

Centipedes (Chilopoda) and Millipedes (Diplopoda) of Acadia National Park: A First Survey

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Abstract

The results of a millipede and centipede (Myriapoda) survey in Acadia National Park are summarized. The survey took place during the 2015 annual BioBlitz coordinated by the Schoodic Institute, and 160 myriapod specimens were collected by 55 citizen scientists on 18 July 2015. Eight millipede and eight centipede species were collected, with the introduced species *Lithobius forficatus*, *Lithobius crassipes*, *Cylindroiulus caeruleocinctus*, and *Ophiulus pilosus* being the most abundant. When combined, introduced species had a much higher relative abundance than native species.

Introduction

The centipede (Chilopoda) fauna of Maine is exceptionally poorly-known. The most recent catalogue of North American centipedes (Mercurio 2010) lists only four species as having been recorded from the state, all from the order Lithobiomorpha: *Bothropolys multidentatus*, *Lamyctes emarginatus*, *Lithobius forficatus*, and *Lithobius microps*. Of these, the last three are considered to be European introductions while the first is indigenous to North America. No geophilomorph or soil centipedes are listed, although several species are in fact present in Maine, as this report demonstrates.

Maine's known millipede (Diplopoda) fauna is more extensive but remains poorly-documented. Hoffman's checklist (1999) of North and Middle American millipedes provides geographic information on the continent's millipede species, but unlike Mercurio (2010) does not provide individual state records. As such, a species' presence in Maine must be inferred from its approximate range boundaries. Species found both in southeastern Canada and New England are here considered to "likely to occur" in Maine even though some may not have actually been documented in the state.

Under this criterion, the following 19 millipede species may be expected to occur in Maine: *Apheloria virginensis*, *Blaniulus guttulatus*, *Brachyiulus pusillus*, *Choneiulus palmatus*, *Cylindroiulus caeruleocinctus*, *Cylindroiulus latestriatus*, *Narceus americanus*, *Nopoiulus kochii*, *Ophiulus pilosus*, *Polydesmus angustus*, *Polydesmus inconstans*, *Polydesmus superus*, *Polyxenus lagurus*, *Pseudopolydesmus canadensis*, *Proteroiulus fuscus*, *Scytonotus granulatus*, *Sigmoria trimaculata*, *Underwoodia iuloides*, and *Uroblaniulus canadensis*.

Both centipedes and millipedes belong to the arthropod subphylum Myriapoda. This is an ancient group represented by trace fossils at least 420 million years old, and during the Carboniferous Period, Myriapoda included the largest terrestrial arthropods known to have ever existed (Shear and Edgecombe 2010). Today there are some 13,000 described species, with many more undescribed. They are important members of forest litter-layer communities, including those that dominate Maine's landscape.

Centipedes and millipedes are superficially similar in having long bodies with many legs, but are only distantly related and have distinct lifestyles and morphologies. Millipedes are detritivores with calcified exoskeletons (Figure 1), and feed largely on decaying plant matter

such as leaf litter. They possess diplosegments or fused pairs of segments, and therefore have two pairs of legs beneath every visible tergite. Centipedes have one pair of legs per tergite, uncalcified exoskeletons, and are fast-moving predators. The anterior-most legs are modified into venom-injecting apparatuses known as forcipules (Figure 2). Two additional classes of Myriapoda, the minute and poorly-known Symphyla and Pauropoda, occur in Maine but were not examined in this study.

This report details the results of centipede and millipede collections during Acadia National Park's 2015 Annual BioBlitz, an arthropod-focused biological survey in which specimens are collected by citizen-scientist volunteers. The event was coordinated by the Schoodic Institute, took place from 17-20 July 2015, and was attended by 55 participants.

Methods

Five teams of approximately 11 citizen scientists each were dispatched to field sites throughout Acadia National park, in the towns of Bar Harbor, Southwest Harbor, Tremont, and Winter Harbor. For additional information on the technical aspects of the annual BioBlitz in Acadia National Park, as well as data from previous BioBlitz events, readers are referred to Chandler *et al.* (2012).

Citizen scientists were given basic instruction on how to properly collect and preserve myriapod specimens. All collections were done by hand, using forceps if needed. Myriapods are readily found on the forest floor, for example by peeling loose bark from rotting logs, overturning stones and woody debris, and sifting through leaf litter.

