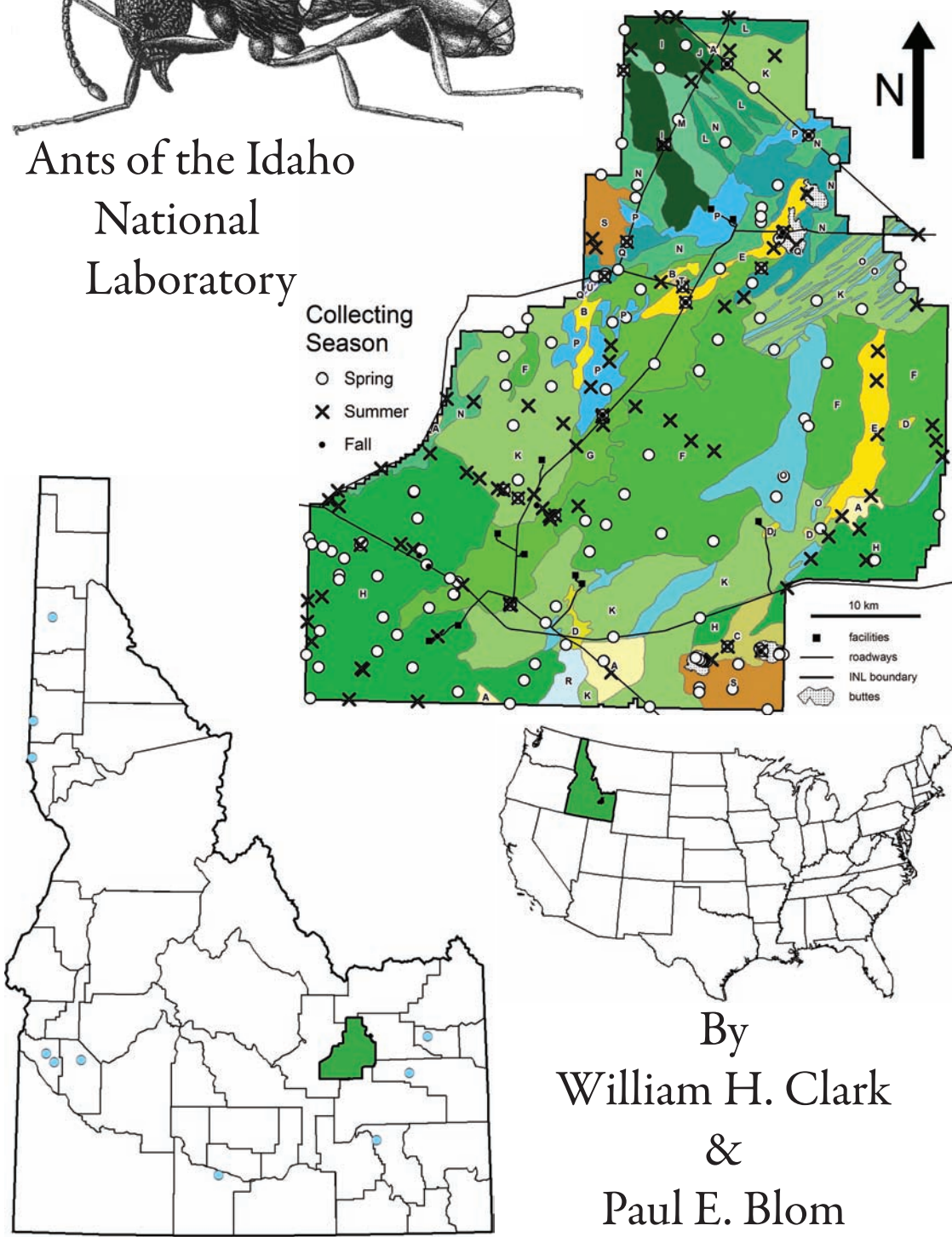




Ants of the Idaho
National
Laboratory



By
William H. Clark
&
Paul E. Blom

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Dr. David H. Kistner
Dept. of Biological Sciences
California State University
Chico, CA 95929-0515, U.S.A.
email: dkistner@csuchico.edu

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Annotated Checklist of the Ants on the Idaho National Laboratory (Hymenoptera: Formicidae)

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William H. Clark & Paul E. Blom

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Annotated Checklist of the Ants on the Idaho National Laboratory (Hymenoptera: Formicidae)

by

William H. Clark¹ & Paul E. Blom^{2,3}

ABSTRACT

Many invertebrates, including ants, tunnel and nest in soils. Because of these habits they are potentially important at the Idaho National Laboratory (INL) where they may tunnel into and disturb buried waste. Ants are very important components of the desert ecosystem based on their distribution, habitat preferences, food habits, and relative abundance. For these reasons the ant taxa present at the INL were investigated. A cursory survey of the ants at the site was published in 1971 which reported 22 species. A more thorough examination was needed.

Our research in the northeastern portion of the Snake River Plain at the INL from 1986 to 1996 produced thousands of ant collections, of which 1,115 (mostly nest series) are used in this manuscript. These collections contained 46 species in 19 genera from three subfamilies. This more than doubles the number of the species previously reported from the INL. Of the ant species found, 18 (39 %) are considered rare on the site, 12 (26 %) are present but not common, 11 (24 %) are common, and only five (11 %) are found to be abundant. All but three ant genera known for the state of Idaho can be found at the INL. Additionally, four species collected during this research are reported from Idaho for the first time: *Liometopum luctuosum*, *Formica gynocrates*, *Formica spatulata*, and *Myrmica* sp.

Formicoxenus diversipilosus was only found within the nests of the *Formica rufa* group, *Formica planipilis* and *Formica subnitens*. These represent new host records for the species. *Formicoxenus hirticornis* was found nesting with the

¹Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell, ID 83844-2339, U.S.A. email: belark@albertson.edu

²Division of Entomology, Dept. of Plant, Soil, and Entomological Sciences, University of Idaho, Moscow, ID 83844-2339, U.S.A

³Present address: USDA-ARS, 24106 N. Bunn Road, Prosser, WA 99350-9687, U.S.A. email: pblom@BioDataManagement.com.

thatch ants: *Formica planipilis*, *Formica ciliata*, *Formica laeviceps*, and *Formica subnitens*, all of which represent new host records for this species.

The goal of this investigation is to provide a more thorough survey of the INL ant fauna for both biodiversity and waste management purposes. The objectives were: 1) to produce an updated checklist of the INL ants, 2) to summarize the pertinent published information and literature on the INL ants, and 3) to present keys, distribution maps, illustrations, and ecological information on each taxon. This information should allow for the identification of ants encountered at the site and be of use to ecologists and other scientists working at the site. Much new information concerning the biology, ecology, and natural history of many of the species found on INL is presented. The literature on the ants of the INL is summarized. This work paves the way for more detailed ecological studies of the INL ant fauna.

Keywords: Annotated check list of ants, keys to ants, color pictures and distribution maps of ants, Idaho National Laboratory, Hymenoptera, Formicidae.

INTRODUCTION

Ants are a very common, widespread and well known group; possibly the most successful of all the insect groups. They occur practically everywhere in terrestrial habitats and outnumber in individuals most other terrestrial animals. The habits of ants are often very elaborate, and a great many studies have been made of their behavior. Ants all belong to the class Insecta of the order Hymenoptera (ants, bees and wasps). Bolton (1995) recognized 9,536 valid extant ant taxa. Estimates for the total number of living ant species in the world range from 15,000 to 20,000 (Hölldobler & Wilson 1990, Bolton 1994). Ants are one of the few groups of insects, that are universally recognized by their very similar body forms. But there are a few other insects that strongly resemble and mimic ants, and some of the winged forms of ants resemble wasps from which they are derived. Ants can be separated from most other insects by noting the presence of a one- or two-segmented pedicel bearing a hump or node which connects the gaster to the mesosoma, and their antennae are elbowed (geniculate) with the first segment much longer than the others.

Data on species diversity and the ecology of those species are fundamental to our understanding of both natural and disturbed ecosystems. Despite their real and potential importance, our knowledge of the diversity of soil arthropods is still very incomplete. The role ants play is pivotal as recognized by Hölldobler & Wilson (1990): “Ants are everywhere, they run much of the terrestrial world as the premier soil turners, channelers of energy, dominatrices of the insect fauna...”. Mandel & Sorenson (1982) and Gentry & Stritz (1972) showed the importance of *Pogonomyrmex* in soil formation and soil nutrient relationships. Ants may form very important high protein food sources for many animals including birds, (sage thrashers at INL, Clark & Blom 1992a) and horned lizards (Clark & Comanor 1976, Whiting *et al.* (1993). Ants also help recycle nutrients by utilizing carrion as food (Clark & Blom 1991). Our research provides additional information concerning the ants at the Idaho National Laboratory (INL) located in the upper Snake River Plain in southeastern Idaho.

The INL is a U.S. Department of Energy multi-purpose laboratory whose primary mission has been to research nuclear technologies. Historically it has been known as the National Reactor Testing Station (NRTS), Idaho National Engineering Laboratory (INEL), Idaho National Engineering and Environmental Laboratory (INEEL), and presently the Idaho National Laboratory (INL). In the process of fulfilling this mission, the INL researchers have generated radioactive and hazardous wastes (U.S. Department of Energy 1994). Much of the waste generated in the past is buried in shallow subsurface pits. Reynolds & Laundré (1988) have discussed the importance of the burrowing by small mammals on the integrity of the soil cover over buried wastes at the INL. Many invertebrates, including ants, burrow into and nest in the soil. *Pogonomyrmex salinus* has been studied at the INL because of its potential for nesting deep in the soil and its habit of carrying soil particles to the surface (Blom 1990, Blom *et al.* 1991b, Blom & Johnson 1995, Markham 1987). Little is known concerning the potential roles of ants in the restoration aspects of waste management (Blom 1990, Blom & Johnson 1995). Karr & Kimberling (2003) developed a terrestrial arthropod index of biological integrity using INL as one of two shrub-steppe sites in relation to human disturbance. They found that the number of ant taxa decreased with human disturbance while the relative abundance of ants increased.

