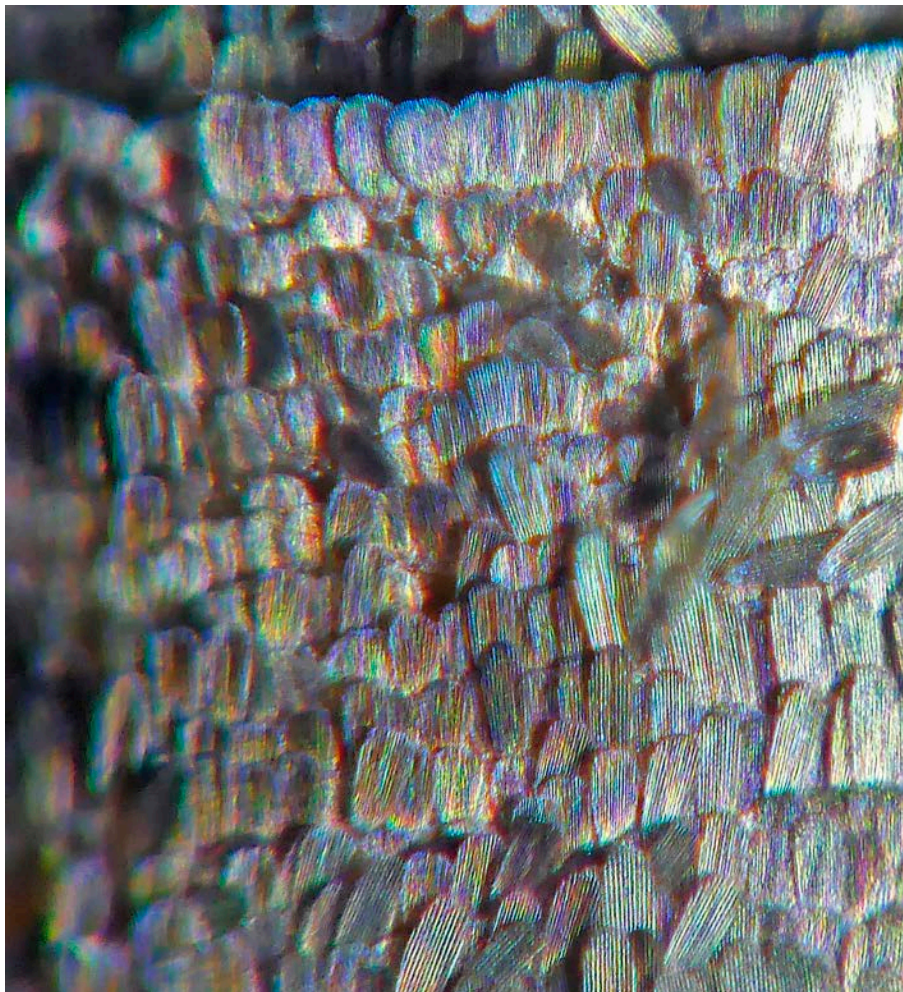


This close photo of the tails shows the numerous bristles -- hence the common name "bristletails."

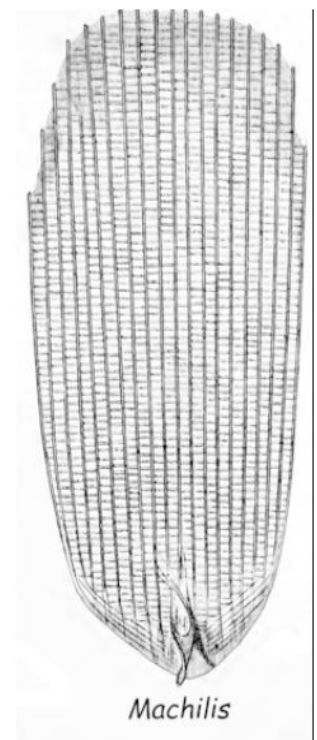


Bristletails have large compound eyes that meet at the top of the head and are presumably an adaptation for nocturnal living.





Their body is covered with tiny detachable scales, which might make it difficult for a predator to grab one.



Drawing from Wikipedia




In the left part of this photo you can see the two claws that are at the end of each leg. These no doubt help the bristletails climb on the vertical rocks. In the right part of the photo are the **labial palps** which help the insect eat.



This shows some of the tiny legs of the bristletail, which are called **styli**. Note that each of these also has two "claws" at their end.

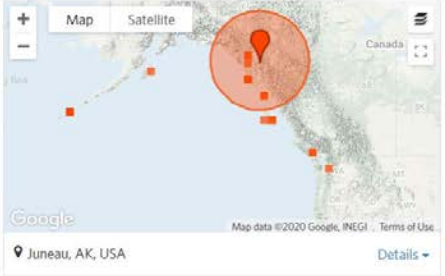
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Arctic Bristletail (*Petridiobius arcticus*) Needs ID Follow



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Observed: Oct 5, 2020 - 8:09 PM UTC
Submitted: Oct 6, 2020 - 10:45 AM AKDT



Juneau, AK, USA Details

This is from iNaturalist showing the locations in Alaska that the Arctic bristletail has been documented. I submitted an observation for Juneau that is currently pending (documentation requires confirmation by two other people).

The Evolution of Flight in Insects: Reconstruction and Biomechanical Analysis of a Protopterygote Insect Ancestor

by
Ryan Joseph Chlebak

A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in
Biology

Carleton University
Ottawa, Ontario

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An amazing amount of information about the evolution of flight in Insects can be found in this 500 + page thesis which is available on-line.

In this study they used jumping Bristletails in a lab setup with high speed photography.

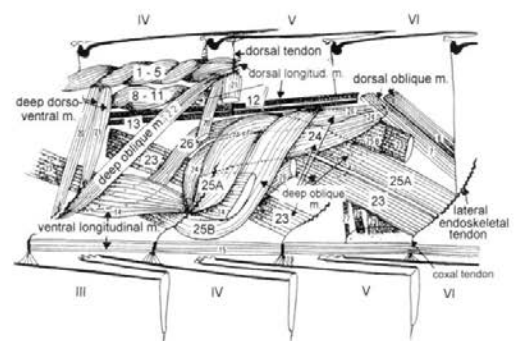


Figure 1.5. Longitudinal section of a jumping Bristletail, *Petrobius brevistylis*, and its abdominal musculature. Note the twisted dorsal longitudinal 'rope like' muscles 1-5, and 8-11 used for the rapid abdominal jumping behaviour. From Sturm and Machida, (2001).

Photographing Arctic bristletails was fairly easy. I used the Panasonic FZ300 camera with a Raynox Macroscopic Lens attached. I set the camera at f8 at ISO 100 on A and used the camera's built in flash. This setting allowed for a nearly full frame photograph of a bristletail from a few inches away. The camera was handheld and I could focus with the viewing screen or through the eye piece. I used a headlamp which allowed my hands free to focus and operate the camera. For indoor photographs of the bristletail specimen I used the same equipment but for lighting I used LED lights. I had the camera attached to a microstand for ease of focusing.



The following is an article that Mary Willson wrote for the Juneau Empire Newspaper



Arctic bristletails, like the ones shown in this photo, are wingless insects that live along the shoreline. (Courtesy Photo / Aaron Baldwin)

We're still learning about these unusual insects

They've been around for 400 million years.

