A Preliminary Study of Ant Diversity and of Ant Dependence on Dead Wood in Central Interior British Columbia[1]

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Abstract

Nineteen species of ants in three subfamilies and seven genera were found during a preliminary survey near Prince George, British Columbia. Ant diversity was low to moderate, with up to 7 species collected within areas of less than 1 ha in size. Wood was the preferred nest substrate for the majority of species, with 12 of the species utilizing wood in more than 69 percent of the collections. The nests of three to four species frequently shared logs or stumps.

Introduction

Ants are known to be ecologically significant invertebrates in many ecosystems (Hölldobler and Wilson 1990). They positively affect physical and chemical soil properties, plant and animal distribution, and forest health. Some species (e.g., carpenter ants [*Camponotus* spp.]) attain direct pest status because they may cause serious structural damage in buildings. Other species invade homes, and some cause indirect damage to plants by tending aphids and scale insects. Ants serve as important food for many vertebrates, including woodpeckers (Torgersen and Bull 1995) and both grizzly and black bears (Kansas and others 1989, Raine and Kansas 1990). For example, Raine and Kansas (1990) found that "The ant season was found to occur from mid-June to mid- to late July, when berries began to ripen. Ants and ant larvae were the main food items observed to be eaten by bears during this season. Bears searched for ants in old logs and under stones" (p. 299). In terms of biomass, ants often dominate in warm temperate and tropical ecosystems, but become increasingly less important with increasing latitude. For example, Francoeur (1983) found only four species at the tree line in Quebec.

Ants have been poorly studied in the sub-boreal forests of central British Columbia (BC). Few collections are available, and the species that occur there can only be deduced by puzzling together data from adjacent regions. In a recent synthesis of what is known about the ant fauna in BC (Naumann and others 1999), only one species, *Formica podzolica* Francoeur, is represented by collections near Prince George *(table 1),* where our study is conducted. Francoeur (1997) found 19 species in the Yukon, the majority of which are also present in BC. It is also possible

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that transcontinental species not listed in *table 1*, but listed by Francoeur (1997) as being present in the Yukon, occur in north-central BC. However, no records exist. The number of species in the north-central part of BC is uncertain, because Buckell (1932), from which most of the northern information in *table 1* is derived, does not specify locales. Instead, he indicates wide geographic regions, *e.g.*, the Chilcotin, which spans several biogeoclimatic zones (Meidinger and Pojar 1991). In other words, many ant species that occur in the southern parts of the Chilcotin or Cariboo regions are unlikely to occur in the Prince George area.

Table 1—*Ant species listed as occurring in north central British Columbia, or that can reasonably be expected to occur there. Data based on Naumann and others (1999) and Francoeur (1997).*

Subfamily Species	Locality/range	Reference
Myrmicinae		
Myrmica alaskensis	Cordillera	Francoeur 1983
Myrmica incompleta	Lac LaHache	RBCM[1]
Myrmica lobicornis	Arizona-Alaska	Smith 1979
Myrmica brevispinosa	Chilcotin, Cariboo, Alaska	Buckell 1932 Nielsen 1987
Aphaenogaster subterranea	Chilcotin	Buckell 1932
Solenopsis molesta	Throughout BC	Buckell 1932
Leptothorax muscorum	Arizona-Alaska	Smith 1979
Leptothorax retractus	Yukon	Francoeur 1997
Dolichoderinae		
Tapinoma sessile	Chilcotin	Buckell 1932
Formicinae		
Camponotus herculeanus	Chilcotin	Buckell 1932
Camponotus modoc	Chilcotin	Buckell 1932
Camponotus noveboracensis	Chilcotin	Buckell 1932
Camponotus vicinus	Chilcotin	Buckell 1932
Lasius alienus	70 Mile House	RBCM
Lasius flavus	Chilcotin	Buckell 1932
Lasius pallitarsis	Lac La Hache	RBCM
Formica lasioides	Chilcotin	Buckell 1932
Formica neogagates	Chilcotin	Buckell 1932
Formica fusca	Chilcotin, Cariboo	Buckell 1932
Formica neoclara	Lac LaHache	RBCM
Formica neorufibarbis	Barkerville	Buckell 1932
	Liard Hot Springs	Francoeur 1973
Formica podzolica	Prince George	UBC[2]
Formica subpolita	Chilcotin	Buckell 1932
Formica dakotensis	New Mexico-Alaska	Smith 1979
Formica obscuripes	Chilcotin	Buckell 1932
Formica oreas	Chilcotin	Buckell 1932
Formica aserva	Lac LaHache	RBCM
Polyergus breviceps	Chilcotin	Buckell 1932

[1] Royal British Columbia Museum, Victoria, B.C.
[2] Spencer Museum, University of British Columbia, Vancouver, B.C.