Once collected, specimens were then killed and preserved in vials of 70% ethyl alcohol before being transported to the Schoodic Education and Research Center for curation. Identifications were performed by the taxonomist (J.W. DeSisto), using a Wild Heerbrugg M5A dissecting microscope, at magnifications between 6x and 50x.

Results

Because the BioBlitz was primarily focused on Hymenoptera, with Myriapoda as an additional program, not all participants elected to collect myriapods. Nonetheless, 89 centipede and 71 millipede specimens were taken, representing 16 species. A list of each species, with taxonomic affiliations and basic occurrence information, is found in Figure 3. The number of specimens taken of each species, and the number of sites at which each species was found, is given in Figure 4. Although the BioBlitz was a weekend-long event, all myriapod collections took place on 18 July 2015.

Occurrence data is organized by family and species. For each family, relevant natural history information and distinguishing characteristics are provided. For each species, the number of specimens taken is stated, followed by the location and lot number (or site code) for each observation. Along with each lot number, the number of species taken at a particular site is listed as $n = [\text{number taken}]$. For example: "Three specimens were taken, from Bar Harbor (Lot 38 $n=2$) and Tremont (Lot 15 $n=1$)."

Each lot number corresponds to a collection site, the latitude and longitude of which are listed in Supplemental Materials. Coordinates were determined on-site using a handheld GPS.

Lithobiidae

Lithobiids or “stone centipedes” have 15 pairs of legs, long antennae, and dorso-ventrally flattened bodies, all adaptations for a life exploring tight spaces in leaf litter and rotting logs in search of arthropod prey (Lewis 1981). They are extremely fast and may be difficult to catch. If grasped, they readily detach their legs in order to escape, which is unfortunate given that identification often requires examination of certain legs beneath a microscope.

Although stone centipedes will invariably try to bite when handled, only two species in New England grow large enough to puncture human skin to inject venom. These are *Bothropolys multidentatus* and *Lithobius forficatus*, which can attain lengths exceeding an inch. A bite is typically no worse than a honeybee sting (Hoffman 1995).

Bothropolys multidentatus (Newport 1845)

Four specimens were taken, from Bar Harbor (Lot 10 n=1; Lot 77 n=2) and Tremont (Lot 15 n=1).

Lithobius crassipes L. Koch 1832

Twenty-seven specimens were taken, from Bar Harbor (Lot 28 n=4; Lot 29 n=2; Lot 39 n=1; Lot 44 n=1; Lot 58 n=1; Lot 60 n=4; Lot 62 n=2; Lot 71 n=2; Lot 73 n=2; Lot 75 n=1), Tremont (Lot 15 n=2; Lot 24 n=2), and Winter Harbor (Lot 99 n=1; Lot 115 n=2).

Lithobius forficatus (Linnaeus 1758)

Forty-five specimens were taken, from Bar Harbor (Lot 6 n=1; Lot 11 n=1; Lot 33 n=2; Lot 58 n=9; Lot 60 n=7; Lot 62 n=2; Lot 71 n=3; Lot 73 n=1), Tremont (Lot 37 n=5), and Winter Harbor (Lot 72 n=5; Lot 114 n=1; Lot 115 n=1; Lot 119 n=4; Lot 126 n=2; Lot 128 n=1).

Lithobius microps Meinert 1868

Three specimens were taken from Bar Harbor (Lot 27 n=1; Lot 38 n=1; Lot 60 n=1).

Nampabius fungiferopes (Chamberlin 1904)

Three specimens were taken from Bar Harbor (Lot 12 n=1; Lot 77 n=1) and Winter Harbor (Lot 126 n=1).

Geophilidae

Geophilids or “soil centipedes” are long and thread-like, with at least 29 but as many as 177 pairs of legs, depending on the species (Lewis 1981). Unlike stone centipedes they do not sprint, but instead tunnel through soil in search of prey. All are too small to successfully envenomate a human handler.

Soil centipedes exhibit maternal care. When a female lays her clutch of eggs in a secluded, moist location, she coils around them much like a female python. She cleans them regularly and, if disturbed, will attempt to bite the assailant while not leaving her brood (Crabill 1952).

Geophilus flavus (De Geer 1778)

One specimen was taken from Bar Harbor (Lot 58 n=1).