- Tuesday, October 6, 2020 11:43am
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By Mary F. Willson

For the Juneau Empire

Bristletail is a name applied to several different kinds of small, wingless insects, all of which have three long, thin appendages at their rear ends; these “tails” often bear lots of little bristles, hence the name. Official taxonomy, however, now divides them into separate categories. Here I am focused on one group, called the jumping bristletails — because they can jump several inches up and away from a perceived threat. The jump is accomplished by using some of their six legs and body flexure.

Jumping bristletails are one of several groups that arose very early in the course of insect evolution. They've been around for about 400 million years or so, ever since most of the land plants were mosses and lichens. A modern representative known as the Arctic bristletail (*Petridiobius arcticus*) lives on our rocky shores. A careful look at certain parts of the shoreline in daytime might reveal them as they forage and sun themselves and occasionally jump around or at least their molted exoskeletons stuck on a rock; however, they are reputed to be more active at dusk and night. They share their shoreline habitat with harvestmen, millipedes, slugs, spiders and who knows what else.

This species eats mostly lichens. Young ones hatch from overwintered eggs in early spring. Growing and molting through the summer, they are near mature by autumn. They overwinter again, in rocky crevices or under moss, and continue to grow through a second summer, reaching maturity at the end of that summer. That's when mating occurs (the process in this species is so far undocumented by scientists), and eggs are laid in moss and debris among the rocks.

In general, the various species of jumping bristletails occupy a variety of habitats, including leaf litter and under stones, in bark crevices, in places ranging from high in a tree canopy to deserts and the arctic. They feed on algae and organic debris, as well as lichens and mosses. Their exoskeleton is very thin, so they are often at risk of desiccation. The small body, less than an inch long, is covered with small detachable scales that might make them difficult for a predator to grab.

They are unusual insects in several ways. In their lifetime of up to about four years, they molt many times, three to five times a year or even more, depending on how fast they are growing. When ready to molt, they glue themselves to a hard substrate and crawl out of the old exoskeleton.

Young and old ones look alike except for size; there is no metamorphosis. They may take two years to mature. After some courtship dancing, most reports say that males typically accomplish mating indirectly: they spin a silk thread and attach packets of sperm there for a female to pick up. It is not clear just when the eggs get fertilized — perhaps when the eggs are laid. Females scatter their eggs in crevices and other protected places, where they may remain dormant for several months.

One arboreal species can steer its descent from the tree canopy with a long filament extending from its rear end. The filament has been shown to be necessary for a successful glide and for landing. Who knows what other amazing things may emerge as we learn more about these unusual insects.

Little invertebrates like these must have many predators. Spiders are reported to eat them. Foraging birds are likely to pick them up. Who else?

Thanks to Aaron Baldwin with Alaska Department of Fish and Game, and Matt Bowser with the U.S. Fish and Wildlife Service in Kenai, for helpful information, and to Bob Armstrong for spotting the array of exoskeletons that led to this essay. Armstrong's videos at his website www.naturebob.com.

Mary F. Willson is a retired professor of ecology. "On The Trails" is a weekly column that appears in the Juneau Empire every Wednesday.

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Evolution of the Insects

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The following chapter 5 on the Earliest Insects is from this book on the Evolution of the Insects.

5 Earliest Insects

ARCHAEOGNATHA: THE BRISTLETAILS

Bristletails, or Archaeognatha (= Microcoryphia), are the most primitive of living insects, having persisted since at least the mid-Devonian. These cryptic, somewhat cylindrical insects occur under loose bark or stones (Figure 5.1). Except for a rare few, bristletails are nocturnal and typically hide in crevices during the day. About 500 species are known worldwide and live in diverse habitats, including elevations as high as 4,800 meters (15,749 feet) in the Himalayas. The typical diet of bristletails is composed of algae and lichens, which they glean using their monocondylic mandibles as picks. While they are not predatory, some species will scavenge remains of arthropods and some will even eat their own exuviae. Major references for the Archaeognatha include accounts by Paclt (1956), Sturm (1984, 1994a,b, 1995a,b, 1997, 2003a), Kaplin (1985), Mendes (1990, 2002), Sturm and Bach de Roca (1993), Larink (1997a,b), Bitsch and Nel (1999), and Sturm and Machida (2001).

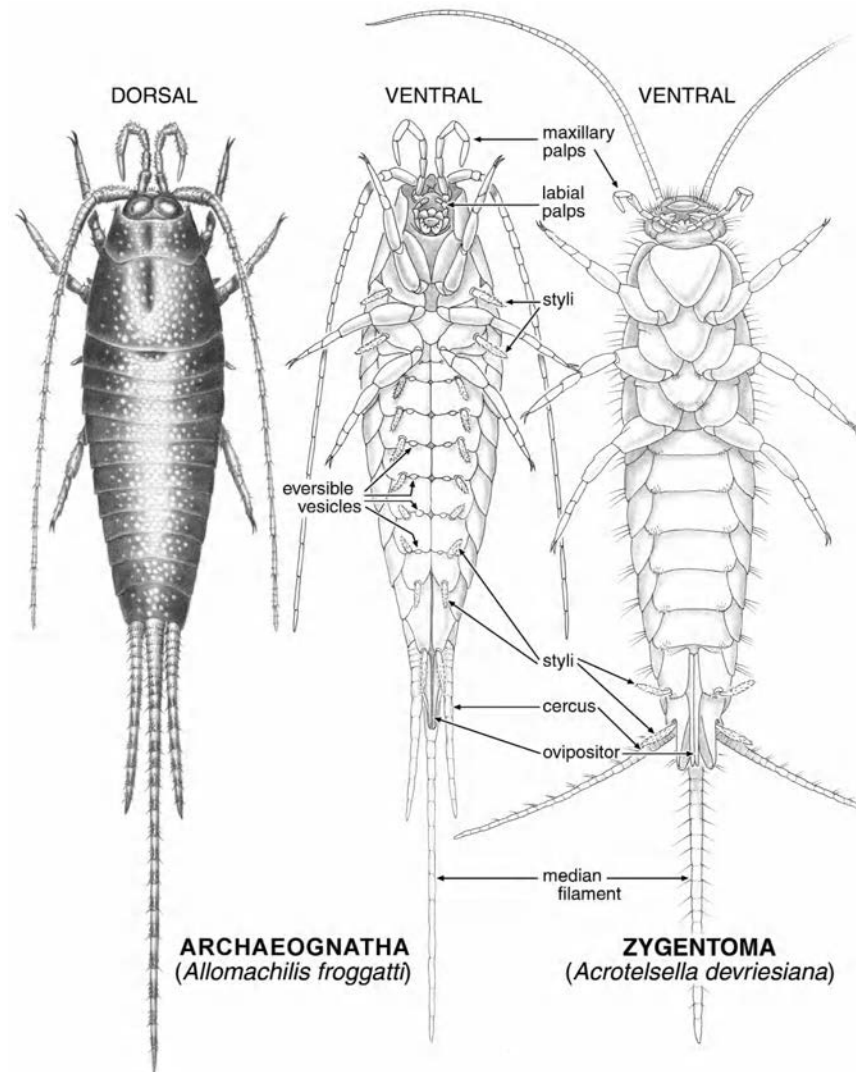
Particularly noteworthy is the mating behavior of Archaeognatha, which have three principal modes of sperm transfer. Species do not technically copulate, and sperm transfer is indirect even though fertilization is internalized. Males transfer to the female droplets of sperm or spermatophores. Perhaps as a result, the genitalia of archaeognaths are simple and males and females differ relatively little in the appendicular structures of the genital segments. Couples remain in close contact during mating and have distinctive courtship behaviors. In many machilids the males use a “carrier-thread” (Sturm, 1952, 1955). The male taps the female with his maxillary palpi and once she becomes receptive he secretes a thread of silk. The silken line is drawn out, to which the male attaches droplets of sperm. The female is prevented from moving forward by the male and while the female is facing away from the thread, the sperm droplets are transferred to her ovipositor and eventually into her gonopore. In the “firebrat,” *Petrobius*, the sperm droplets are set directly onto the female ovipositor and in Meinertellidae the male creates stalked spermatophores that are retrieved by the

female (Sturm and Machida, 2001). The ovipositor is used to lay eggs in deep crevices or in holes actually dug by the ovipositor.