Ants utilize various substrates for nesting, including dead wood. Hölldobler and Wilson (1994) note that ants nest preferentially under flat rocks in cooler climates, because these have low specific heat when dry, and thus heat up faster than the surrounding soil. Similarly, the large thatch mounds of many species in the *Formica rufa* group are beneficial in cold climates (Hölldobler and Wilson 1994). Wheeler and Wheeler (1986) provide a list of ants in Nevada, indicating typical nest substrates. Of 177 species, only 15 regularly utilize dead wood substrates for nesting, and another two species nest under wood or other substrates. Most nest under rocks, or build nests directly in exposed soil, which is prevalent in the drier biomes of Nevada (Wheeler and Wheeler 1986). Of the 17 species listed as utilizing wood, 10 are listed in *table 1*, i.e., they are likely to occur in central BC. Of 82 species of ants occurring in North Dakota, Wheeler and Wheeler (1963) listed 29 that nest in wood, and an additional 9 species that nest in soil under wood, i.e., almost half of the species regularly utilize wood for their nests.

In the relatively wet sub-boreal forests, typical of the area around Prince George, exposed rocks are rare but dead wood of all sizes and ages is plentiful, both in natural stands and in stands with a history of harvesting. Thus, it is reasonable to hypothesize that dead wood constitutes an important nest substrate for many ant species. The objectives of this study are: 1) to conduct a survey of ant species in the Prince George area, 2) to determine to what extent wood is utilized as a nest substrate, and if specific substrate attributes are associated with particular species of ants, and 3) to estimate ant abundance. This paper reports on preliminary findings from data collected in 1999. No formal measurements of ant abundance were made at this preliminary stage due to limitations in time and resources. Thus, ant abundance in this paper is only reported subjectively.

Materials and Methods

The study was conducted in the area around Prince George in central BC. The area is in the sub-boreal spruce biogeoclimatic zone, which is dominated by lodgepole pine (*Pinus contorta* var. *latifolia* Dougl. ex Loud) and hybrid spruce (*Picea glauca x engelmanni* (Parry) Engelmann) forests (Meidinger and Pojar 1991).

Species Survey

Ants were collected from a variety of environments, including urban sites within the city of Prince George. Since the objective was to obtain and identify as many species as possible, we included ants from traps and collections of unrelated studies conducted from 1997 to 1999 in the same area, ants from the nest survey (see below), and stray ants that were encountered. Ants were tentatively identified to species by using the keys of Francoeur (1973), Hansen and Akre (1985), Naumann and others (1999), and Wheeler and Wheeler (1963, 1977, 1986). In cases where identification to species was not possible, ants were designated a morphospecies number. Specimens were then sent to experts for identification. Dr. André Francoeur (Directeur, Centre de données sur la biodiversité du Québec, Chicoutimi, Québec) (*Myrmica, Leptothorax*) and W. B. Preston (946 McMillan Ave., Winnipeg, Manitoba) (all other genera) identified these to species.

Nest Survey

The nest survey was restricted to lodgepole pine stands at this preliminary stage of the study, but will eventually be expanded to include all forest types. Thus, collections were done in lodgepole pine stands approximately 15–100 years old located west and southwest of Prince George. Twenty to thirty worker ants were collected from nests by hand. Reproductives were collected when available. Depending on the species, individuals were picked directly from the nest, or a portion of the nest substrate was transferred to a white plastic bucket, from which the ants could be transferred to small vials containing 70 percent ethanol. The most aggressive species were transferred again by tipping the bucket and directing the ants to run out over the edge into a small container containing soapy water, from which they could easily be collected after a few minutes. Each nest was assigned a field number, and in the majority of cases the substrate was photographed. The nest substrate was measured, and the integrity and general condition of the wood noted.

Results and Discussion

Species Survey

Species identification of ants is difficult because of a lack of reference collections and the fact that most of the available keys are either out of print and unavailable (e.g., Creighton 1950), or are restricted to the ant fauna of specific regions (Wheeler and Wheeler 1963, 1986). A manuscript version of the key in Naumann and others 1999, which is specific to ants in BC, was valuable in that distribution records for the province could be consulted *(table 1)*. However, since most collections have been done in southern BC, even these records were of limited use. Existing keys for the genera *Myrmica* and *Leptothorax* (Subfamily Myrmicinae) are unreliable, and these genera are under revision (Francoeur 1997). The names used follow Bolton (1995).