Geophilus vittatus (Rafinesque 1820)

Five specimens were taken from Tremont (Lot 14 n=1; Lot 24 n=3; Lot 22 n=1).

Strigamia chionophila Wood 1862

One specimen was taken from Tremont (Lot 17 n=1).

Chordeumatidae

This is an unusual family of small, stocky, vermiform millipedes. In *Underwoodia* and related genera, the body width gradually tapers anteriorly, giving specimens a “pin-headed” appearance. This is an adaptation to burrowing through soil and rotting wood. *Underwoodia* is a northern taxon found in boreal forests throughout Canada and the northern United States (Shelley 1993).

Underwoodia iuloides (Harger 1872)

One specimen was taken from Southwest Harbor (Lot 54 n=1).

Blaniulidae

There are two blaniulid species found in Maine (Hoffman 1999): the introduced *Blaniulus guttulatus* or “spotted snake millipede” and the native *Virgoiulus minutus*. Both are small, thin, vermiform millipedes with large dark spots occurring laterally on each segment. The spots mark the position of the ozopores, which secrete defensive toxins (Hopkin and Read 1992). Unlike in Julidae, in Blaniulidae the lateral striations on each tergite, if present, occur only below the ozopores on each side of the body.

The spotted snake millipede has been reported as a pest of potatoes, beets, and other tubers (Cloudsley-Thompson 1950). Although they seldom attack a healthy crop, if a potato’s skin is damaged they may enter and eat the tuber from the inside.

Blaniulus guttulatus (Fabricius 1798)

Eight specimens were taken from Bar Harbor (Lot 12 n=2; Lot 29 n=1; Lot 58 n=1; Lot 77 n=1), Tremont (Lot 24 n=2), and Winter Harbor (Lot 119 n=1).

Virgoiulus minutus (Brandt 1841)

Twelve specimens were taken from Bar Harbor (Lot 73 n=1), Southwest Harbor (Lot 54 n=2), Tremont (Lot 37 n=2; Lot 68 n=3), and Winter Harbor (Lot 119 n=4).

Julidae

The julids or “snake millipedes” are vermiform millipedes with uniformly cylindrical bodies. Uniquely, they have a row of lateral striations encircling each tergital ring. All snake millipedes in the northeastern United States are introduced from Europe, and as such are common in gardens (Kevan 1983).

The two genera in Maine are easily distinguished by their habit of curling into a spiral when disturbed. *Cylindroiulus* is capable of forming a two-dimensional spiral like a heat coil, while *Ophiulus* forms a three-dimensional spiral like a coiled spring.

Cylindroiulus caeruleocinctus (Wood 1864)

Eighteen specimens were taken from Bar Harbor (Lot 60 n=5; Lot 71 n=1; Lot 73 n=8; Lot 75 n=2) and Winter Harbor (Lot 119 n=2).

Ophiulus pilosus (Newport 1842)

Twenty-four specimens were taken from Bar Harbor (Lot 2 n=2; Lot 7 n=1; Lot 28 n=3; Lot 58 n=1; Lot 71 n=2; Lot 73 n=2; Lot 77 n=7), Southwest Harbor (Lot 36 n=3), Tremont (Lot 87 n=1), and Winter Harbor (Lot 119 n=2).

Parajulidae

Like the blaniulids, parajulid millipedes may have lateral striations on their tergites but only below the poison-secreting ozopores. Unlike Blaniulidae, Parajulidae in North America is comprised mostly of native species (Hoffman 1999), including *Uroblaniulus canadensis*. This species, the only known parajulid in Acadia National Park, is distinguished by its hook-like, downward-curling epiproct, a pointed structure that projects posteriorly from the animal's last tergite. Oddly, this genus contains some of the few millipedes reported to engage in carnivory, and one specimen was even observed preying on marbled salamander (*Ambystoma opacum*) eggs (Mitchell *et al.* 1996).

Uroblaniulus canadensis (Newport 1844)

Two specimens were taken from Bar Harbor (Lot 6 n=1) and Tremont (Lot 37 n=1).

Polydesmidae

Polydesmids or “flat-backed millipedes” have, instead of cylindrical bodies, flattened tergites often with laterally-projecting structures called paranota. In contrast to the vermiform families, whose bodies are adapted to tunneling through soil and rotting wood, the polydesmid body is better-suited to walking about on the surface (Hopkin and Read 1992). Both species documented here are native to North America. An additional genus, *Polydesmus*, contains many European introduced species (Hoffman 1999) and is likely to occur in Acadia National Park.