The Archaeognatha consists of only four families and approximately 500 species: Meinertellidae, Machilidae, Triasomachilidae, and Dasyleptidae (the last two are extinct). The Meinertellidae occur predominantly in the Southern Hemisphere (Sturm, 1984). The Machilidae, considered by many authors to possess more primitive features than the Meinertellidae (e.g., Sturm and Machida, 2001), are mostly found in the Northern Hemisphere, although a few machilines can be found below the equator in Africa and Asia.

Together with silverfish (*Zygentoma*, which are discussed later), the bristletails comprise the only surviving orders of primitively wingless insects and were at one time considered a single group, Thysanura (e.g., Remington, 1954), as well as often being united with the Entognatha into a larger grouping called the Apterygota, neither of which are monophyletic. Defining features of the Archaeognatha are the large compound eyes that meet at the top of the head, and the well-developed ocelli, both presumably adaptations for nocturnal living. Other features include “jumping,” which is actually a sudden flexion of the abdomen that propels the insect into the air. Also, the meso- and metapleura consist of a single sclerite with large pleural apodemes. Primitively, the archaeognaths have monocondylic mandibles, the head skeleton is composed of paired anterior and posterior plates, “styli” (exopodites?) are usually on the mid and hind coxae, and, unlike abdominal styli, these lack musculature. They also have long, seven-segmented maxillary palpi (even longer than the legs); a terminal filament; eversible vesicles; and abdominal styli (Figure 4.7). Like the *Zygentoma*, the integument of archaeognaths is generally covered with scales that sometimes form patterns.

Even though the putative archaeognaths are among the oldest fossil insects on record, the overall record of the order is still sparse enough that it has provided little insight into the internal evolution of the order. Among macerated material taken from the mid-Devonian Gaspé fossil beds of Quebec



5.1. Representative basal, wingless insects: a bristletail (Archaeognatha) and a silverfish (Zygentoma). These are modern species belonging to groups that evolved at least as early as the Devonian, 400 MYA. Redrawn from *Insects of Australia*.

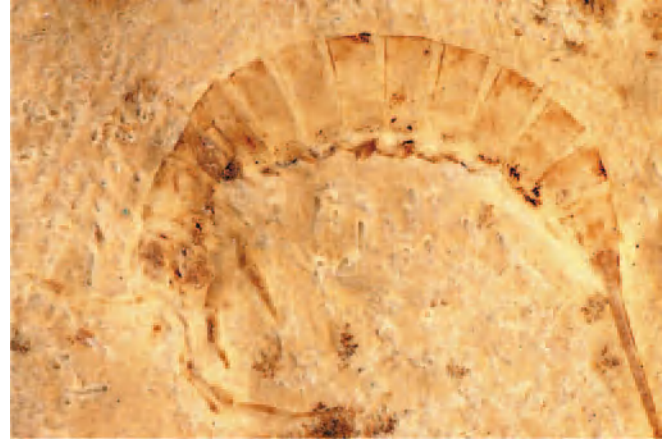
were two fragments of a bristletail, a head and thorax, representing the oldest record of insects in North America (Labandeira *et al.*, 1988). The Gaspé fragments, however, preserve only primitive features of the Archaeognatha, and no more conclusive assignment can be made concerning them.

Several species from the Carboniferous and Permian are placed in the extinct genus *Dasyleptus* (Dasyleptidae) (Figures 5.2, 5.3). These enigmatic Paleozoic fossils were previously considered to represent an extinct order of moncondylic ectognaths called Monura, closely related to the Archaeognatha (Sharov, 1957). This position was strongly supported by a reconstruction of *Dasyleptus* (e.g., Kukulová-Peck, 1987, 1997); however, this interpretation has been challenged (e.g., Kaplin, 1985; Bitsch and Nel, 1999; Rasnitsyn, 1999), and, instead, individuals of *Dasyleptus* appear to be typical juvenile silverfish, albeit larger. Rasnitsyn (1999) has recently reviewed the family Dasyleptidae.

The earliest Mesozoic fossils of the order are *Triassomachilis uralensis* (Triassomachilidae) from the Upper Triassic of Russia (Sharov, 1948). *Triassomachilis* has at times been excluded from the Archaeognatha (e.g., Kukulová-Peck, 1991; Sinitshenkova, 2000c). The fossils are poorly preserved but do exhibit the dorsal, thoracic hump typical of Archaeognatha as well as annulated, abdominal styli and a terminal filament in addition to the long cerci. However, Sharov's renderings of the fossils show relatively small compound eyes that do not meet on the vertex, as well as short maxillary palpi, which are primitive differences from all other Archaeognatha including the much older Dasyleptidae. Paclt (1972) considered the differences of *Triassomachilis* and other bristletails to be artifacts of preservation misinterpreted by Sharov. The original material should be newly studied to determine the affinities of *Triassomachilis* and the validity of a family Triassomachilidae.



5.2. *Dasyleptus brongniarti* (Dasyleptidae) from the Permian of Russia was formerly placed in an extinct order, Monura, but is today considered an immature bristletail and a sister group to all other Archaeognatha. PIN 1197; length 10.5 mm.



5.3. *Dasyleptus sharovi* from the Early Permian of Elmo, Kansas. MCZ; length 11 mm.

All other fossil bristletails occur in Cretaceous or Tertiary ambers. The earliest is a meinertellid in Early Cretaceous amber from Lebanon, a species typical of the *Machiloides* group of genera and attesting to the antiquity of this family (Sturm and Machida, 2001). Other Cretaceous amber archaeognaths are known from Burma and New Jersey (Grimaldi *et al.*, 2000a, 2002). Fossil machilids are also known from Baltic amber, while meinertellids are known from Dominican amber (e.g., Silvestri, 1912; Sturm and Machida, 2001). Although described as an archaeognath, the Pliocene fossil *Onychomachilis fischeri* (Pierce, 1951) is actually a silverfish, perhaps near the Nicoletiidae (Sturm and Machida, 2001).