Table 1. A chronological list of the literature concerning the ants of the Idaho National Laboratory*.

DATE	AUTHOR(S)	SUBJECT
1971	Allred & Cole	ant checklist
1977	Yensen <i>et al.</i>	checklist of Idaho ants (included INL records)
1977	Anonymous	checklist of invertebrates at the INL including ants
1987	Stafford	Ph.D. dissertation on insects and sagebrush
1987	Blom <i>et al.</i> *	ants of INL, abstract
1987	Markham*	<i>Pogonomyrmex salinus</i> impacts on radioactive waste
1988	Blom <i>et al.</i> *	<i>Pogonomyrmex salinus</i> nesting near reactor coolant ponds
1988	Clark & Blom*	ants and <i>Araeoschizus</i>
1988	Clark*	ants of INL, abstract
1989	Blom & Schoep*	<i>Pogonomyrmex salinus</i> and <i>Okanagana</i> predation
1989	Clark & Blom*	collection technique for mound-building ants
1989	Clark <i>et al.</i> *	ants of INL, abstract
1990	Blom*	<i>Pogonomyrmex salinus</i> impacts on radioactive waste
1990	Laundré	soil moisture and <i>Pogonomyrmex salinus</i>
1990	Nowak <i>et al.</i>	<i>Oryzopsis</i> (= <i>Achnatherum</i>) <i>hymenoides</i> and <i>Pogonomyrmex salinus</i>
1991	Reynolds	gravel movement by <i>Pogonomyrmex salinus</i>
1991	Blom*	waste disposal areas, invertebrate intrusion
1991	Clark & Blom*	ants utilizing carrion
1991	Jackson <i>et al.</i> *	chemotaxonomic study of <i>Myrmica</i> sp.
1991a	Blom <i>et al.</i> *	colony densities of <i>Pogonomyrmex salinus</i>
1991b	Blom <i>et al.</i> *	radionuclides in nests of <i>Pogonomyrmex salinus</i>
1992	Blom <i>et al.</i> *	insect associates of <i>Pogonomyrmex salinus</i> , abstract
1992a	Clark & Blom*	mating swarm of <i>Pogonomyrmex salinus</i> and predation
1992b	Clark & Blom*	spider predation on <i>Pogonomyrmex salinus</i>
1993	do Nascimento <i>et al.</i> *	*chemical secretions of <i>Pogonomyrmex</i> and <i>Messor</i>
1994	Blom <i>et al.</i> *	<i>Pogonomyrmex salinus</i> and soil water movement
1994	Merickel & Clark*	<i>Liometopum luctuosum</i> found on INL
1995	Blom*	waste repositories, invertebrate intrusion
1995	Blom & Johnson*	waste repositories, invertebrate intrusion, abstract
1995	Johnson & Blom*	biobarriers and <i>Pogonomyrmex salinus</i>
1995	Clark & Blom*	diversity of ant fauna
1996	Johnson & Blom*	biobarriers and <i>Pogonomyrmex salinus</i>
1996	Clark & Blom*	diversity of ant fauna

Table 1. (continued) A chronological list of the literature concerning the ants of the Idaho National Laboratory*.

DATE	AUTHOR(S)	SUBJECT
1997	Clark & Blom*	diversity of ant fauna
1997	Gaglio <i>et al.</i>	biobarriers and <i>Pogonomyrmex salinus</i>
1998	Clark & Blom*	diversity of ant fauna
1998a	Gaglio <i>et al.</i>	biobarriers and <i>Pogonomyrmex salinus</i>
1998b	Gaglio <i>et al.</i>	biobarriers and <i>Pogonomyrmex salinus</i>
1998c	Gaglio <i>et al.</i>	biobarriers and <i>Pogonomyrmex salinus</i>
1999	Clark & Blom*	diversity of ant fauna
2000	Clark & Blom*	diversity of ant fauna
2002	Clark & Blom*	diversity of ant fauna, abstract
2003	Clark & Blom*	diversity of ant fauna, abstract
2003	Karr & Kimberling	Terrestrial arthropod index of biological integrity
in press	Francoeur, André*	provides description of the newly recognized <i>Myrmica</i>

*Results of current studies by Blom and Clark

The ants of the INL were first summarized by Allred & Cole (1971) from specimens collected during ecological studies of vertebrate ectoparasites in 1966 and 1967 (Allred 1968). The site was then known as the National Reactor Testing Station. Twenty-two species of ants from three subfamilies and 11 genera were recorded by Allred & Cole (1971). Since that time there has been increased interest concerning the ants of the area including various aspects of their ecology, natural history and potential significance concerning impacts on buried waste at the site (Table 1). We have organized these papers into four categories. Ecological, biological, and natural history aspects of ants at the site are discussed in Clark & Blom (1988, 1991, 1992a, 1992b), Gaglio *et al.* (1998a), Laundré (1990), Nowak *et al.* (1990), Reynolds (1991), Jackson *et al.* (1991), Blom *et al.* (1991a, 1992, 1994), and do Nascimento *et al.* (1993). Several papers provide biodiversity information: In 1977 Yensen *et al.* provided the first checklist of the ants of the state of Idaho. They reported four subfamilies, 23 genera and 115 species which included records

from the INL (Allred & Cole 1971). Anonymous (1977) lists only 12 INL taxa. Blom *et al.* (1987), Clark (1988), Clark *et al.* (1989), Merickel & Clark (1994), and Clark & Blom (1995, 1996, 1997, 1998, 1999, 2000, 2004) add information to the species inventory. André Francoeur has recognized a new species of *Myrmica* from the INL and will soon provide a description of the taxon. Publications with implication for waste management include Markham (1987), Blom (1990, 1991), Blom *et al.* (1991b), Blom & Johnson (1995), and Johnson & Blom (1995, 1996). A single paper by Clark & Blom (1989) describes a collection methodology for mound building ants.

Several recent publications on ants or that include ants have aided in efforts to update the INL checklist: The monograph on the Colorado ants (Gregg 1963), a revision of the *fusca* group of *Formica* (Francoeur 1973), revision of the genus *Myrmecocystus* (Snelling 1976), a list of the Utah ants (Allred 1982), a review of the genus *Messor* (Bolton 1982), a review of *Formicoxenus* (Francoeur *et al.* 1985), a revision of the *minimum* group of *Monomorium* (DuBois 1986), publication of the ants of Nevada (Wheeler & Wheeler 1986), a study on the *Pogonomyrmex occidentalis* complex (Shattuck 1987), a review of *Camponotus* subgenus *Myrmentoma* (Snelling 1988), a world catalogue of ants (Bolton 1995), a checklist of North American insects (Poole & Gentili 1996), a review of the subgenus *Myrafant* (*Temnothorax*) by MacKay (2000) and a revision of the New World *Pheidole* (Wilson 2003). Hansen & Klotz (2005) have provided a monograph on the genus *Camponotus* in North America. MacKay & Vinson (1989) summarized the literature helpful in making species identifications of ants in the New World, and Ward *et al.* (1996) compiled a comprehensive bibliography of ant systematics. Bolton (2003) recently published a synopsis and classification for the ants.

Identification of many ant groups can be problematic as their systematics has not been fully explored. Of the 19 genera found at the INL, MacKay & Vinson (1989) note that revisions are needed in six of them: *Aphaenogaster*, *Camponotus* (in part, currently under revision by MacKay), *Formica* (*rufa* group), *Temnothorax* (in part, subgenus *Leptothorax*), *Myrmica* (currently under revision by A. Francoeur), and *Tapinoma*.

The goal of this investigation is to provide a more thorough survey of the INL ant fauna for both biodiversity and waste management purposes with the specific objectives:

Table 2. Paired 50 X 50 m survey plots within the Idaho National Laboratory. These key areas were selected for intensive ant inventory in an attempt to survey the major terrestrial habitats of the INL. Vegetation and soils are from Blom *et al.* (1991a).

PLOT CODE	DESCRIPTIVE LOCATION	LAT. (N) / LONG. (W)	ELEV. (M)	DOMINANT VEGETATION	SOILS
ACG	NNE Atomic City	43°29'11" / 112°50'27"	1518	<i>Agropyron cristatum</i>	Thin loess over basalt
BCD	Birch Cr., 9.7 km S. Hwys. 22 & 28	43°54'40" / 112°47'04"	1504	<i>Artemisia tridentata</i>	Alluvium
GHN	W. of checkpoint N. Lincoln Blvd.	43°46'55" / 112°45'25"	1465	<i>Achnatherum hymenoides</i> , <i>Chrysothamnus viscidiflorus</i> , <i>Opuntia polyacantha</i>	Sandy loam
JUN	On alluvial fans from Lemhi Range	43°49'50" / 112°49'31"	1481	<i>Juniperus osteosperma</i>	Sandy loam over alluvium
M17*	E. MP 17 on Lincoln Blvd.	43°43'51" / 112°47'27"	1462	<i>Artemisia tridentata</i>	Sandy loam
NRF	S. NRF on Rd. T-3	43°37'29.5" / 112°57'26"	1487	<i>Elymus cinereus</i>	Thin loess over basalt
PLG	Power line, nr MP 13, Lincoln Blvd.	43°41'18" / 112°50'53"	1469	<i>Artemisia tridentata</i>	Deep, clay loam
RWM	Ca. 0.8 km east of RWMC	43°30'13" / 113°01'34"	1527	<i>Artemisia tridentata</i>	Loess over basalt
TBG	Between East and Middle Buttes	43°30'02" / 112°42'06"	1622	<i>Artemisia tripartita</i>	Thin loess over basalt
WIN	NE Hwy. 28	43°55'16" / 112°37'18"	1461	<i>Krascheninnikovia lanata</i>	Sandy loam over clay

*M17 did not have the paired survey plots but was used for other purposes.

- 1) to produce an updated checklist of the INL ants with supporting voucher specimens, as the 1971 list of species is no longer useful,
- 2) to summarize the pertinent published information and literature on the INL ants, and
- 3) to present keys, distribution maps, illustrations, and ecological information about each taxon. This information should allow for the identification of

ants encountered at the site, and provide information to investigators working on the site and in the surrounding region.