Based on our preliminary survey, we found 19 species of ants in 7 genera that occur in the area *(table 2)*. Of these *Manica invidia* Wheeler (= *mutica* Emery), *Myrmica fracticornis* Forel (= *detritinodis* Emery), *Lasius subumbratus* Viereck, *Formica hewitti* Wheeler, *F. argentea* Wheeler, and *F. obscuriventris* Mayr were not expected to occur in the area surveyed based on available information *(table 1)*. In other words, 31.6 percent of the species we found in this preliminary survey had not been collected previously in north central British Columbia. Diversity can be moderate locally, e.g., Lindgren (personal observation) has found seven species occurring in and around the yard of his personal residence (an area of about 0.25 ha) in the city of Prince George. Normally, we found four to six species in any one area, often with three or more species sharing nest resources, or at least nesting in close proximity to each other.

Nest Survey

Subfamily Myrmicinae

We found that wood was utilized by ants to a high degree for nesting. In an unrelated study in 1998, we found that small nests of *Myrmica incompleta* (Provancher), *M. alaskensis* Wheeler and *M. fracticornis* Forel were common under the bark of lodgepole pine stumps, which were only 12 months old and still had

active bark beetle infestations. Of 24 records of these three *Myrmica* species located in this study, more than 75 percent were found in wood (*table 2*). In most cases they were found in the mature forest.

Table 2—*Species list of ants collected in the Prince George area, May–August, 1999, and information of their use and characteristics of wood for nesting.*

Subfamily Species	Use of wood (pct)	Length range (cm)	Diameter range (cm)	Predominant consistency of wood	N
Myrmicinae					
Myrmica alaskensis	100	17-900	10-59	Rotten	6
Myrmica brevispinosa	25	38	10	Rotten	4
Myrmica fracticornis	83.3	3-120	4-8	Very rotten	6
Myrmica incompleta	75	15-1300	10-50	Rotten	12
Manica invidia	0	–	–	–	1
Leptothorax muscorum	91.7	10-1300	5-25	Rotten	12
Dolichoderinae					
Tapinoma sessile	50	17-700	10-59	Solid	6
Formicinae					
Camponotus herculeanus	100	50-800	10-50	Solid	10
Camponotus modoc	100	50	500	Solid	1
Lasius pallitarsis	73.3	15-350	8-53	Very rotten	15
Lasius subumbratus	0	–	–	–	1
Formica lasioides	n/a	–	–	–	1
Formica obscuripes	0[1]	–	–	–	3
Formica obscuriventris	50	300	30	Rotten	2
Formica argentea	50	20-100	16-46	Rotten	10
Formica fusca	100	33-150	20-77	Variable	3
Formica hewitti	100	36	6	Rotten	2[2]
Formica neorufibarbis	100	250	15	Heartrot	1
Formica aserva	91.7	10-900	10-77	Rotten	12

[1] Pine needle thatch mounds.
[2] Measurement missing from a log.

In 11 of the 24 records, the nests were found in logs also occupied by other ant species, and in 6 of those records these were nests of *Formica* spp. or *Camponotus herculeanus* (Linnaeus). One nest of *Myrmica brevispinosa* Wheeler was found in wood in an open area at the edge of a ca. 15-year old stand of lodgepole pine, but this species appears to be more likely to nest in the soil. We never found this species in the mature forest.

Nests of *Leptothorax muscorum* Nylander (=*canadensis* Provancher) were particularly common in wood occupied by other species. The nests of these minute ants were found in a variety of situations, but were often close to the surface of the wood, where it was dry and relatively firm. Nests were also found in very small pieces (10 x 15 cm in one case) of wood on the ground, where other species were not present. Nests of these ants were easily found by looking for fine excavating dust, which would accumulate under or in crevices on the wood containing an active nest.

Subfamily Formicinae

Camponotus herculeanus was the only species of carpenter ant we encountered in the pine forests, and it was always found in relatively large pieces of wood, i.e., stumps or down logs. This is similar to what was found for *C. modoc* Wheeler in Oregon (Torgersen and Bull 1995). Although we found evidence of *C. herculeanus* nests in standing live trees, we did not collect from these, since collecting would have required cutting the trees down. The nests were usually not evident until the wood was broken open, since carpenter ants frequently pack excavated wood in tunnels and galleries (Sanders 1964). Majors of *C. herculeanus* are quite impressive in size, but this is a very timid species. When a nest was opened, the ants would rush about trying to save their brood, but were extremely reluctant to attack. In fact, groups of workers were frequently found cowering in chambers as they tried to escape the intruders. *C. herculeanus* occurred mainly in shaded locations, e.g., in mature stands. Unlike *C. modoc*, which Torgersen and Bull (1995) found to apparently avoid lodgepole pine, *C. herculeanus* used this species frequently. *C. modoc* was found during the species survey in a Douglas-fir stand, situated on the ridge at the top of a south-facing slope, but was never encountered elsewhere.