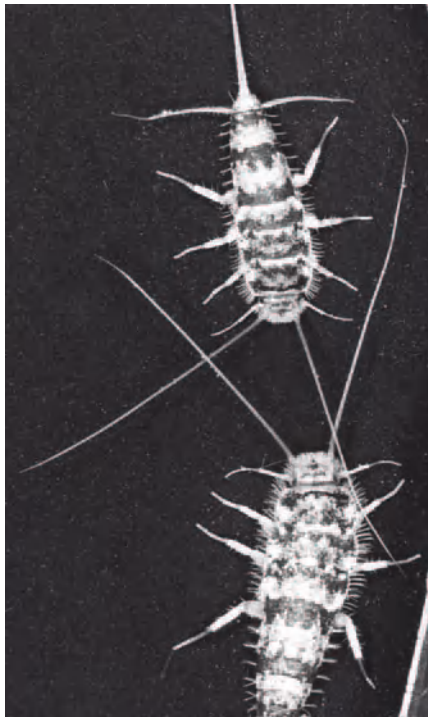
DICONDYLIA

The traditional taxon Thysanura, or Apterygota, has been recognized as an unnatural group for decades because silverfish (Zygentoma) are more closely related to the winged insects (Pterygota) than to the bristletails (e.g., Snodgrass, 1935). In his monumental work on the phylogeny and classification of insects, Hennig (1953, 1969, 1981) proposed the name Dicondylia for the group uniting the silverfish with the winged insects. Recent molecular studies have also supported the Dicondylia as a lineage (e.g., Wheeler *et al.*, 2001). The hallmark character of this group is the presence of a novel, secondary articulation to the mandible (i.e., the *dicondyllic mandible*) (Figure 5.9). This second articulation results in the movement of the mandible being roughly confined to a single plane of motion rather than the rotating motion possible in Archaeognatha. It is homologous to the monocondylic joint in Archaeognatha and Entognatha, since the condyle for the new point of articulation is located on the head capsule with the acetabulum on the mandible itself. Another significant character defining Dicondylia is the development of the gonangulum in the ovipositor base

(Figure 4.8). The gonangulum represents a basal differentiation of the second gonocoxa to form a sclerite with three points of articulation – to the ninth abdominal tergum, the first gonapophysis, and the second gonocoxa. Other features of dicondyllic insects are the reduced maxillary palpi (primarily five-segmented, but this is also observed within Entognatha, the Ellipura in particular), and the development of tracheal commissures and connectives in the abdomen (Kristensen, 1981). Thus, despite the great overall similarity of bristletails and silverfish, important but subtle features indicate that silverfish are actually more closely related to winged insects.

ZYGENTOMA: THE SILVERFISH

Silverfish are similar to bristletails in gestalt but are more flattened; they lack the distinctive hump of the latter group and, therefore, do not jump. Like bristletails, these primitively wingless insects have a long terminal filament between the cerci and a surface covering of scales (which are lost in Nicoletiidae and Maindroniidae) (Figures 5.1, 5.4). The biology of the order is superficially similar to that described for the Archaeognatha, including the occurrence of indirect sperm transfer via a spermatophore; however, Zygentoma are mostly diurnal and omnivorous with the notable exception of the family Nicoletiidae, which is principally subterranean and vegetarian. Though they are not capable of jumping, silverfish are very agile and run swiftly, as anyone who has chased one across a kitchen counter or sink knows. In contrast to the Archaeognatha, the compound eyes are reduced or absent in Zygentoma, and most families except Lepidotrichidae lack ocelli entirely. Defining features of the silverfish are not immediately apparent, though the enlargement and modification of the distalmost palpal segment of the labium and the dorsoventrally flattened and enlarged coxae may be significant. The enigmatic



5.4. A male and female of the common European silverfish, *Thermobia domestica* (Lepismatidae), as they initiate their courtship. Photo: H. Sturm.

Lepidotrichidae are at times excluded from the order. Otherwise, most differences between Zygentoma and Archaeognatha lie in those traits the former shares with winged insects. Major recent references for the Zygentoma include Mendes (1991, 1994, 2002), Larink (1997a,b), and Sturm (1997, 2003b).

The order consists of five Recent families in two groups:

Lepidotrichidae, and the families Lepismatidae, Nicoletiidae, Ateluridae, and Maindroniidae. The apparently primitive family Lepidotrichidae today is represented by a single modern species living in northern California, *Tricholepidion gertschi* (Wygodzinsky, 1961) (Figure 5.5), but the family was originally described from a fossil species, *Lepidothrix pilifera*, in mid-Eocene Baltic amber. This family, however, may not be monophyletic, since *Lepidothrix* may be more closely related to the remainder of the Zygentoma (Euzygentoma). *Tricholepidion* possesses distinct ocelli while *Lepidothrix* and *Euzygentoma* lack ocelli. Regardless of potential paraphyly of Lepidotrichidae, the family possesses a number of putative primitive features relative to *Euzygentoma*, including the large abdominal sterna and large number of abdominal styli and eversible vesicles. However, eversible vesicles are only absent in Lepismatidae and Maindroniidae, and this character is shared (primitively?) with Nicoletiidae and Ateluridae. Indeed, *Tricholepidion* and Nicoletiidae share a unique modification of sensillar structures on the terminal filament (Wygodzinsky, 1961) and the former shares sperm conjugation with Lepismatidae (Wingstrand, 1973; Kristensen, 1997), whereby individual sperm cells pair in the vas deferens of the testes. Evidence for sperm conjugation in Nicoletiidae (Jamieson, 1987) is apparently not conclusive (Dallai *et al.*, 2001). It is possible that Lepidotrichidae is the sister group to all other Zygentoma, with Nicoletiidae and Ateluridae being sister to a clade consisting of Lepismatidae and Maindroniidae. Interestingly, *Tricholepidion* has five-segmented tarsi, like the presumed primitive condition for Pterygota. Archaeognatha and the remaining silverfish families have two- or three-segmented tarsi, conditions typically interpreted as derived, independent reductions. Alternatively,



5.5. The relict silverfish, *Tricholepidion gertschi* (Lepidotrichidae), from California. The only other member of the family is found in Baltic amber, which together may comprise the sister group to the remainder of the order Zygentoma. Photo: H. Sturm.



5.6. A silverfish from Brazil's Early Cretaceous Santana Formation. Although silverfish undoubtedly are of Devonian age, this relatively modern-looking species is among the earliest records of the order Zygentoma, leaving a presumed 280 MY gap in their earliest fossil record. AMNH; body length 14 mm.

but an unlikely scenario, pentamerous tarsi developed independently in *Tricholepidion* and Pterygota, or these are sister groups (e.g., Wheeler *et al.*, 2001).

The Euzygentoma have been defined by the reduction of the abdominal sterna (although this also occurs in Archaeognatha), the reduced number of abdominal styli, and the absence of ocelli. Reduction in the number of tarsomeres may also represent a defining feature of this lineage. The Maindroniidae is a rare family of three species restricted from Asia Minor and Chile. Little is known or understood of these presumed relics, but they may be derivatives of the Lepismatidae (e.g., Remington, 1954). The Lepismatidae is the largest family of the order, with over 200 species worldwide and as such are the group most frequently encountered. The families Nicoletiidae and Ateluridae are close relatives, both lacking eyes and at times having been included in a single family (e.g., Remington, 1954; Paclt, 1963, 1967). The Nicoletiidae are, like the lepismatids, cosmopolitan in distribution. Interestingly, some nicoletiids can reproduce parthenogenetically. Ateluridae are inquilines that live in subterranean ant and termite nests, though a few lepismatids are also inquilines.