MATERIALS AND METHODS

Study Site

The study site is located at the INL on 2300 km² of the northeastern portion of the Snake River Plain in Bingham, Bonneville, Butte, Clark, and Jefferson Counties, of southeastern Idaho (Map 1). The INL is a National Environmental Research Park. The vegetation is diverse with 409 species of vascular plants in 10 vegetation/cover classes (juniper woodlands, grasslands, sagebrush steppe, sagebrush steppe off lava, low shrubs on lava, sagebrush-rabbitbrush, sagebrush-winterfat, salt desert shrub, wetlands and playas, bare ground and disturbed areas) (Anderson *et al.* 1996). We sampled ants from all of these zones.

For intensive collection and study, we established 10 survey plots (Table 2) for use during this project. These sites were selected to represent major terrestrial habitats on the INL and gave us areas to repeat our collection methods across diel, seasonal and yearly time frames (Table 2, Blom *et al.* 1991a).

Field Methods

Field methods included a general reconnaissance for ants in all available habitats, epigeal habitats being the most common. Collections were made manually (usually with hand or mouth operated aspirators) from nests with visible external entrances or found under rocks, wood, or debris. Nests with large above ground mounds were often sampled by inserting a collecting tube into them forming a small pitfall trap (Clark & Blom 1989). Mound nests were also sieved for inquiline species. Arboreal habitats included the trunks and stems of shrubs and trees. These were cut or split open for collection of species nesting within them. Aerial collections of winged reproductives were collected with nets, or a suction trap (Halbert *et al.* 1990) which extended over six meters above the ground surface at the Experimental Field Station (EFS). The suction trap ran from May through September each year and was collected on a weekly basis.

At nine selected sites (Table 2, excluding M17) we conducted more intense monitoring for ant species, establishing paired 50 X 50 m survey plots.

Ants of the INL

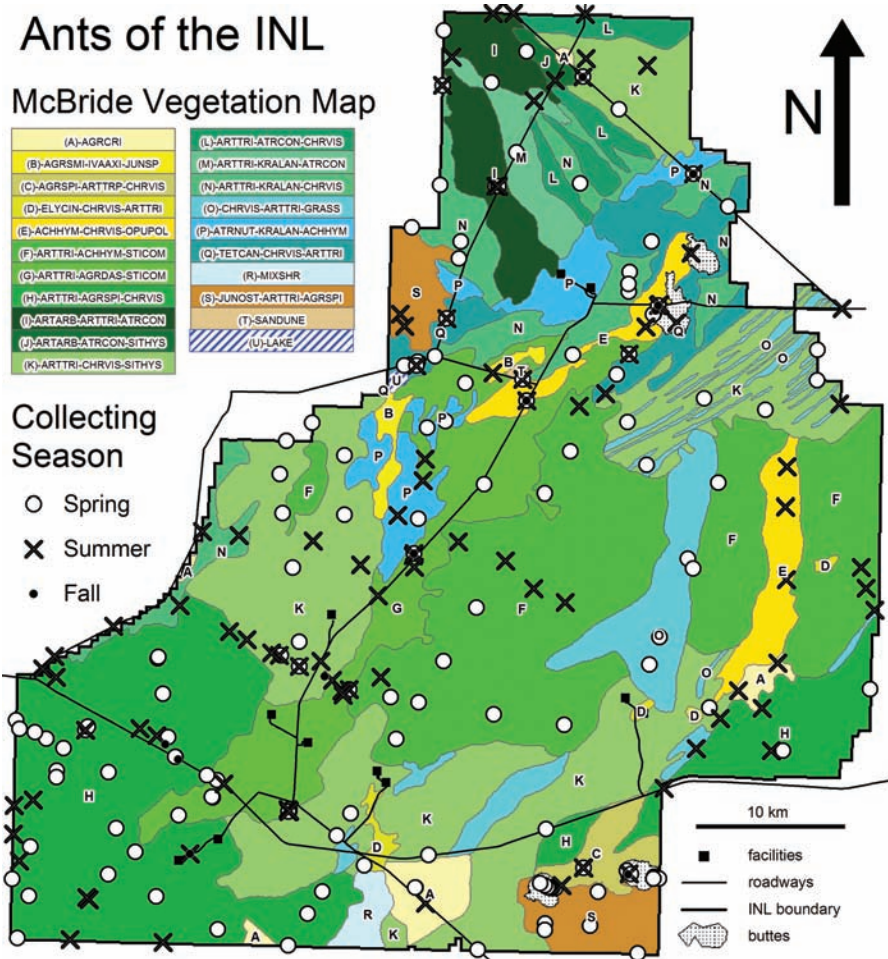
McBride Vegetation Map

(A)-AGRCRI
(B)-AGRSMI-VAAXI-JUNSP
(C)-AGRSPI-ARTTRP-CHRVIS
(D)-ELYCIN-CHRVIS-ARTTRI
(E)-ACHHYM-CHRVIS-OPUPOL
(F)-ARTTRI-ACHHYM-SITCOM
(G)-ARTTRI-AGRDAS-SITCOM
(H)-ARTTRI-AGRSPI-CHRVIS
(I)-ARTARB-ARTTRI-ATRCON
(J)-ARTARB-ATRCON-SITHYS
(K)-ARTTRI-CHRVIS-SITHYS

(L)-ARTTRI-ATRCON-CHRVIS
(M)-ARTTRI-KRALAN-ATRCON
(N)-ARTTRI-KRALAN-CHRVIS
(O)-CHRVIS-ARTTRI-GRASS
(P)-ATRNU-ATRCON-ACHHYM
(Q)-TETCAN-CHRVIS-ARTTRI
(R)-MIXSHR
(S)-JUNOST-ARTTRI-AGRSPI
(T)-SANDUNE
(U)-LAKE

Collecting Season

- Spring
- ✕ Summer
- Fall



Map 1. Map of the INL showing the location of all ant collection localities reported in this study. These collecting locations are overlaid on the McBride *et al.* (1978) vegetation map classified seasonally: Spring = March-June, Summer = July-August, and Fall = September-October. ACHHYM = *Achnatherum hymenoides*, AGRCRI = *Agropyron cristatum* (Seeded), AGRDAS = *Agropyron dasystachyum*, AGRSMI = *Agropyron smithii*, AGRSPI = *Agropyron spicatum*, ARTARB = *Artemisia arbuscula*, ARTTRI = *Artemisia tridentata*, ARTTRP = *Artemisia tripartita*, ATRCON = *Atriplex confertifolia*, ATRNUT = *Atriplex nuttallii*, CHRVIS = *Chrysothamnus viscidiflorus*, ELYCIN = *Elymus cinereus*, IVAAXI = *Iva axillaris*, JUNOST = *Juniperus osteosperma*, JUNSP = *Juniperus* sp., KRALAN = *Krascheninnikovia lanata*, MIXSHR = Mixed shrubs, OPUPOL = *Opuntia polyacantha*, SITHYS = *SSitanion hystris*, SITCOM = *Stipa comata*, TETCAN = *Tetradymia canescens*.

Table 3. Checklist of ants of the Idaho National Laboratory. Relative abundance is given in Table 7. A notation is made if the species was reported by Allred and Cole (1971).

TAXON	RELATIVE ABUNDANCE*	Allred & Cole 1971
DOLICHODERINAE		
<i>Forelius pruinosus</i> (Roger 1863)	present	
<i>Liometopum luctuosum</i> Wheeler 1905	rare	
<i>Tapinoma sessile</i> (Say 1836)	abundant	X
FORMICINAE		
<i>Camponotus hyatti</i> Emery 1893	common	
<i>Camponotus vicinus</i> Mayr 1870	abundant	X
<i>Formica adamsi</i> Wheeler 1909	rare	X
<i>Formica argentea</i> Wheeler 1912	common	
<i>Formica ciliata</i> Mayr 1886	rare	
<i>Formica densiventris</i> Viereck 1903	rare	
<i>Formica gynocrates</i> Snelling and Buren 1985	rare	
<i>Formica laeviceps</i> Creighton 1940	rare	
<i>Formica lasioides</i> Emery 1893	rare	X
<i>Formica limata</i> Wheeler 1913	rare	
<i>Formica manni</i> Wheeler 1913	common	X
<i>Formica neoclara</i> Emery 1893	rare	
<i>Formica neogagates</i> Emery 1893	rare	X
<i>Formica obscuripes</i> Forel 1886	present	X
<i>Formica obtusopilosa</i> Emery 1893	common	X
<i>Formica oreas</i> Wheeler 1903	present	X
<i>Formica planipilis</i> Creighton 1940	common	
<i>Formica querquetulana</i> Kennedy & Dennis 1937	rare	
<i>Formica ravidata</i> Creighton 1940	rare	X
<i>Formica spatulata</i> Buren 1944	rare	
<i>Formica subnitens</i> Creighton 1940	present	
<i>Formica subpolita</i> Mayr 1886	abundant	X
<i>Formica vinculans</i> Wheeler 1913	common	
<i>Lasius crypticus</i> Wilson 1955	abundant	X
<i>Lasius latipes</i> (Walsh 1862)	present	
<i>Lasius neoniger</i> Emery 1893	rare	
<i>Myrmecocystus pyramicus</i> Smith 1951	present	
<i>Myrmecocystus testaceus</i> Emery 1893	present	
<i>Polyergus breviceps</i> Emery 1893	present	
MYRMICINAE		
<i>Aphaenogaster uinta</i> Wheeler 1917	present	

Table 3. (continued) Checklist of ants of the Idaho National Laboratory. Relative abundance is given (Table 7). A notation is made if the species was reported by Allred and Cole (1971).