Pseudopolydesmus serratus (Say 1821)

Three specimens were taken from Bar Harbor (Lot 39 n=1; Lot 62 n=1) and Tremont (Lot 87 n=1).

Scytonotus granulatus (Say 1821)

Three specimens were taken from Bar Harbor (Lot 73 n=2) and Tremont (Lot 37 n=1).

Discussion

The 2015 BioBlitz was the first systematic survey of the myriapods in both Acadia National Park and the State of Maine. The results reflect this fact: the known centipede fauna of Maine, for example, has now more than doubled from four to nine recorded species (Mercurio 2010). One millipede, *Virgoiulus minutus*, was previously only recorded as far north as New York (McAllister *et al.* 2005).

Among centipedes, the two introduced lithobiids *Lithobius crassipes* and *Lithobius forficatus* were by far the most frequently collected, with the latter having a relative abundance of 0.504 (Figure 5). Among millipedes the two most frequently collected species were the introduced julids *Cylindroiulus caeruleocinctus* and *Ophiulus pilosus* (Figure 6), with relative abundances 0.254 and 0.338, respectively. Relative abundance was calculated as the number of

specimens taken for a particular species, divided by the total number of either centipedes or millipedes taken.

In both millipedes and centipedes, the combined relative abundances of introduced species far outweighed the combined relative abundances of native species (Figure 7). This is more pronounced with centipedes: introduced species have a combined relative abundance of 0.854, compared with introduced millipedes' 0.704. This is due to the high abundance of particular introduced species (*L. forficatus*, *L. crassipes*, *C. caeruleocinctus*, and *O. pilosus*), in spite of the fact that nine native myriapod species and seven introduced species were documented in this survey.

Several species may yet be found in Acadia National Park. *Schendyla nemorensis* and *Cryptops hortensis*, both introduced centipedes from Europe, are common in southern New England (Crabill 1952). Furthermore, I have collected specimens of *S. nemorensis* from Prospect Harbor on Schoodic Peninsula. This species is a minute soil centipede that prefers to burrow deeper in the soil than its larger relatives, which may explain its absence in BioBlitz collections. *Lamycetes emarginatus*, a henricopid, has previously been documented in Maine but was not observed in this survey (Mercurio 2010).

The introduced polydesmid genus *Polydesmus*, close relative to the native *Pseudopolydesmus*, was notably absent from BioBlitz collections. The large, brightly-colored *Sigmoria trimaculata* and *Apheloria virginiensis* have been observed in New England and southern Canada and may occur in coastal Maine (Hoffman 1999). The diversity of the family Parajulidae in North America (Hoffman 1999) suggests that other species beside *Uroblaniulus canadensis* may occur in Acadia National Park.

Maine's myriapod fauna is poorly-known, not because myriapods are difficult to study, but because of a lack of scientific effort. This is probably because most of Maine's species are either non-native or common elsewhere. It is more academically rewarding to conduct research in southern Appalachia or the tropics, where diversity is higher and a greater number of species remain to be discovered.

A BioBlitz, in which citizen-scientists carry out the majority of data-collection, is possibly the most efficient way to document understudied taxa in a region neglected by taxonomists. Such a program also serves the purpose of introducing these animals to people who otherwise might never bother to examine one up-close. For those curious enough, millipedes and centipedes are just as fascinating in Maine as they are anywhere else.

Acknowledgments

The BioBlitz described above was run by the Schoodic Institute and took place at the Schoodic Education and Research Center. Seth Benz was the BioBlitz coordinator and was responsible for most administrative and planning aspects of the myriapod program. Finally, many thanks are owed to the 55 citizen scientists who attended the blitz and collected the specimens whose data appears in this report.

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Figures



Figure 1: *Cylindroiulus caeruleocinctus*, an introduced European julid millipede, common in Acadia National Park.