Despite the apparent antiquity of Zygentoma as the sister group to all other dicondylic insects, there is a huge gap in their early fossil record. We would expect to find fossil Zygentoma as early as the Devonian, but their fossil record is almost entirely restricted to Cretaceous and Tertiary resins (e.g., Mendes, 1997, 1998; Sturm and Mendes, 1998),

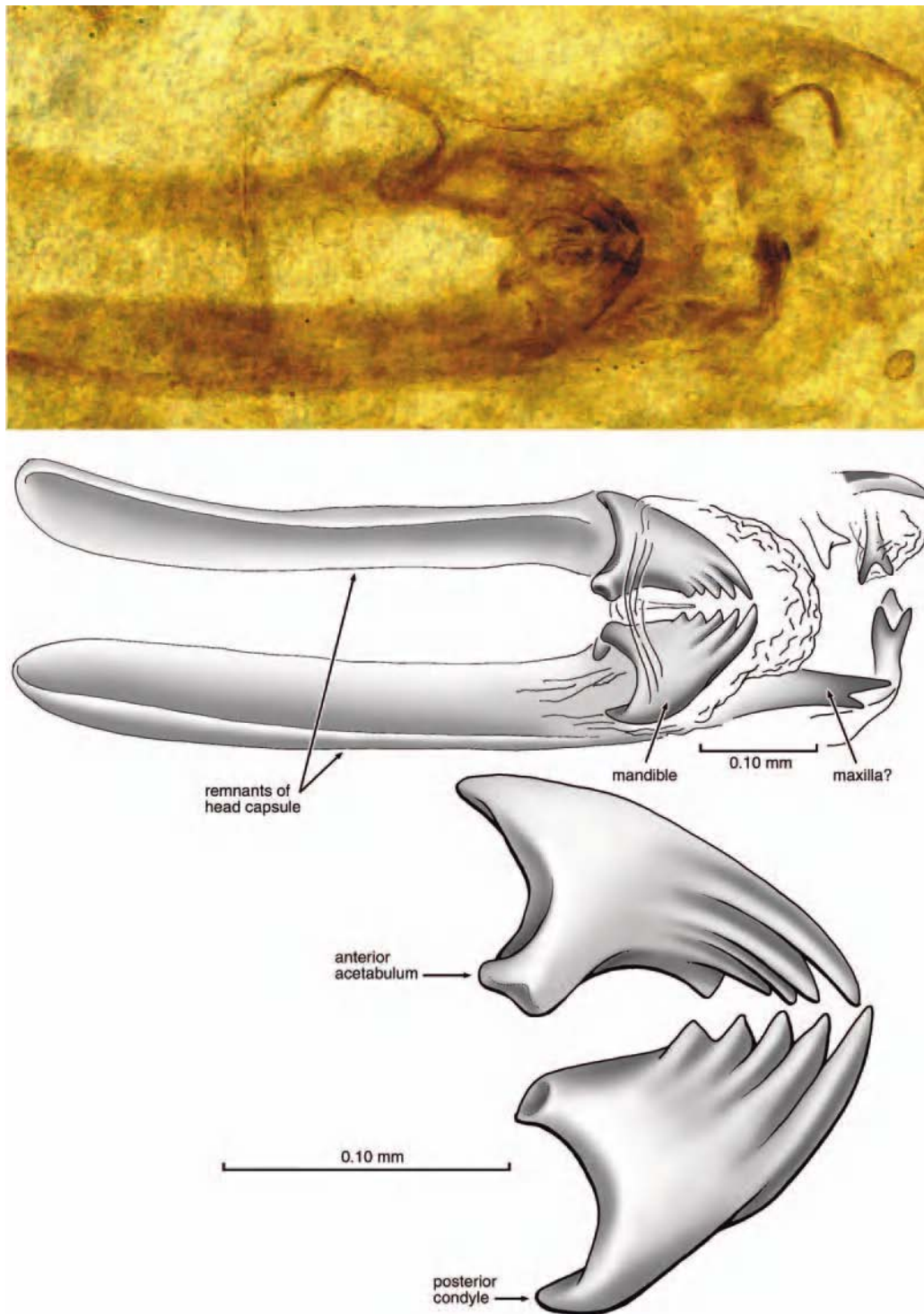


5.7. An immature silverfish (*Zygentoma*) in Miocene Dominican amber. Morone Collection; length 4 mm.

although nice compressions of Lower Cretaceous silverfish have been recovered from the Santana Formation of Brazil (e.g., Sturm, 1998: Figures 5.6, 5.7). Cuticular fragments from the Devonian of Gilboa, New York, may represent a species of *Zygentoma* (Shear *et al.*, 1984), but a conclusive assignment remains impossible to make. Similarly, *Carbotriplura kukalovae* from the Late Carboniferous of the Czech Republic is likely a silverfish (Kluge, 1996), and although its assignment to *Zygentoma* is tentative, its placement in a separate suborder of wingless insects is unjustified. The Pliocene fossil *Onychomachilis fischeri* was described as a bristletail (Pierce, 1951) but is actually a silverfish (Sturm and Machida, 2001).