TAXON	RELATIVE ABUNDANCE*	Allred & Cole 1971
<i>Formicoxenus diversipilosus</i> (Smith 1939)	rare	
<i>Formicoxenus hirticornis</i> (Emery 1895)	present	
<i>Manica invidia</i> Bolton 1995	rare	X
<i>Messor lobognathus</i> Andrews 1916	common	X
<i>Monomorium minimum</i> (Buckley 1867)	common	X
<i>Myrmica</i> sp.	common	X
<i>Pheidole pilifera</i> (Roger 1863)	present	
<i>Pogonomyrmex salinus</i> Olsen 1934	abundant	X
<i>Solenopsis molesta</i> (Say 1836)	common	
<i>Stenamma smithi</i> Cole 1966	rare	
<i>Temnothorax nevadensis</i> Wheeler 1903	common	
<i>Temnothorax rugatulus</i> Emery 1895	present	
<i>Temnothorax tricarinatus</i> Emery 1895	rare	

TOTALS: 3 subfamilies, 19 genera, 46 species

*Relative Abundance defined in Table 7

At each site we used 30 ethylene glycol pitfall traps and 30 bait cards (total 270 each method) and 20 cover boards (total 180) over several seasons during three years. The cover boards ($\sim 13.3 \times 13.3 \times 3.8$ cm, Douglas fir) were placed on the ground at these sites to provide nesting opportunities for ants. They were checked periodically for the presence of ant nests. The use of these nine sites allowed us to monitor seasonal as well as annual changes in ant phenology and abundance. These quantitative data will be reported elsewhere but additional INL ant records resulting from the use of these methods are included here (Table 3).

Each collection was placed in a glass vial with 70 % ethyl alcohol and given a label with a unique field collection-event number and other basic collection information (locality, date, and collector). Locality, date, time, collector, taxon, field collection number, microhabitat, vegetation, behavior, arthropod or other animal associates, and any other notes were recorded in bound field notebooks with permanent ink.

At each locality we made an attempt to collect all the apparent species. In this way we did not bias our frequency data by ignoring an ant species collected at nearby localities. Thus, our abundance classification for each species should be a reasonable representation of the INL fauna.

Laboratory Methods

In the laboratory, the field samples were sorted from soil and debris with the aid of a dissecting microscope. A representative subsample (usually three or four pins) from each nest series was pointed or pinned following Wheeler & Wheeler (1963) worker protocol of three to a pin. At times a fourth ant was added to a pin if both sexes were available in addition to the workers or in the case of the *fusca* group of *Formica* (Francoeur 1973, Wheeler & Wheeler 1977). Some taxa, *Pogonomyrmex* and *Lasius*, require the mandibles to be spread for positive identification. The vial and pins were then labeled using archival grade paper with complete collection data. Ant brood, certain groups ofinquilines, and most sexuals were retained in alcohol.

The ants were identified using standard keys (Cole 1968, DuBois 1986, Francoeur 1973, Francoeur *et al.* 1985, Hansen & Klotz 2005, Shattuck 1987, Snelling 1976, 1988, Snelling & Buren 1985, Taber 1998, Wheeler & Wheeler 1963, 1986, and Wing 1968) and through comparison with reference collection specimens. Many of the collections were then sent to appropriate specialists for either verification or identification of problematic specimens (see Acknowledgments).

Information from field notes was entered into a museum database, along with collection event data, determinations, and specimen locations. Voucher specimens of all collections are housed in the Orma J. Smith Museum of Natural History, Albertson College of Idaho, Caldwell (ALBRCIDA). Duplicate vouchers for many collections are housed in the William F. Barr Entomology Collection, University of Idaho, Moscow (WFBM). Collections representing many *Formica* and *Myrmica* are deposited with the Université du Québec à Chicoutimi (CAFQ). Other miscellaneous specimens were requested by Stefan Cover, Mark DuBois, William P. MacKay and Roy Snelling for study and these will remain with their collections.

Each field collection locality (Map 1) was plotted on U.S. Geological Survey 1:24000 topographic maps (North American Datum 1927). Latitude and

Table 4. Status of the 22 ant taxa of the Idaho National Laboratory reported by Allred & Cole (1971).

PRESENT TAXON	STATUS	STUDY
DOLICHODERINAE		
<i>Tapinoma sessile</i>	no change	X
FORMICINAE		
<i>Camponotus vicinus</i>	no change	X
<i>Formica fusca</i>	not found by us & no voucher specimen found	
<i>Formica haemorrhoidalis</i>	changed to <i>Formica ravidus</i> (Bolton 1995)	X
<i>Formica hewitti</i>	not found by us & no voucher specimen found	
<i>Formica lasioides</i>	no change	X
<i>Formica manni</i>	no change	X
<i>Formica montana</i>	not found by us & no voucher specimen found	
<i>Formica neogagates</i>	no change	X
<i>Formica obscuripes</i>	no change	X
<i>Formica obtusopilosa</i>	no change	X
<i>Formica oreas</i>	no change	X
<i>Formica subpolita</i>	no change	X
<i>Formica whymperei</i>	no voucher specimen found	X
	changed to <i>Formica adamsi</i> (Bolton 1995)	
<i>Lasius crypticus</i>	no change	X
<i>Myrmecocystus mojave</i>	synonomized with <i>M. testaceus</i> (Snelling 1976)	X
MYRMICINAE		
<i>Leptothorax andrei</i>	not found by us & no voucher specimen found	
	changed to <i>Temnothorax andrei</i> (Bolton 2003)	
<i>Manica mutica</i>	changed to <i>Manica invidia</i> (Bolton 1995)	X
<i>Monomorium minimum</i>	no change	X
<i>Myrmica lobicornis</i>	all are <i>Myrmica</i> sp.	X
<i>Pogonomyrmex owyheei</i>	changed to <i>Pogonomyrmex salinus</i> (Shattuck 1987)	X
<i>Veromessor lobognathus</i>	changed to <i>Messor</i> (Bolton 1982)	X

*The status of many of Allred and Cole's collections and taxa are in question as we have been unable to locate voucher specimens from their study. A status of "no change" means we have collected the species at INL, agreeing with the species name reported by Allred & Cole even though we could not verify their determination.

longitude estimates for each collection were made from these quadrangles and used to generate the species distribution maps.

Photographs were taken of each species using a Canon EOS 20D with remote switch RS-80N3, and a Canon EF 100mm Macro with Canon LIFE

SIZE converter and Canon EF25 II extension tube. Illumination was with a Canon Macro Twin Lite MT-24EX.

RESULTS AND DISCUSSION

We collected ants from much of the INL (Map 1) over a period of 11 years. Results presented here are based on 1,115 collections (mostly nest series) which included 46 ant species in three subfamilies and 19 genera (Table 3).

Four of these ant species were new to the list of Idaho taxa (Yensen *et al.* 1977), including a species of *Myrmica* under description by André Francoeur (Jackson *et al.* 1991). *Liometopum luctuosum* was recently reported from the Pacific Northwest for the first time (Merickel & Clark 1994) and it was first discovered at the INL from the top of Middle Butte (Map 3). It is considered rare at the site. *Formica gynecrates* has not been previously reported from Idaho nor from the western United States (Snelling & Buren 1985). It is considered rare at the site (Map 14) and is an especially interesting species because of its slave-making behavior. *Formica spatulata* is also rare at the site (Map 8).

More than half of the ants reported here are new records for the site, they include: Dolichoderinae - *Forelius pruinosus*, *Liometopum luctuosum*; Formicinae - *Formica argentea*, *Formica ciliata*, *Formica densiventris*, *Formica gynecrates*, *Formica laeviceps*, *Formica limata*, *Formica neoclara*, *Formica planipilis*, *Formica querquetulana*, *Formica spatulata*, *Formica subnitens*, *Formica vinculans*, *Lasius latipes*, *Lasius neoniger*, *Myrmecocystus pyramicus*, *Myrmecocystus testaceus*, and *Polyergus breviceps*; Myrmicinae - *Aphaenogaster uinta*, *Formicoxenus diversipilosus*, *Formicoxenus hirticornis*, *Pheidole pilifera*, *Solenopsis molesta*, *Stenamma smithi*, *Temnothorax nevadensis*, *Temnothorax rugatulus*, *Temnothorax tricarinatus*. A species was reported for Idaho as "*Camponotus* sp. (near *hyatti* Emery)" (Yensen *et al.* 1977, page 184). The current work at the INL has documented several collections of *Camponotus hyatti* from the site where it is considered common (Map 5).

The Allred & Cole (1971) checklist is no longer useful, especially to the non-myrmecologist conducting ecological research at the site. They reported less than half the number of species that we found. Four of those species we have been unable to verify (Table 4) both because no voucher specimens were found from their work, nor were they discovered in our extensive collecting. Of the remaining 18, six have undergone name changes: *Formica*

haemorrhoidalis to *Formica ravid*a (Bolton 1995), *Formica whymp*eri to *Formica adams*i (Bolton 1995), *Manica mutica* to *Manica invid*ia (Bolton 1995), *Myrmecocystus mojave* was synonymized under *Myrmecocystus testaceus* (Snelling 1976), *Pogonomyrmex owyhee*i to *Pogonomyrmex salinus* (Shattuck 1987), and *Veromessor lobognathus* to *Messor lobognathus* (Bolton 1982). One additional species, identified as *Myrmica lobicornis* by Allred & Cole (1971), has been recognized as an undescribed taxon and now being described by André Francoeur (Jackson *et al.* 1991). This means that only 18 (39 %) of the taxa reported by Allred & Cole (1971) and 11 (24 %) of the ant names they used have been verified as occurring at the INL.