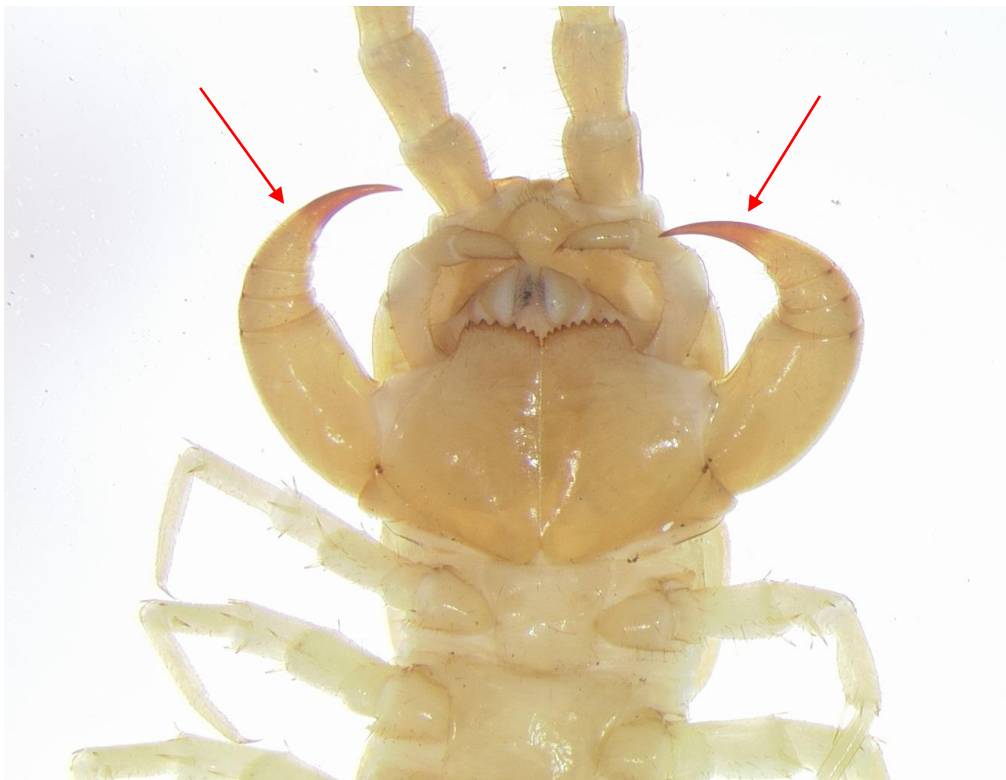


Figure 2: Ventral view of the head of lithobiid centipede *Bothropolys multidentatus*, showing venom-injecting, tusk-like forcipules (arrows).

Class	Order	Family	Genus	Species
Chilopoda	Geophilomorpha	Geophilidae	<i>Geophilus</i>	<i>flavus</i>
Chilopoda	Geophilomorpha	Geophilidae	<i>Geophilus</i>	<i>vittatus</i>
Chilopoda	Geophilomorpha	Geophilidae	<i>Strigamia</i>	<i>chionophila</i>
Chilopoda	Lithobiomorpha	Lithobiidae	<i>Bothropolys</i>	<i>multidentatus</i>
Chilopoda	Lithobiomorpha	Lithobiidae	<i>Lithobius</i>	<i>crassipes</i>
Chilopoda	Lithobiomorpha	Lithobiidae	<i>Lithobius</i>	<i>forficatus</i>
Chilopoda	Lithobiomorpha	Lithobiidae	<i>Lithobius</i>	<i>microps</i>
Chilopoda	Lithobiomorpha	Lithobiidae	<i>Nampabius</i>	<i>fungiferopes</i>
Diplopoda	Chordeumatida	Caseyidae	<i>Underwoodia</i>	<i>iuloides</i>
Diplopoda	Julida	Blaniulidae	<i>Blaniulus</i>	<i>guttulatus</i>
Diplopoda	Julida	Blaniulidae	<i>Virgoiulus</i>	<i>minutus</i>
Diplopoda	Julida	Julidae	<i>Cylindroiulus</i>	<i>caeruleocinctus</i>
Diplopoda	Julida	Julidae	<i>Ophiulus</i>	<i>pilosus</i>
Diplopoda	Julida	Parajulidae	<i>Uroblaniulus</i>	<i>canadensis</i>
Diplopoda	Polydesmida	Polydesmidae	<i>Pseudopolydesmus</i>	<i>serratus</i>
Diplopoda	Polydesmida	Polydesmidae	<i>Scytonotus</i>	<i>granulatus</i>

Figure 3: Centipede (Chilopoda) and millipede (Diplopoda) species collected in Acadia National Park.