RHYNIOGNATHA

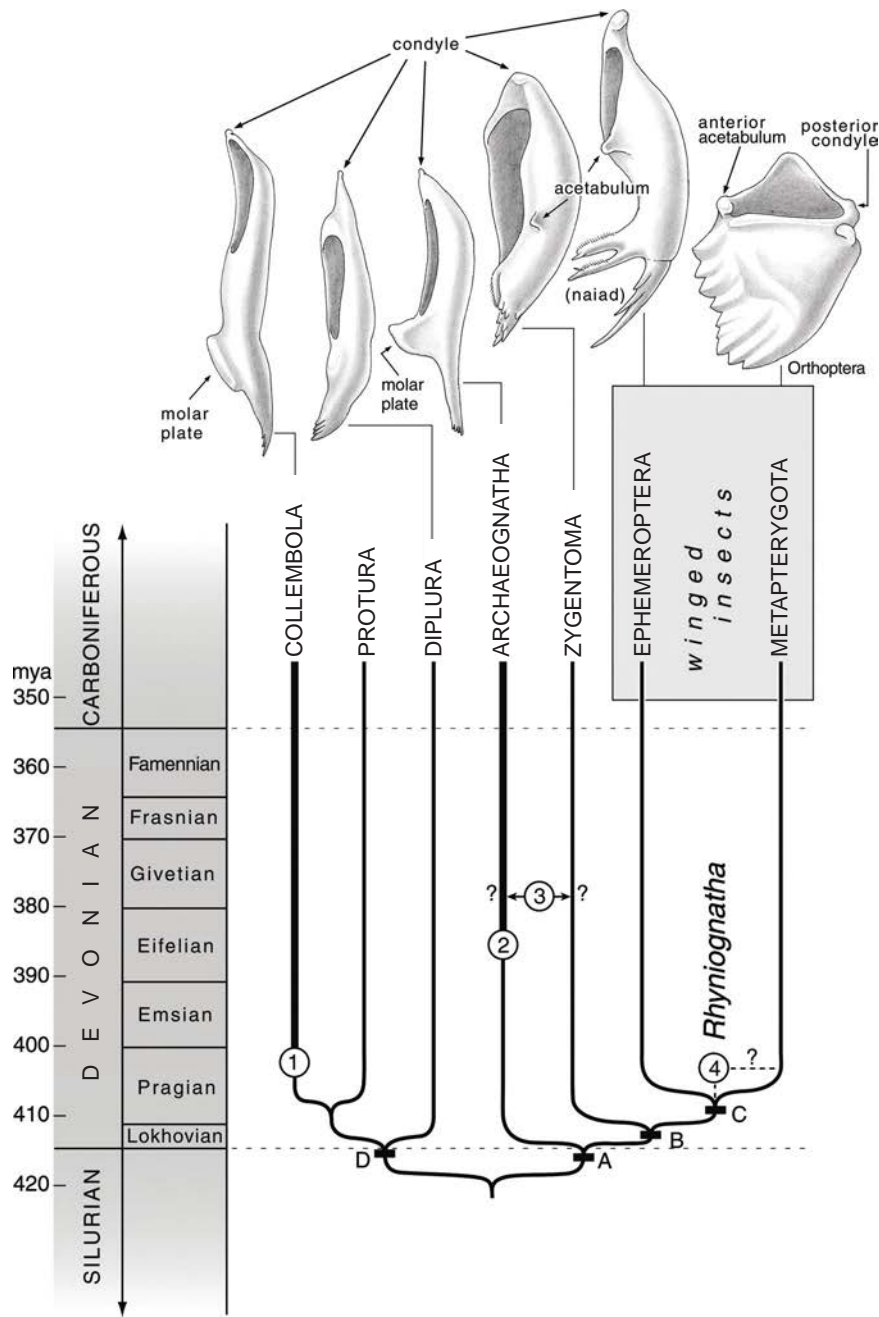
Rhyniella, the collembolan in Early Devonian Rhynie chert, has long been heralded as the oldest hexapod, while fragmentary remains from the same chert had been mostly forgotten. In the original paper announcing the discovery of *Rhyniella*, Hirst and Maulik (1926) also reported a pair of mandibles preserved with largely unidentifiable tissues surrounding them (Figure 5.8). Later, Tillyard (1928b) formally described the mandibular elements and named them, *Rhyniognatha hirsti*. Tillyard was the first to note that they were insect-like, but he did not place them formally into any group. Indeed, subsequent authors relied on Tillyard's illustration and followed his interpretation that the mandibles were "suggestive" of an insect (e.g., Hennig, 1981). Most authors, however, considered *Rhyniognatha* as too fragmentary to make any determination, and Carpenter (1992) even excluded it from his monumental treatise on insect paleontology.



5.8. The oldest insect, *Rhyniognatha hirsti*, from the Early Devonian chert near Rhynie, Scotland. Only portions of the head are preserved, but the dicondylic mandibles indicate it was an insect; their triangular shapes indicate it may even have been a winged insect. NHML In. 38234.

In a recent study of the unique holotype of *Rhyniognatha* (Engel and Grimaldi, 2004a), the presence of an anterior acetabulum and posterior condyle on the mandibles was confirmed, conclusively demonstrating that the mandibles are dicondylic (Figures 5.8, 5.9). Furthermore, the mandibles are short and triangular, a morphology characteristic of a subset

group among the pterygote insects, the Metapterygota, implying that *Rhyniognatha* possessed wings. This would place the origin of wings at least 80 million years earlier than previous fossil evidence allowed, and interestingly agrees with a recent molecular study that estimated insects originated in the Early Silurian and neopterous insects in the



5.9. Phylogeny of basal insect lineages indicating the position of *Rhyniognatha*, the oldest insect, as based on the structure of mandibles. Fossils (numbers): 1. *Rhyniella praecursor*; 2,3. undescribed; 4. *Rhyniognatha hirsti*. Characters (letters): A. insectan (see text), B. dicondylic mandibles, C. wings, D. entognathous mouthparts.

mid-Devonian (Gaunt and Miles, 2002) (see also the *Origin of Wings* in Chapter 6). A Devonian origin of wings could only be conclusively proven with fossilized wings from that period.

It is impossible to say to what order *Rhyniognatha* might have belonged, or if it belonged to an unknown, extinct lineage of primitive insects. All that can be said is that *Rhyniognatha* is the oldest insect, and that it was more

derived than bristletails and silverfish, and probably more than Ephemeroptera. Regardless, *Rhyniognatha's* occurrence in the Early Devonian indicates that insects likely originated in the latest Silurian and were among the earliest of terrestrial faunas (Engel and Grimaldi, 2004a). *Rhyniognatha* also reflects the serious need for intensive exploration of insects from the Devonian and Early Carboniferous.



Insects

You are: [Home](#) > [Insects](#) > [Insect fact files](#) > [Insect groups](#) > [Subclass: Aterygota](#) > Three-pronged bristletails (Order: Thysanura)

What bug is this?

Three-pronged bristletails (Order: Thysanura)

Insect fact files

The term thysanura is derived from the Greek thysanos meaning fringed and ura meaning tail. Three-pronged bristletails can be up to 2cm long, with a carrot-shaped body and a long tail consisting of 3 fringed filaments, two of which are [cerci](#) and one of which is called the epiproct.

- Antennae
- Wings
- Respiration
- Mouthparts
- Life cycles
- Overwintering
- Classification
- Insect groups (Orders)**
- A to Z of insects

These insects mostly live in leaf litter and crevices in wood. However, they include the familiar Silverfish (*Lepisma saccharina*) which has scales on its body and likes human dwellings, especially slightly moist areas, where they eat starchy food such as paper. If you put the light on in a dark room at night - especially the kitchen or bathroom - you might see them scurrying quickly away.

The Firebrat (*Thermobia domestica*) is also a three pronged bristletail which is bristly rather than scaly, and again likes human dwellings, especially warm places such as hearths, heating ducts and bakeries.

Although they are tiny and primitive, the bristletails have a mating ritual that involves the male dancing around near a female and leaving a spermatophore on a silk thread. The female then picks this up between the valves of her ovipositor.

The eggs are laid in cracks and crevices. When the young hatch from the egg they are like miniature adults, but without the scales. They moult ten times, and unlike the more developed winged insects they moult all their adult lives.



Silverfish (*Lepisma saccharina*) are commonly found inside houses.

Insects & Man

Related links: Three-pronged bristletails (Order: Thysanura)

Caresheets

- [Thysanura - Compendium of hexapod classes and orders](http://www.cals.ncsu.edu/course/ent425/library/compendium/thysanura.html)
http://www.cals.ncsu.edu/course/ent425/library/compendium/thysanura.html
- [Thysanura - earthlife.net](http://www.earthlife.net/insects/thysan.html)
http://www.earthlife.net/insects/thysan.html
- [Thysanura - Tree of Life](http://tolweb.org/tree?group=Thysanura)
http://tolweb.org/tree?group=Thysanura

Become an entomologist

Conservation

Biodiversity & biological recording

Glossary

What I observed in the same places as the bristletails at night



Millipede



Earthworm



Fly



Snail



**Beetles (several) Agyrtidae.
Probably *Ipelates latus***



**Spider Genus *Callobius*
probably *C. pictus***



Harvestmen (Opiliones) Probably *Leptobunus parvulus* These Harvestmen were very common in the same areas as the bristletails.



Note: by going to the on-line version of this report you can access the references Matt has provided.