In exposed areas, carpenter ants were replaced by *Formica aserva* Forel (=*subnuda* Emery). These aggressive ants were particularly prevalent in stumps, where their presence was usually quite evident due to the bustling activity of the ants themselves, excavating dust, and accumulations of thatching materials around the base of the nest. Disturbance of the nest brought about an immediate response of a large numbers of ants, which never hesitated to attack. Based on our preliminary observations, these ants favored low stumps and down logs with limited decay. *F. aserva* workers were at times observed carrying prey or tending aphids. It is the ants in the *Formica rufa* and *F. sanguinea* groups, along with the carpenter ants, that may contain the majority of potentially beneficial ants (Youngs and Campbell 1984), both by physically breaking down wood and as predators (although see Sanders and Pang 1992).

In one mature lodgepole pine stand within the city of Prince George, we found numerous large thatch mounds of *Formica obscuripes* Forel. The nests appeared to be polycalic, i.e., small accessory thatch mounds were in close proximity to the two large mounds from which we collected the ants. The largest dome had a base of 200 x 250 cm and was about 100 cm tall. This attractive species was also extremely aggressive when defending nests. We could not determine if nests were initiated in wood, since this would have meant destroying the mounds

Ants in the *Formica fusca* group, primarily *F. argentea, F. hewitti,* and *F. fusca* Linnaeus also commonly used wood *(table 2)*. *F. argentea* were found in soil nests in seven of ten cases. These soil mounds can be quite large, e.g., we found one nest covering more than 4 m^2 with a height of about 30 cm at its apex. Thus, this species is potentially important in terms of soil processes in the area surveyed, as are other species in the *F. fusca* group (Wiken and others 1976). In one of two cases where we dug up the nest, we found a rotten piece of wood at the center of a nest, indicating that the nest had been founded in wood. Both *F. hewitti,* and *F. fusca* nests were found in wood. These species were relatively aggressive, but in small nests workers usually tried to hide, rather than defend the nest.

Lasius pallitarsis (Provancher) was the only species in this genus encountered during the nest survey. In forest environments we found this small species in very wet, rotten wood more or less buried in the soil. Small-diameter stumps were a

particularly favored habitat. In several cases, the nest substrate was shared with *Myrmica* species. Nests were found in mature, as well as young pine forests, but we also found nests of these versatile ants under rocks and other objects in open fields. This is consistent with the information in Naumann and others 1999.

Subfamily Dolichoderinae

The only species in this genus was the ubiquitous *Tapinoma sessile* (Say). This diminutive, but aggressive, species showed no preference for nest substrate, consistent with its ability to inhabit virtually any habitat (Wheeler and Wheeler 1963).

Abundance

Although no quantitative assessment of ant abundance was made, we judged ants to be numerous locally, particularly in open areas. Thus, they may be presumed to be an important component of the arthropod fauna in the area studied. The relative abundance of most of the species encountered in our study appeared to be favored by the presence of woody debris. A quantitative assessment of the relationship between the abundance of ants and woody debris needs to be done to establish whether or not this is true.

Conclusion

Because little is known about the ecology of most of the species present in the sub-boreal forests of interior BC, it is difficult to assess in what ways ants contribute to ecosystem function. Some species of ants are highly significant as predators of forest defoliators, and as a primary food source for woodpeckers (Torgersen and Bull 1995). Further studies on the ecological roles of ants in sub-boreal forests are needed to determine their relative importance. It is clear from our preliminary study that woody debris constitutes an important habitat component for ants. For some species, the availability of woody nest substrates may limit nest founding success, and ultimately populations of ants. Additional information is required on the ecological significance of ants in sub-boreal forests, and the characteristics of wood associated with the nests of different species. Such information would ensure that beneficial species of ants could be promoted by providing suitable nest habitats in a manner similar to what is being done for cavity nesting birds. We intend to continue with the species inventory, and to conduct research on the ecological roles of ants in sub-boreal forests.

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References

Bolton, B. 1995. **A new general catalogue of the ants of the world.** Cambridge, MA: Harvard University Press; 504 p.