Species	# specimens found	# sites
<i>Underwoodia iuloides</i>	1	1
<i>Uroblaniulus canadensis</i>	2	3
<i>Scytonotus granulatus</i>	3	2
<i>Pseudopolydesmus canadensis</i>	3	3
<i>Blaniulus guttulatus</i>	8	6
<i>Virgoiulus minutus</i>	12	5
<i>Cylindroiulus caeruleocinctus</i>	18	5
<i>Ophiulus pilosus</i>	24	10
<i>Geophilus flavus</i>	1	1
<i>Strigamia chionophila</i>	1	1
<i>Lithobius microps</i>	3	3
<i>Nampabius fungiferopes</i>	3	3
<i>Bothropolys multidentatus</i>	4	3
<i>Geophilus vittatus</i>	5	3
<i>Lithobius crassipes</i>	27	14
<i>Lithobius forficatus</i>	45	15

Figure 4: The number of specimens taken for each species, and the number of sites at which each species was observed.

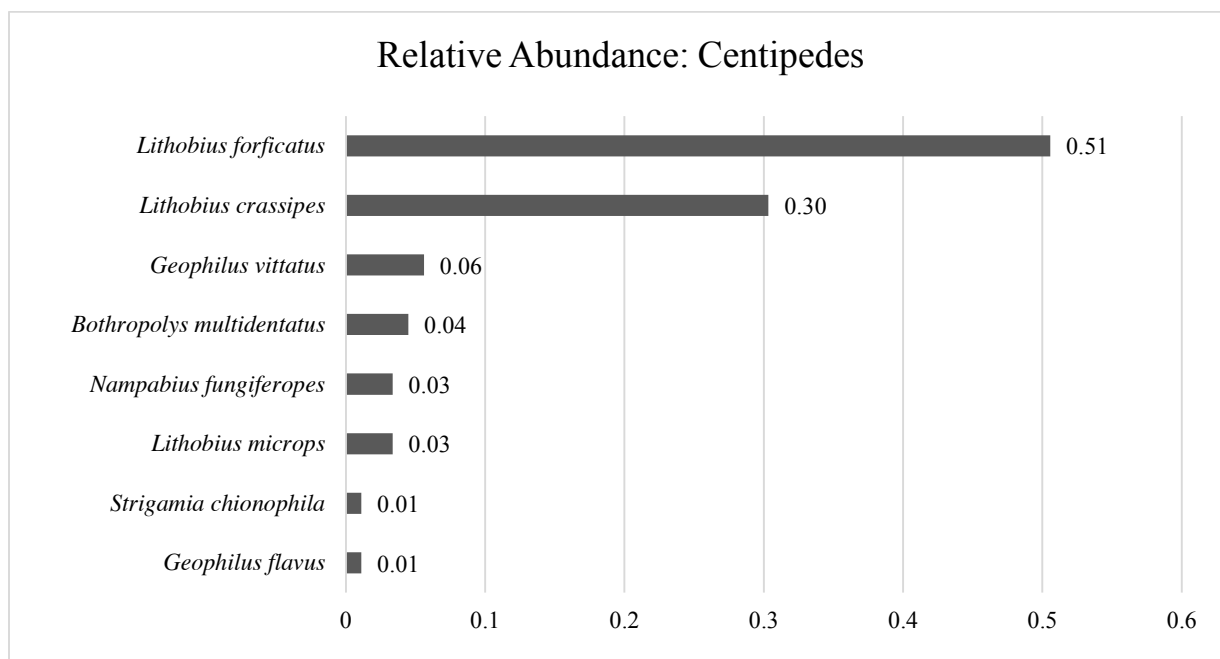


Figure 5: The relative abundance of centipede species documented in Acadia National Park.