Archaeognatha of Canada

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Abstract

Current knowledge of the Canadian bristletail (Archaeognatha) fauna is summarized and compared with Tomlin's 1979 chapter on the group in *Canada and Its Insect Fauna*. Since that time the number of species known from Canada has increased from three to eight. While much work remains to be done to document an estimated eight additional species from Canada, this can be accomplished using an integrated approach.

Keywords

Archaeognatha, biodiversity assessment, Biota of Canada, jumping bristletails, Microcoryphia

Introduction

Substantial progress has been made in our understanding of the bristletail fauna of Canada since Tomlin's (1979) chapter in *Canada and its insect fauna*, but a great deal of work remains to be done before this fauna is well documented.

Tomlin (1979) reported three species known from Canada and estimated that there were an additional ten species yet to be documented or described. He had considered all Canadian members of the order Microcoryphia (= Archaeognatha) to be in the family Machilidae, but it is unclear whether this was because he differed in opinion regarding the family Meinertellidae proposed by Verhoeff (1910) or because he was not aware of any meinertellid species from Canada at that time.

The one Canadian species mentioned by Tomlin (1979), *Machilis variabilis* Say, has since been considered unidentifiable because the type material has been lost and Say (1821) did not describe taxonomically useful characters to distinguish this species

(see Wygodzinsky and Schmidt 1980). However, it may still be possible to associate this name with an existing species based on the type locality. Say (1821) provided a broad type locality of “probably in almost every temperate part of North America” but specifically included Florida. It is highly probable that this material came from the northeast corner of Florida, where Say had made one collecting trip over the winter of 1817–1818 (Bennet 2002). An unidentified species of *Neomachilellus*, the only archaeognathan besides *M. variabilis* reported from Florida, was later reported from the eastern Florida-Georgia border area (Wygodzinsky 1967, Sturm 1984) and is likely the same species as some of Say’s original types of *M. variabilis*.

North American Archaeognatha are presently a difficult group to work with due to a lack of modern descriptions for some species and inherent challenges of recognizing morphologically similar species. Most progress on the North American fauna since 1979 has been due to the work of Pedro Wygodzinsky and Helmut Sturm, both experts on this group working at a worldwide scope. Wygodzinsky and Schmidt (1980) published the only modern regional treatment applicable to Canadian bristletails, covering the northeastern United States and adjacent provinces of Canada. More recent work by Sturm and others pertaining to the Canadian fauna (Sturm 1991, 2001, Sturm and Bach de Roca 1992, Sturm and Bowser 2004) has been incremental, with additions of species and treatment of one genus (*Mesomachilis* Silvestri).

A total of eight species of bristletails are now known from Canada, representing two families (Table 1). Of these, two species were introduced from the Palearctic to the east coast of North America, apparently in ship ballast material (Wygodzinsky and Schmidt 1980). No species in the Canadian fauna are known to be widespread across Canada; most appear to be restricted to defined ecological zones. Distinct bristletail assemblages are present in the Pacific Maritime, Western Interior Basin, and Montane Cordillera ecozones.

There are few DNA barcodes for Canadian bristletails. Ten BINs (Barcode Index Numbers) of bristletails have been obtained from Canada, only two of which have been associated with accepted species names. Some of the unidentified BINs will likely be eventually identified as previously described species, but some likely represent undescribed species. DNA barcode sequences from the two Palearctic species established in eastern Canada have been obtained from elsewhere but not yet from Canada.

The author is aware of six potentially undescribed species: two entities in the genus *Petridiobius* Paclt represented by the BINs BOLD:AAV1529 and BOLD:AAV1531 from the Canadian Rockies; specimens representing one of two BINs BOLD:AAV1528 and BOLD:ACJ4257 from coastal British Columbia (BC) that are indistinguishable from the original description of *Pedetontus submutans* Silvestri; a *Mesomachilis* sp. and a species of *Pedetontoides* Mendes from the Western Interior Basin ecozone of British Columbia (BC); and a species similar to *Leptomachilis* Sturm from Kootenay National Park represented by BIN BOLD:AAV1530. More species are likely to be found in Canada, especially in regions with complex glacial history, a situation that has led to high species diversity of bristletails in the European Alps (Wachter et al. 2012, Gassner et al. 2014, Dejaco et al. 2016).

Table 1. Census of Archaeognatha in Canada.

Taxon ¹	No. species reported in Tomlin (1979)	No. species currently known from Canada	No. BINs ² available for Canadian species	Est. no. undescribed or unrecorded species in Canada	General distribution by ecozone ³	Information sources ⁴
Machilidae	3	7 (2)	9	7	southern Canada from Pacific Maritime to Atlantic Maritime	Wygodzinsky and Schmidt 1980, Sturm 1991, Sturm 2001, Chlebak 2013; specimens in DEBU, RBCM, UBCZ
Meinertellidae	0	1	1	1	Pacific Maritime, Western Interior Basin, Prairies	Sturm and Bach de Roca 1992, Acorn 2011; specimens in DEBU, RBCM; observations on iNaturalist.org
Total	3	8 (2)	10	8		

¹Classification follows Sturm and Machida (2001). ²Barcode Index Number, as defined in Ratnasingham and Hebert (2013).

³See figure 1 in Langor (2019) for a map of ecozones. ⁴Data source collection codens: DEBU, University of Guelph; RBCM, Royal BC Museum; UBCZ, University of British Columbia, Spencer Museum.

Dejaco et al. (2012, 2016) and Gassner et al. (2014) have recently demonstrated success in discriminating among morphologically similar species of bristletails using an integrated approach incorporating multiple morphometric and molecular methods. Appropriate next steps toward improving our understanding of the Canadian archaeognathan fauna would be to collect high-quality specimens that are suitable for both morphological and molecular methods, then apply an integrated taxonomic approach to produce treatments which include identification keys. Areas where additional collecting would be most helpful include the Western Interior Basin and Montane Cordillera ecozones, apparently home to the greatest diversity of Canadian bristletails; the Prairies ecozone, where bristletails are known (Acorn 2011) but have neither been DNA barcoded nor identified to species; and the Atlantic Maritime ecozone, from which no bristletail specimens have been DNA barcoded. While Tomlin's (1979) concluding remark regarding the Canadian bristletails that, "obviously much work remains to be done in this group", remains true today, fortunately tools are now available to complete this work much more satisfactorily.

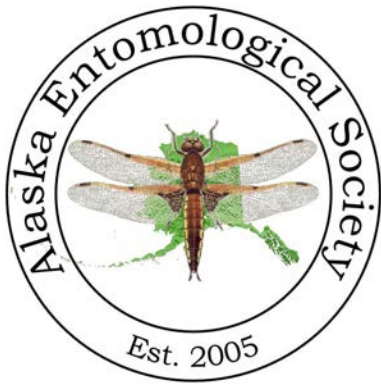
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and according to Matt The best overall treatment of the bristletails is a book entitled *Archaeognatha* by Sturm and Machida (2001). This book covers basically all aspects of the biology of bristletails.



Newsletter

of the

Alaska Entomological Society

Volume 3, Issue 1, March 2010

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Ocellated Emerald dragonfly (*Somatochlora minor*) new to Alaska

by John Hudson¹



Figure 1: A male Ocellated Emerald at Auke Lake in Juneau. Photograph by John Hudson.