Buckell, E. R. 1932. **A list of the ants of British Columbia.** Proceedings of the Entomological Society of British Columbia 29: 22-25.

Creighton, W. S. 1950. **The ants of North America.** Bulletin of the Museum of Comparative Zoology 104: 1-585.

Francoeur, A.; Maldague, M. 1966. **Classification des micromilieux de nidification des Fourmis.** Le Naturaliste Canadien 93: 473-478.

Francoeur, A. 1973. **Rèvision taxonomique des espèces nèarctiques du groupe *fusca*, genre *Formica* (Formicidae, Hymenoptera).** Memoires du Société Entomologique du Québec 3: 1-316.

Francoeur, A. 1983. **The ant fauna near the tree-line in northern Québec (Formicidae, Hymenoptera).** Nordicana 47: 177-180.

Francoeur, A. 1997. **Ants of the Yukon.** In: Danks, H. V.; Downes, J. A., eds. Insects of the Yukon. Ottawa: Biological survey of Canada (terrestrial arthropods); 901-910.

Hansen, L. D.; Akre, R. D. 1985. **Biology of carpenter ants in Washington State (Hymenoptera: Formicidae: Camponotus)**. Melanderia 43: 1-61.

Hölldobler, B.; Wilson, E. O. 1990. **The ants.** Cambridge, MA: Harvard University Press; 732 p.

Hölldobler, B.; Wilson, E. O. 1994. **Journey to the ants.** Cambridge, MA: The Belknap Press of the Harvard University Press; 228 p.

Meidinger, D.; Pojar, J. 1991. **Ecosystems of British Columbia.** Victoria, BC: Ministry of Forests: Special Report Series Number 6; 330 p.

Kansas, J. L.; Achuff, P. L.; Raine, R. M. 1989. **A food habits model for grizzly bear habitat evaluation in Banff, Jasper, Kootenay and Yoho national parks.** Final Report. Beak Associates Cons. Ltd. for Canada Parks.

Naumann, K.; Preston, W. B.; Ayre, G. L. 1999. **An annotated checklist of the ants (Hymenoptera: Formicidae) of British Columbia.** Journal of the Entomological Society of British Columbia 96: 29-68.

Nielsen, M. G. 1987. **The ant fauna (Hymenoptera: Formicidae) in northern and interior Alaska. A survey along the trans-Alaskan pipeline and a few highways.** Entomological News 98: 74-88.

Raine, R. M.; Kansas, J. L. 1990. **Black bear seasonal food habits and distribution by elevation in Banff National Park, Alberta.** International Conference Bear Research and Management 8: 297-304.

Sanders, C. J. 1964. **The biology of carpenter ants in New Brunswick.** The Canadian Entomologist 96: 894-909.

Sanders, C. J.; Pang, A. 1992. **Carpenter ants as predators of spruce budworm in the boreal forests of northwestern Ontario.** The Canadian Entomologist 124: 1093-1100.

Smith, D. R. 1979. **Superfamily Formicoidea.** In: Krombein, K. V.; Hurd, Jr., P. D.; Smith, D. R.; Burks, B. D., eds. Catalog of Hymenoptera in America North of Mexico. Volume 2. Apocrita (Aculeata). Washington, DC: Smithsonian Institution Press; 1323-1467.

Torgersen, T. R.; Bull, E. L. 1995. **Down logs as habitat for forest-dwelling ants–the primary prey of pileated woodpeckers in northeastern Oregon.** Northwest Science 69: 294-303.

Wheeler, G. C.; Wheeler, J. 1963. **The ants of North Dakota.** Grand Forks, ND: University of North Dakota Press; 326 p.

Wheeler, G. C.; Wheeler, J. 1977. **North Dakota ants updated.** Reno, NV: Desert Research Institute, University of Nevada System; 27 p.

Wheeler, G. C.; Wheeler, J. 1986. **The ants of Nevada.** Los Angeles, CA: Natural History Museum of Los Angeles County; 138 p.

Wiken, E. B.; Broersma, K.; Lavkulich, L. M.; Farstad, L. 1976. **Biosynthetic alteration in a British Columbia soil by ants (*Formica fusca* Linné).** Soil Science Society of America Journal 40: 422-426.

Youngs, L. C.; Campbell, R. W. 1984. **Ants preying on pupae of the western spruce budworm, *Choristoneura occidentalis* (Lepidoptera: Tortricidae), in eastern Oregon and western Montana.** The Canadian Entomologist 116: 1665-1669.