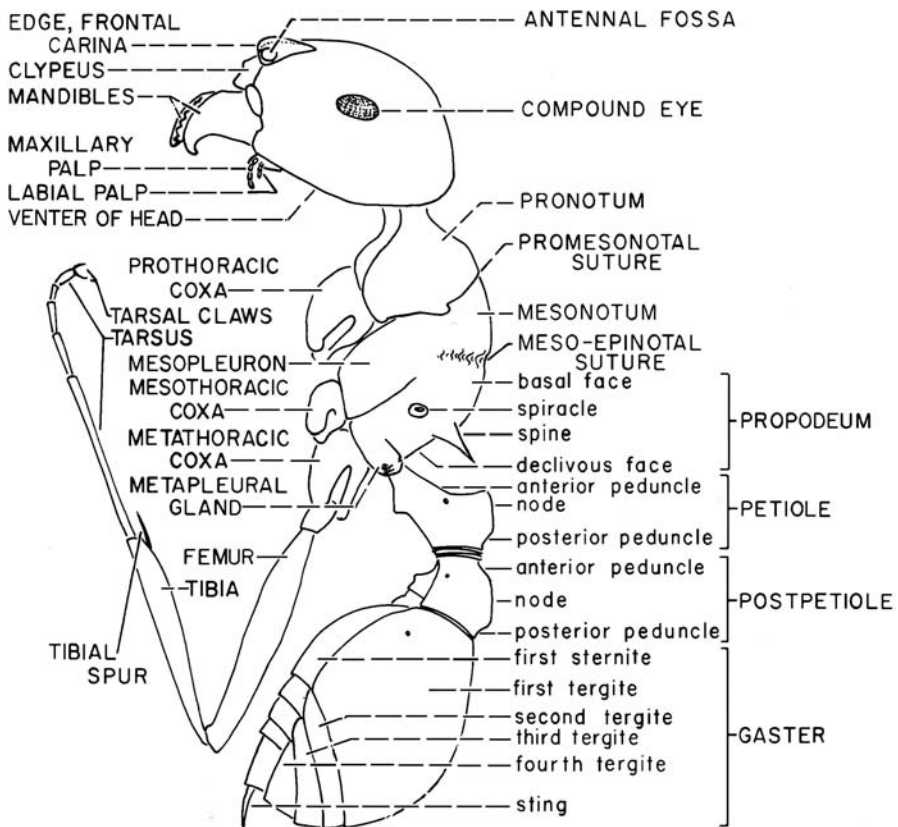


Fig. 1A. Diagram of ant external morphology for use with taxonomic keys, lateral view (modified with permission from Wheeler & Wheeler 1986).

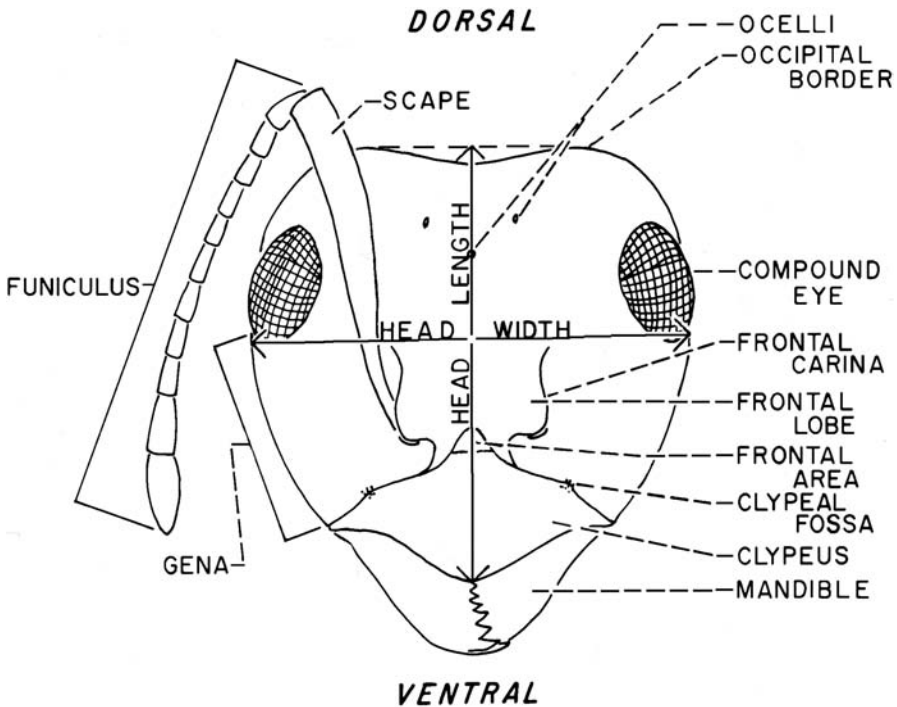


Fig. 1B. Diagram of ant external morphology for use with taxonomic keys, frontal view of the head (modified with permission from Wheeler & Wheeler 1986).

Almost all of the ant species are edaphic and while many are not as conspicuous as the harvester ant, they may still be important to waste management (Johnson & Blom 1996). For example, ants of the genus *Formica* could be important because they are so common at the INL and some of the thatching species have very large nests which probably include tunneling deep into the soil profile.

Thus far, up to 40 % of the ant species known for Idaho (Yensen *et al.* 1977) are found on the INL. This relatively large percentage may be a reflection of the amount of effort put into collecting ants at the INL, and it also points to both the importance of ants at the site and the importance of this area in Idaho's biodiversity. We expected to find *Crematogaster* and *Brachymyrmex* at the INL, but were unable to do so. Both were reported from Idaho by Yensen *et al.* (1977), and we have collected *Crematogaster* elsewhere on the Snake

River Plain. *Brachymyrmex* is a minute, cryptic, uncommon species that we expected to find in the juniper woodlands areas.

Identification

First, one must determine if the insect at hand is an ant. Most people know what an “ant” looks like, but there are a variety of arthropods that closely resemble ants, including termites. The easiest and most important key characters to look for are: 1) a pedicel of one or two segments often bearing a hump or node and 2) the antennae are usually elbowed (geniculate) with the first (nearest the head) segment much longer than the others. The workers are wingless, and the males and females are winged. The queens and other females may have removed their wings, but will have “wing scars” where the wings used to be. The males and females are usually encountered only briefly during the year. Klotz *et al.* (1999) provide a simple way to distinguish alate termites and ants: In contrast, termites have straight antennae, a thick waist and wings of equal size (the ant hind wing, as characteristic of the order Hymenoptera, is smaller than the forewing).

The following presents dichotomous keys for identification to the subfamilies, genera, and species (and for *Formica*, species groups) of all ant taxa (Hymenoptera, Formicidae) known for the INL. Bolton (1994) and Hölldobler & Wilson (1990) provide illustrations of the ant genera of the world and may be helpful companions to these keys. A line drawing of an ant (Fig. 1) has also been provided to assist with interpretation of morphological characters. These dichotomous keys are taken, and often modified, from several standard sources including Wheeler & Wheeler (1986) and are for the most commonly encountered caste, the workers, unless otherwise noted. Additional information to assist with identification of the INL ants can be found in the species accounts, photographs and distribution maps following these keys.

KEY TO THE SUBFAMILIES OF FORMICIDAE FOUND AT THE INL

- 1a. Pedicel of 2 somites; sting usually functional Myrmicinae
- 1b. Pedicel of 1 somite; sting vestigial or absent 2a.

- 2a. Opening at posterior end of gaster (acidopore) circular, and usually surrounded by a fringe of hairs Formicinae
 2b. Opening at posterior end of gaster (cloacal orifice) slit-like, not surrounded by a fringe of hairs Dolichoderinae

KEY TO THE GENERA AND SPECIES OF THE SUBFAMILY OF DOLICHODERINAE

- 1a. Moderately polymorphic (2.5 - 6 mm); ocelli usually present (at least in larger workers); a distinct gap between lateral margin of clypeus and mandible *Liometopum luctuosum*
 1b. Monomorphic; ocelli usually absent; without a distinct gap between clypeus and mandible 2
 2a. Petiolar node very small and indistinct, strongly inclined forward and adnate to anterior peduncle; without hairs on dorsum of mesosoma or head; (1.25 - 3.25 mm) *Tapinoma sessile*
 2b. Petiolar node small but distinct; a few coarse hairs on head and mesosoma; (1.5 - 2.5 mm) *Forelius pruinus*

KEY TO THE GENERA AND SPECIES OF THE SUBFAMILY OF FORMICINAE

- 1a. Profile of thoracic dorsum evenly convex, propodeum not depressed below level of mesonotum; metanotal suture not impressed or very slightly impressed; antenna inserted well above dorsal edge of clypeus, polymorphic *Camponotus*
 1b. Profile of thoracic dorsum with propodeum distinctly depressed below level of mesonotum; metanotal suture always distinct, often deep, antenna inserted at or near dorsal border of clypeus 2
 2a. Mandible sickle-shaped, its medial border with very minute teeth *Polyergus breviceps*
 2b. Mandible triangular, its inner border distinctly dentate 3
 3a. Maxillary palp very short and consisting of 3 segments *Lasius latipes*
 3b. Maxillary palp longer and consisting of 6 segments 4
 4a. Maxillary palp longer than head, 3rd and 4th segments very long, each as long or longer than the 2 terminal segments combined; psammophore present *Myrmecocystus*

- 4b. Maxillary palp not longer than head, 3rd and 4th segments not unusually long; psammophore absent 5
- 5a. Larger ants (2.5 - 9 mm); propodeal spiracle a narrow slit; frontal carina prominent, its lateral margin slightly raised; ocelli conspicuous *Formica*
- 5b. Smaller ants (2 - 4.5 mm); propodeal spiracle round; frontal carina feebly developed, its lateral margin rounded or nearly flat; ocelli small or absent *Lasius*

KEY TO THE SPECIES OF THE GENUS *CAMPONOTUS*

- 1a. Small, length of major 8 mm or less, ventral border of clypeus with a narrow median notch, dark, mostly shining, usually arboreal *hyatti*
- 1b. Large, length of major more than 8 mm, bicolor, mostly dull *vicinus*

KEY TO THE SPECIES GROUPS OF THE GENUS *FORMICA*, SUBGENUS *FORMICA* (INCLUDING FEMALES)

- 1a. Ventral border of clypeus notched in middle; pubescence dense, at least on gaster; body dull to feebly shining *sanguinea* group
- 1b. Ventral border of clypeus not notched or, if so, pubescence is very sparse and body shining 2
- 2a. Slender; surface shining; propodeum rounded in profile (base and declivity not differentiated) *neogagates* group
- 2b. Generally robust; surface usually dull; propodeum usually angulate in profile (base and declivity clearly differentiated) 3
- 3a. Concolorous black or brown or bicolored; if bicolored, mesosomal lighter than gaster and upper portion of head *fusca* group
- 3b. Bicolored: head and mesosoma reddish or yellowish red and notably lighter than gaster or, if infuscated, infuscation not completely masking reddish ground color in larger workers; gaster brown or black; surface mostly dull; polymorphic 4
- 4a. Queen larger than the largest workers, measuring 6 - 11 mm; erect hairs on the pronotum, when present, not notably clavate or spatulate *rufa* group