Alaska's dragonfly list grew by one last year with the discovery of a single female Ocellated Emerald (Figure 1)

in the Kanuti National Wildlife Refuge. The specimen was netted at a *Sphagnum* bog in the heart of the refuge during a 3-day collecting trip targeting the genus. Since efforts to document the refuge's odonate fauna began in 2004, 25 species have been documented at Kanuti making it one of the top areas for dragonfly diversity in the state. Remarkably, the following month a population of Ocellated Emeralds was discovered at Juneau's Auke Lake, an area that has been intensively surveyed since 1997.

Emeralds (Corduliidae) comprise the most species rich family of dragonflies in Alaska. The common name refers to the brilliant emerald-green eyes and metallic green thorax. Nine species are currently known from the state. They are locally rare, secretive, and difficult to capture. The two species of dragonflies that likely occur here, but have yet to be collected are emeralds: Brush-tipped Emerald (*S. walshii*) and Muskeg Emerald (*S. septentrionalis*).

The Kanuti survey was funded by a Challenge Cost Share grant from the U.S. Fish and Wildlife Service. This year the same grant will fund dragonfly surveys in Kanuti and the Selawick National Wildlife Refuges. To date 35 dragonfly species have been found in Alaska.

¹Alaska Odonata Survey, Juneau. jhudson@gci.net

Assessing larch mortality and regeneration after a landscape level sawfly outbreak in interior Alaska

Forest Health Monitoring Evaluation Monitoring grant
#WC-EM-08-03

by Roger Burnside⁴ and Mark Schultz³

The larch sawfly (LSF, *Pristiphora erichsonii*), is an invasive defoliator of larch (*Larix laricina*) in Alaska. Based on aerial survey data, it is estimated that 600,000-700,000 acres of larch forest in interior Alaska have been impacted by a LSF outbreak that began in 1999 and continues to a lesser degree to the present time. The mortality of larch affected by the LSF has been documented, largely from aerial surveys, to reach 80%. However, due to the majority of interior Alaska larch stands being inaccessible (unroaded) and the difficulty of obtaining accurate assessments of associated mortality agents (e.g., larch beetle, LSF, *Armillaria* root disease, etc.), concerns have been expressed that many stands are not regenerating and that factors unrelated to insect agents are the primary forces affecting larch stand succession, regeneration success and larch sustainability.

An evaluation project was previously conducted (2006 & 2007) to resolve mapping inaccuracies that estimated the range of larch distribution in interior Alaska. In addition, it also assessed the extent of healthy larch within the area of heaviest mortality, LSF caused or otherwise. The lack of any landscape level remote sensing data coverage for this area makes it difficult to easily delineate the extent, basal area or

% composition of larch in stands that are mostly composed of black spruce (*Picea mariana*) in interior Alaska. Forest health risk assessments are continually challenged by the inability to cost effectively access stands for current and repeat data collection. The current project was initiated to better determine the primary source of larch mortality within LSF-impacted stands, to add to the limited body of information on stand-level larch dynamics, to establish permanent plot points for subsequent analysis/stand delineation, and to better assess larch regeneration. This information allows for more informed determinations of forest health risk factors associated with larch stand establishment after repeated insect and/or abiotic disturbance.

Between July-August of 2008 and 2009, ground plots were established along a series of transects and stand assessments were conducted at 14 sites across the mapped extent of larch in interior Alaska. Stand exams were conducted along the existing road system and at more remote areas accessible only by float-plane. Estimates of stand composition, tree and shrub regeneration, presence/absence of cone-bearing trees, stocking, basal area, stand age, and cause(s) of recent larch mortality were recorded. Conclusions were drawn as to relative site quality, actual mortality causal agent(s), future of larch succession and regeneration potential for the sites evaluated.

A poster about this project is available at http://www.akentsoc.org/doc/Burnside_R_et_al_2010.pdf.

A second Alaskan bristletail

by Matthew L. Bowser⁸

Until recently, *Petridiobius arcticus* (Folsom, 1902) was the only species of bristletail (Microcoryphia) known from Alaska. *P. arcticus* is widely distributed in southern coastal Alaska, inhabiting rocky places from the Aleutians to Southeast Alaska.

Schultz and De Santo (2006) collected bristletails of the genus *Pedetontus*, subgenus *Verhoeffilis* in tree bole intercept traps on Prince of Wales Island, the first record of this genus in Alaska. They were apparently the same species reported by Mendes (1992) and Sturm (2001) from British Columbia. Mendes (1992) noted that the only difference between his specimens and Silvestri's (1911) description of *Pedetontus submutans* (Silvestri, 1911) from Washington and Oregon was the length of the ovipositor. In *P. submutans*, the ovipos-

itor extends about 1 mm beyond the apices of the terminal spines of the stylets of the 9th abdominal segment; in Mendes' specimens, the ovipositor only reached the bases of these terminal spines. Mendes (1992) commented that this could have been merely a difference in development.

In order to resolve the identity of the Alaskan specimens, I sought topotypical specimens for comparison, borrowing bristletails from the following collections: Maurice T. James Entomological Collection, Washington State University, Pullman, Washington (WSU); the Burke Museum of Natural History and Culture, University of Washington, Seattle, Washington (UWBM); the Spencer Entomological Collection, Vancouver, British Columbia (UBCZ); the University of Alaska Museum, Fairbanks, Alaska (UAM); and

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the Juneau USDA Forest Service collection, Juneau, Alaska (FSAJ).

In the loaned material were numerous specimens of *Pedetontus* subg. *Verhoeffilis* from Juneau, Alaska to Galliano Island, British Columbia, but none from Washington or Oregon. All of these specimens, including a female with an ovipositor extending slightly beyond the terminal spines of the 9th stylets, appeared to be the same species. Due to a lack of topotypes, I could not determine whether *Pedetontus* specimens from Alaska and British Columbia were conspecific with *P. submutans*.



Figure 1: Frontal view of heads of *Petridiobius arcticus* (left) and *Pedetontus* subg. *Verhoeffilis* (right) from Sitka, Alaska (UAM).



Figure 2: *Pedetontus* subg. *Verhoeffilis* ♂ from Prince of Wales Island, Alaska (FSAJ). The caudal filaments are missing in this specimen.

Judging from label data, this *Pedetontus* is a forest species. They were found on tree boles, on the forest floor, in moist logs, in moss, and on trunks of Sitka spruce

(*Picea sitchensis*), western hemlock (*Tsuga heterophylla*) and red alder (*Alnus rubra*).

The two Alaskan species can be separated by the generic characters of the lateral ocelli as in the key of Mendes (1990). In *Pedetontus*, the lateral ocelli are sole-shaped, extending well into the fronto-ocular area, sometimes nearly touching; the lateral ocelli of *Petridiobius* are constricted little if at all medially and are shorter, not extending onto the fronto-ocular area (Figure 1). The color and general appearance of the two species also differ. In preserved specimens, *P. arcticus* has more and darker integumental pigmentation than the Alaskan *Pedetontus*. The scales of *P. arcticus* are mostly dark gray (in alcohol), where the scales of the Alaskan *Pedetontus* are brown. The legs and maxillary palpi of *P. arcticus*, especially males, are also more robust than those of the Alaskan *Pedetontus*.

I thank Karen Needham (UBCZ), Richard S. Zack (WSU), Rod Crawford (UWBM), Derek Sikes (UAM), and Mark Schultz (FSAJ) for the loans of material.

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