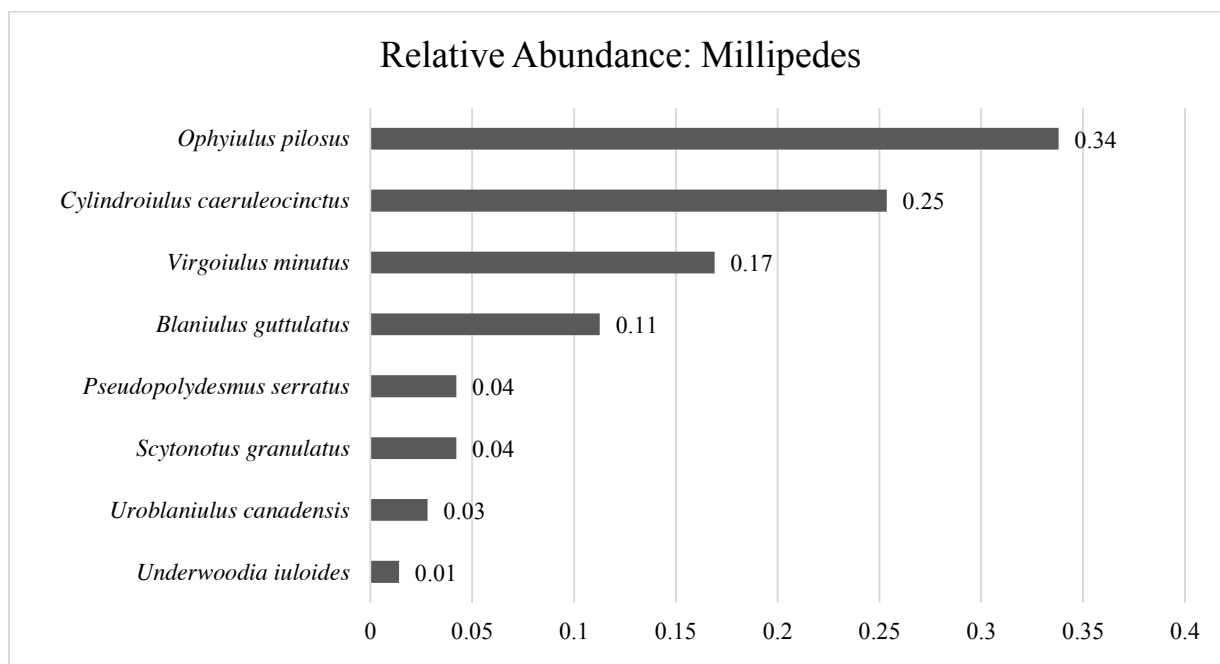


Figure 6: The relative abundance of millipede species documented in Acadia National Park.

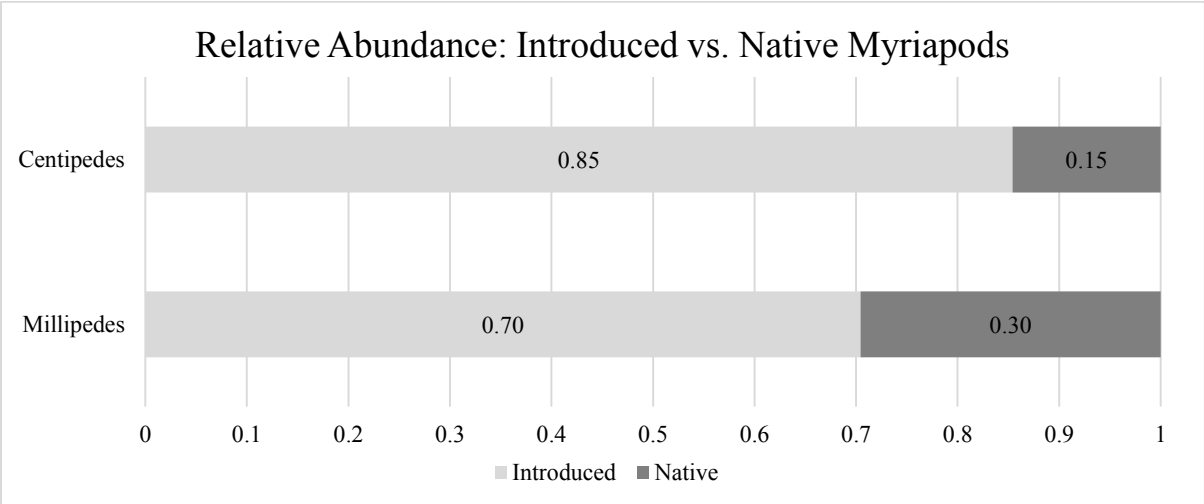


Figure 7: The combine relative abundances of introduced vs. native centipede and millipedes documented in Acadia National Park.