- 4b. Queen not larger and sometimes even smaller than the large workers, measuring 4-6 mm; erect hairs on the pronotum of the worker, when present, often clavate or spatulate *microgyna* group

KEY TO THE SPECIES OF THE GENUS *FORMICA*,
SUBGENUS *FORMICA*,
SPECIES GROUP *SANGUINEA*:
FROM SNELLING AND BUREN (1985)

- 1a. Erect hairs of thoracic and gastric dorsa short (0.06 - 0.14 mm), stiff and bristle-like, usually more or less flattened and blunt-tipped, or abruptly tapering *obtusopilosa*
1b. Erect hairs longer, (0.10 - 0.25 mm), evenly tapering to tip ... *gynocrates*

KEY TO THE SPECIES OF THE GENUS *FORMICA*,
SUBGENUS *FORMICA*,
SPECIES GROUP *NEOGAGATES*
FROM WHEELER & WHEELER (1986)

- 1a. Pronotum without erect hairs (rarely 2 or 3) *limata*
1b. Pronotum with 10 or more erect hairs 2
2a. Scape bearing a number of short delicate erect whitish hairs *lasioides*
2b. Scape without erect hairs 3
3a. Gaster black, remainder yellowish red in a majority of the nest series; largest worker 4.5 mm *manni*
3b. Gaster black or deep brown, remainder distinctly brownish 4
4a. Erect hairs on body very delicate, 5.5 mm *neogagates*
4b. Erect hairs on body coarse, 2.5 - 4.5 mm *vinculans*

KEY TO THE SPECIES OF THE GENUS *FORMICA*,
SUBGENUS *FORMICA*,
SPECIES GROUP *MICROGYNA*

- 1a. Occipital border evenly convex in all sizes of workers; erect hairs on mesosoma about 0.06 mm long and spatulate *querquetulana*
1b. Occipital border flat or slightly concave for at least 0.5 width of head in largest workers and often in smaller workers; thoracic hairs various 2

- 2a. The majority of the erect hairs on the dorsum of head and mesosoma notably spatulate and rather short *spatulata*
 2b. Erect hairs otherwise 3
 3a. Erect hairs always present on crest of petiole; sides of gaster feebly shining *densiventris*
 3b. Erect hairs never present on crest of petiole; sides of gaster strongly shining *adamsi*

KEY TO THE SPECIES OF THE GENUS *FORMICA*,
 SUBGENUS *FORMICA*,
 SPECIES GROUP *RUFÆ*
 FROM WHEELER & WHEELER (1986)

- 1a. Scapes with erect or suberect hairs on all surfaces *oreas*
 1b. Scapes with very few or no erect hairs 2
 2a. Clypeal fossa deep and pit-like; edge of clypeus ventral to pit sweeping upward to median lobe; median lobe box-like (i.e., sides descending abruptly to fossae and making angles with its anterior face) *laeviceps*
 2b. Clypeal fossa shallow and scarcely pit-like; edge of clypeus ventral to pit broadly united to base of lobe and not forming a distinct curve with it; median lobe not box-like (i.e., sides descending to fossae through even curves which begin at carina) 3
 3a. Erect hairs on middle and hind tibiae usually abundant on all surfaces, but at least there are more than 2 erect hairs in addition to those on flexor surfaces 4
 3b. Erect hairs on middle and hind tibiae, when present, confined to double row on flexor surface, rarely 1 or 2 erect hairs elsewhere 5
 4a. Head of largest worker as broad as or broader than long; erect hairs on mesosoma unequal in length; head hairs only a little less abundant and not much longer than those on mesosoma *obscuripes*
 4b. Head of largest worker longer than broad; erect hairs on mesosoma short and of about equal length; head hairs notably longer and sparser than those on mesosoma *planipilis*
 5a. Gaster densely clothed with short erect hairs which (in profile) are so close together that they give appearance of a loose plush-like vestiture
 *ciliata*

Table 5. Classification of the *Formica* species in the Idaho National Laboratory arranged by species groupings.

GROUP	TAXON
<i>fusca</i>	<i>Formica argentea</i> Wheeler 1912 <i>Formica neoclara</i> Emery 1893 <i>Formica subpolita</i> Mayr 1886
<i>microgyna</i>	<i>Formica adamsi</i> Wheeler 1909 <i>Formica densiventris</i> Viereck 1903 <i>Formica querquetulana</i> Kennedy & Dennis 1937 <i>Formica spatulata</i> Buren 1944
<i>neogagates</i>	<i>Formica lasioides</i> Emery 1893 <i>Formica limata</i> Wheeler 1913 <i>Formica manni</i> Wheeler 1913 <i>Formica neogagates</i> Emery 1893 <i>Formica vinculans</i> Wheeler 1913
<i>rufa</i>	<i>Formica ciliata</i> Mayr 1886 <i>Formica laeviceps</i> Creighton 1940 <i>Formica obscuripes</i> Forel 1886 <i>Formica oreas</i> Wheeler 1903 <i>Formica planipilis</i> Creighton 1940 <i>Formica ravida</i> Creighton 1940 <i>Formica subnitens</i> Creighton 1940
<i>sanguinea</i>	<i>Formica gynocrates</i> Snelling and Buren 1985 <i>Formica obtusopilosa</i> Emery 1893

- 5b. Erect hairs on gaster much more widely spaced and not forming an even vestiture 6
- 6a. Clypeus, gena and ventral surface of the head strongly shining
.....*subnitens*
- 6b. Clypeus, gena and ventral surface of the head dull *ravida*

KEY TO THE SPECIES OF THE GENUS *FORMICA*,
 SUBGENUS *FORMICA*,
 SPECIES GROUP *FUSCA*
 FROM FRANCOEUR (1973) AND WHEELER & WHEELER
 (1977, 1986)

- 1a. Small to medium-sized. Pubescence not dense on genae and first four gastric tergites, not producing a silvery luster. Head and mesosoma color lighter, yellowish red to brownish yellow, sometimes with dark reddish brown infuscation. Gaster dusky red to black. Metasternum with a pair of distinctly pilose lobes, arising one on either side of median sternal cavity; mesometasternal profile composed of a concavity followed by a pilose triangle 2
- 1b. Small to medium-sized. Pubescence dense to very dense on genae and first four gastric tergites, producing a silvery luster. Head, mesosoma and gaster usually dark, often appearing black, may grade to a reddish black or yellowish red. Legs paler than body. Metasternum without such lobes; mesometasternal profile composed of a concavity followed by a straight or convex line *argentea*
- 2a. Head yellowish red to brownish yellow w/dark reddish brown infuscation; mesosoma reddish to brownish yellow w/dark reddish brown infuscation; gaster black, or very dusky red appearing black. Often appears bicolored; surface dull *neoclara*
- 2b. Head yellowish red with dusky red infuscation; strongly shining, head of largest workers as broad as (or broader than) long; mesosoma strong brown, feebly shining; gaster dusky red, strongly shining, darker than head, which is darker than mesosoma. Strongly bicolored; strongly polymorphic
 *subpolita*

KEY TO THE SPECIES OF THE GENUS *LASIUS*
 FROM WILSON (1955)

- 1a. Maxillary palp very short and consisting of 3 segments *latipes*
- 1b. Maxillary palp longer and consisting of 6 segments 2
- 2a. Scape and tibiae with standing hairs *neoniger*
- 2b. Scape and tibiae lacking standing hairs *crypticus*

KEY TO THE SPECIES OF THE GENUS *MYRMECOCYSTUS*: FROM SNELLING (1976)

1a. Posterior 2/3 of dorsal surface of propodeum strongly and angularly projecting upward; erect hairs very sparse, with few or none on outer surface of hind

tibia *pyramicus*

Table 6. Worker size classes following Wheeler and Wheeler (1986).

Size Class	Body Length in mm
minute	less than 2
small	2-4
medium-sized	4-6
large	6-8
very large	8 or greater.

1b. Dorsal surface of propodeum either flat or evenly convex; often abundantly hairy
testaceus

KEY TO THE GENERA AND SPECIES OF THE SUBFAMILY MYRMICINAE

1a. Antenna with 10 segments, the last 2 forming a distinct club; propodeum unarmed *Solenopsis molesta*

1b. Antenna with more than 10 segments 2

2a. Antenna with 11 segments 3

2b. Antenna with 12 segments 4

3a. Propodeum armed with spines or short teeth; node of petiole well developed; eyes without fine, erect hairs *Temnothorax* (in part)

3b. Found only in the thatch nests of *Formica* (*rufa* group) ants; eyes with fine, erect hairs *Formicoxenus*

4a. Spur of middle and hind tibiae very finely pectinate, the teeth regular but small (may need magnification of 100X) 5

Table 7. Relative abundance categories for ants collected at the Idaho National Laboratory modified from Anderson *et al.* (1996).

Abundance Class	Frequency of collection in Space-Time
rare	found at five locations and/or five times or less
present	found six to 15 locations and/or times
common	found in most habitats over much of the site, (16 - 55 collections)
abundant	found in all or nearly all habitats and sites, (greater than 56 collections)

- 4b. Spurs of middle and hind tibiae simple or absent 7
- 5a. Psammophore present *Pogonomyrmex salinus*
- 5b. Psammophore absent 6
- 6a. Propodeum unarmed *Manica invidia*
- 6b. Propodeum armed with spines *Myrmica* sp.
- 7a. Propodeum unarmed; antennal club of 3 segments
..... *Monomorium minimum*
- 7b. Propodeum armed with spines or teeth 8
- 8a. Worker caste dimorphic, major workers with disproportionately large head *Pheidole pilifera*
- 8b. Worker caste not as above 9
- 9a. Thoracic dorsum flat or feebly convex in profile; anterior peduncle of petiole short, thick and not sharply set off from node; propodeal spines short or at most moderately long; small (less than 2.5 mm)
..... *Temnothorax* (in part)
- 9b. Not as above; large 10
- 10a. Postpetiole only slightly constricted behind, psammophore present
..... *Messor lobognathus*
- 10b. Postpetiole more strongly constricted behind; psammophore never present 11
- 11a. Small ants (2 - 4 mm); scape not reaching occipital border; eye vestigial or small *Stenamma smithi*
- 11b. Larger ants; scape surpassing occipital border; eye prominent
..... *Aphaenogaster uinta*

KEY TO THE SPECIES OF THE GENUS *FORMICOXENUS*
FROM FRANCOEUR *ET AL.* (1985) AND WHEELER &
WHEELER (1986)

- 1a. Circles of hairs of the face pronounced and quite visible. Dorsum of the head and mesosoma clearly dominated by short, stout and blunt hairs
..... *hirticornis*
- 1b. Circles of hairs of the face delicate and not very visible. Dorsum of the head and mesosoma clearly dominated by long, slender and pointed hairs
..... *diversipilosus*

KEY TO THE SPECIES OF THE GENUS *TEMNOTHORAX* FROM WHEELER & WHEELER (1986)

- 1a. Antennae 11 - segmented *rugatulus*
- 1b. Antennae 12 - segmented 2
- 2a. Dorsum of mesosoma completely covered with coarse longitudinal rugae except for a small heavily punctate area on the mesonotum; reddish black *nevadensis*
- 2b. Rugae on dorsum of mesosoma largely confined to propodeum and rear of mesonotum, anterior portion punctate only; concolorous black
..... *tricarinatus*

SPECIES ACCOUNTS

Following are brief accounts about the biology and taxonomy of the ant species known to occur at the INL. These are listed alphabetically by subfamily and then again alphabetically within subfamily, except for the genus *Formica* which is divided up by species group (Table 5) and then listed alphabetically within those groups.

Each account begins with the taxon's scientific name (for a species the generic name followed by the species name, both in italics), followed by the last name of the author and the date of the original description. If available, a common name, and a general meaning associated with the taxonomic name (etymology taken from Wheeler (1956), Brown (1976), Wheeler & Wheeler (1986) or specific taxonomic treatments) is provided.

Next, information about the taxon is provided including a brief DESCRIPTION of the species (usually information not included in the keys). The description includes ant (worker) size, which is difficult to characterize since many species are polymorphic in the worker caste, and there can be some variation among workers of species considered monomorphic. In addition, the size of preserved specimens may vary from that of living or freshly collected material (Gregg 1953). We placed each species into one of five size classes based on worker length following Wheeler & Wheeler (1986) (Table 6). Color of the ant is given, along with a color photograph taken of a preserved museum specimen from this study.

The species' RANGE is given from literature records to contextualize its presence at the INL. Note is made if the species has been previously been

reported from the state of Idaho (Yensen *et al.* 1977). We also note if the species has been reported from Nevada, since that is the closest geographic area to INL with a comprehensive ant treatment (Wheeler & Wheeler 1986).

The range or DISTRIBUTION AT INL of each species is described in general terms and illustrated on a map of the site. Here we also describe how many nest collections we made of a particular species and characterize its relative abundance (Table 3). The relative abundance categories follow those used by Anderson *et al.* (1996) for the flora of the INL, though we prefer the term “abundant” rather than “dominant” (Table 7). We attempt to tie the ant species’ distribution to specific vegetation types (Anderson *et al.* 1996) and other habitat information if possible. We note if the species has previously been reported from the INL (Allred & Cole 1971). Samples of ant colonies were taken from locations distributed all around the INL (Map 1).

The NATURAL HISTORY AT INL highlights various aspects of a species’ biology, behavior, ecology, etc. This includes the type of nest and nesting habits which might be expected within site boundaries. Also, we include our observations bearing on a species phenology (sexual flights and reproductive activity). When possible we note when alates and various immature stages were found in the nest. In this context we use the term ‘brood’ for any or all stages of immatures when specific stages were not resolved in the field notes. We also note when the species was associated with other ants or arthropods.

For more information the reader is referred to the LITERATURE. In general the most useful recent sources of information concerning ant taxa found at the INL are Yensen *et al.* (1977), Smith (1979), Wheeler & Wheeler (1986), and Blom (1990). All literature concerning each taxon at the INL is included. Other select literature is included where it helps the user understand the place of a taxon in the INL ecology. A complete review of the ant literature is not possible in this document and is provided through other sources (see especially Porter 1997, Ward *et al.* 1996).

SUBFAMILY DOLICHODERINAE - THE DOLICHODERINES

The Dolichoderinae are distinguished by a pedicle of one node and a slit-like posterior end of the gaster (cloacal orifice), not surrounded by a fringe

of hairs. They produce a very distinctive odor when agitated or the gaster crushed.

Genus *Forelius* Emery - surname of Auguste Forel

This is a New World genus. According to MacKay & Vinson (1989) it is "a difficult group in a taxonomic jumble" and in need of major revision. Many of the species of *Forelius* were previously placed in *Iridomyrmex*. We collected one species on the INL, *Forelius pruinosus*, which was transferred from *Iridomyrmex* by Snelling & George (1979).

Forelius pruinosus (Roger 1863) - covered with hoarfrost

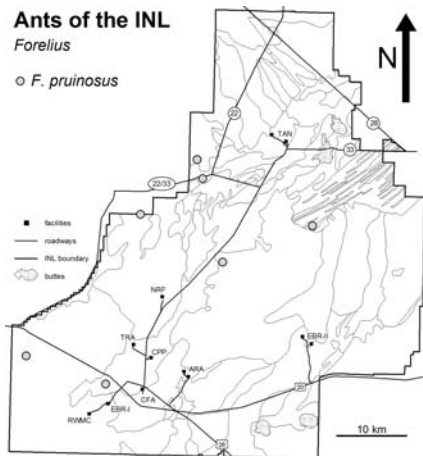
DESCRIPTION - Small, color highly variable from brown to reddish yellow and tip of gaster usually a different color, moderately shining (Fig. 2).

RANGE - Most of the United States including Idaho (as *Iridomyrmex pruinosum*; Yensen *et al.* 1977) and south to Guatemala and the West Indies.

DISTRIBUTION AT INL - Considered 'present' at the INL with eight collections made at seven locations (Map 2). The collections were scattered along the central and western parts of the site primarily in sagebrush steppe, both on and off lava. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Nesting varied at the site: one was a small crater nest, two were under rocks, one under dead roots of *Juniperus osteosperma*, two were small craters, and one was in the stem of a dead *Artemisia tridentata*. At around 1000 h on 3 July 1988 very active foraging trails of this ant were found coming from a nest in a basalt rock crack in a stabilized sand dune area. On 22 June 1988 a nest was found containing brood (orange color) and a single queen, under a rock.

LITERATURE - Smith (1965) notes that the species is a house pest in the southeastern United States, showing a marked preference for sweets.



Map 2. Map of collection locations for *Forelius pruinosus* on the INL.

Snelling & George (1979) note that the species is found throughout the desert areas but is sporadic. They found the ant up to elevations of 4300 ft (~1,300 m) in the California deserts. They found that it has a tolerance for high temperatures with workers foraging from 1000 to 1900 h. Nest debris indicates that flies, beetles and ants are taken as food items. Other ants fed upon included a species of *Solenopsis* and *Monomorium minimum*. Foragers were observed taking nectar from a variety of flowers and they also solicit Hemiptera for liquid. Predators were found to be the horned lizard, *Phrynosoma*, and the blind snake, *Leptotyphlops*. They observed mating flights in April and August.

Wheeler & Wheeler (1986) found this ant to be one of the most common in Nevada. They found it widely distributed from 1,100 to 7,100 ft (~335 - 2,175 m) in both the hot and cool deserts. They found most nests under stones and some with small (3.75 - 5 cm) craters. One colony had 15 queens.

Genus *Liometopum* Mayr - smooth forehead

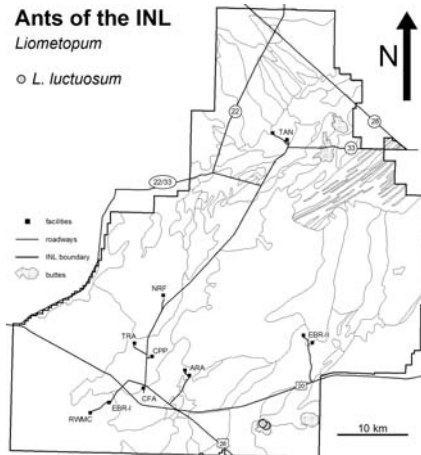
This is a small Holarctic and Oriental genus. They are more aggressive than the other dolichoderines found in Idaho.

Liometopum luctuosum Wheeler 1905 - mournful

Ants of the INL

Liometopum

○ *L. luctuosum*



Map 3. Map of collection locations for *Liometopum luctuosum* on the INL.

DESCRIPTION - Small to medium-sized, concolorous dark reddish brown, feebly shining (Fig. 3). This ant can most easily be confused with *Tapinoma sessile* in the field, but *Liometopum* is noticeably larger.

RANGE - Wyoming to western Texas and westward to Nevada and California. Merickel and Clark (1994) reported *Liometopum luctuosum* from the Pacific Northwest, including the first report from Idaho.

DISTRIBUTION AT INL - This ant is 'rare' at INL. Merickel and Clark (1994) reported *Liometopum luctuosum* on the INL from collections made at the top of

Middle Butte by Clark and Blom in 1989. We only made two collections of these ants in the juniper woodlands on the lava butte (Map 3). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - *Liometopum luctuosum* appeared to be nesting in lava cracks on Middle Butte; we searched but could not find the nests. They were foraging midday among the lava and plant litter beneath the junipers and on the juniper trees themselves.

The ants produced the very distinctive Dolichoderinae odor when they were agitated (collected).

LITERATURE - Wheeler & Wheeler (1986) reported *Liometopum luctuosum* from scattered localities in Nevada. They found the ant either in coniferous forests or pinyon-juniper woodlands or associated with humans. Cole (1966) reported the species at the base of a juniper tree at the Nevada Test Site. Merickel & Clark (1994) reported the species from the juniper woodland vegetation type (INL) and from inside buildings and houses in northern Idaho. One nest in northern Idaho was in a ponderosa pine tree. Little is known concerning the nests of this species.

Genus *Tapinoma* Foerster - lowness (refers to the scale on the petiole)

Tapinoma is a genus of world wide distribution with about 90 species. It is also known from the fossil record. According to MacKay & Vinson (1989) the genus is in need of a thorough revision and the present keys are not useful in correctly identifying species. Smith (1928) provided detailed information on the biology of the species. Under the present taxonomy a single species, *Tapinoma sessile* (Say), is known from Idaho (Yensen *et al.* 1977).

Tapinoma sessile (Say 1836) - sitting, the odorous house ant.

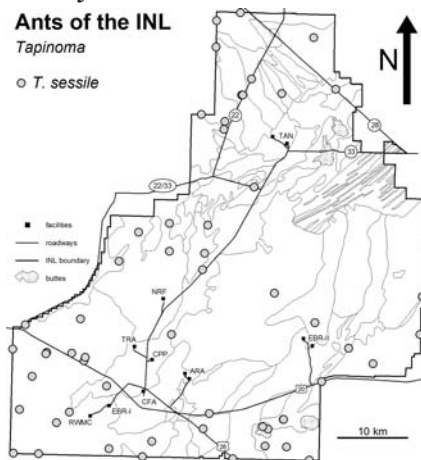
DESCRIPTION - Minute to small, concolorous dark reddish brown to black, dull to moderately shining (Fig. 4). These ants give off a very strong "dolichoderine" odor, especially when crushed. Brood sometimes has a distinctive orange color.

RANGE - This is one of the most common ants in North America, found across southern Canada and much of the United States, including Idaho (Yensen *et al.* 1977).

DISTRIBUTION AT INL - This ant is one of the most 'abundant' found at the site, with 69 collections, making up 6.2 % of the total collections at the site (Map 4). Allred & Cole (1971) reported the species from the site.

NATURAL HISTORY AT INL - Thirty of the nests (43 %) were found under rocks. Eleven of the nests (16 %) were arboreal, found in and around the dead stems and roots of *Artemisia tridentata*. One nest was at the base of a dead grass clump. Nests were also found under our wooden nest blocks, one at BCD, one at PLG, one at TBG, and three at WIN (Table 2). Other nests under human refuse included two under a small scrap boards, one under a discarded metal can and one under a piece of galvanized sheet metal. Four collections of stray foragers were made from flowers.

Brood was found in nests on 25 and 26 May 1988, 31 May 1993, 8 and 9 June 1991 (with orange color), 2 June 1988, 2 June 1993, 4 July 1990, and 30 September 1989. Pupae were found in a nest on Middle Butte, 24 June 1989, and elsewhere on 1 June 1993, 8 June 1991, and 5 July 1986. Alates were found in a nest 27 May 1988, 28 May 1987. A dealate female was found walking across a *Pogonomyrmex salinus* mound on 10 March 1987 and a second on the ground nearby, on the same date. A single queen was found in each of two separate nests on 30 July 1988. Alate males and females were found along with brood on 22 May 1987, 25, 27, and 29 May, 1988, and 8 and 9 June 1991.



Map 4. Map of collection locations for *Tapinoma sessile* on the INL.

On 22 June 1989 at BCD (Table 2) approximately 200 workers were found foraging on a dying cicada (*Okanagana annulata* Davis). The abdomen and some legs were missing at the time of the observation. Workers were found foraging in the flowers and on the pads of *Opuntia polyacantha* on 22 and 23 June 1988, 7 July 1990, and on flower buds of this cactus species on 3 July 1986 and 6 July 1990.

LITERATURE - Smith (1928) provides the most comprehensive work on this species. The ants overwinter as dealate

females, workers, and larvae. Workers begin foraging as early as 7 March. Egg laying and the development of brood begins in late April and continues until cold weather in the fall or approximately 1 November. The overwintering larvae attain maturity in April, having required from six to seven months for development. From April through June workers can be produced in from five to nine weeks, but from July through September may take only six to seven weeks to attain maturity. Smith (1928) postulated that four to five generations of workers could be produced per year. Alate females were found from 17 June to early July and males from 10 June to 9 July. The ants show a wide diversity in their nesting habits. It has been found from sea level to 10,000 ft (~3,050 m) elevation. Workers have been seen foraging at temperatures as low as 50 °F. The natural food of the ants is honeydew, supplemented by the flesh of organisms. Hemiptera are tended for honeydew. Several insects live in association with this ant. A toad and several bird species were reported to feed on these ants. Clark and Blom (1991) reported the ant feeding on a dead montane vole, *Microtus montanus* (Peale) at INL.

Smith (1965) summarizes the information presented in his earlier publication on this species. He notes that the nests in soil are indefinite in form, shallow, and of little permanency. He states that the colonies range in size from a few hundred individuals to many thousands and contain numerous reproductive females (queens).

Snelling & George (1979) describe the species from the California deserts and point out that the ant nests in a broad range of habitats. They note that mating usually takes place within the nest between siblings with occasional mating flights outside. They noted that the ants forage singly from trails and are active during both day and night.

Wheeler & Wheeler (1986) note that *T. sessile* is one of the most common species in Nevada but that it has not been reported from the hot desert habitats. They collected it up to an elevation of 11,320 ft (~3,450 m) on Boundary Peak.

Tapinoma sessile may be considered a pest ant in the United States (Thompson 1990) because of its nesting around habitations. The ant may invade homes for food (Smith 1965).

SUBFAMILY FORMICINAE - THE FORMICINES

Genus *Camponotus* Mayr - a bending back

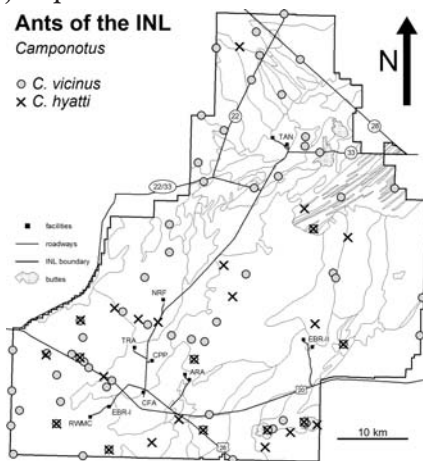
This is the most speciose ant genus and is distributed worldwide. It contains some pest species because of their propensity to nest in wood, but most are not considered of economic importance (Thompson 1990). Klotz *et al.* (1999) give a good summary of the common members of *Camponotus* in the United States.

Camponotus hyatti Emery 1893 - surname of Ed Hyatt

DESCRIPTION - Polymorphic, small to large, head very dusky red, mesosoma red, gaster black, smooth and shining (Fig. 5).

RANGE - This is a western species being found from Washington, Oregon and Idaho south to California, Arizona, and Baja California, Mexico (Hansen & Klotz 2005). Yensen *et al.* (1977) reported a species from Idaho as “near *hyatti*.”

DISTRIBUTION AT INL - *Camponotus hyatti* is ‘common’ at the site with 30 collections (Map 5). Its distribution is scattered across the INL, but is more abundant in the southern half (Map 5). It is most commonly found associated with *Artemisia tridentata* on and off lava. We also found it in the juniper woodlands of the southeastern corner of the INL (Map 5). This species



Map 5. Map of collection locations for *Camponotus* on the INL.

was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - *Camponotus hyatti* is considered arboreal at the INL, found mostly in wood. It was most commonly found nesting in dead stems and roots of *Artemisia tridentata*. Several of the nest collections were from dead stems and stumps of *Juniperus osteosperma*, which represents a new nesting substrate for the species. One nest was found under a rock. One collection was made of workers from *Opuntia polyacantha* flowers. Another

collection was made of workers on the flowers, pods, stems, and leaves of *Astragalus* sp. One individual ant was collected as it walked up a blade of grass; the nest was not found.

A single queen was collected from a nest on 28 May 1988. Alate males were collected on 28 May 1988 and 29 May 1993 from the dead stems of *Artemisia tridentata* located in a mound of *Pogonomyrmex salinus*. One of the ants flew on disturbance. Alate males and larvae were collected from a nest on 31 May 1993. Alate males and brood were collected on 28 May 1988. Alates and brood were collected from two nests on 14 June 1994 as well as a single queen, larvae, pupae and sexual pupae collected in another nest on the same date. Two alate females were collected along with brood in a nest on 9 June 1991. Alate females and two males were found in a nest on 8 June 1991. Alate males and females and pupae were collected in a nest on 13 August 1989. Brood was found in nests on 21 June 1989, 23 June 1988, 24 June 1989, 2 July 1988, 3 July 1986 and 5 July 1990.

LITERATURE - Snelling (1988) provides taxonomic treatment of the subgenus *Myrmentoma* including *Camponotus hyatti*. One word of caution for anyone using his key (Snelling 1988): page 58 contains a typographic error, “*hyatti* Emery” was omitted from couplet 4a in the key to major workers. Snelling (1988) notes that *Camponotus hyatti* nests in wood including oaks, manzanita, chemise, sagebrush stems and roots, and in *Yucca* stalks. Wheeler & Wheeler (1986) found the species scattered across Nevada from desert to pinyon-juniper at elevations ranging from 3,800 - 8,000 ft (~1,150 - 2,450 m). They found several nests in “rotten wood.” Hansen and Klotz (2005) note that these ants are wood nesting in their natural habitat and are considered only nuisance pests in human structures.

Camponotus vicinus Mayr 1870 - near

DESCRIPTION - Polymorphic, major workers are large to very large, head black to reddish black, mesosoma red to dusky red with black markings, gaster black. Dull or head and mesosoma dull, gaster moderately shining (Fig. 6). This is the largest ant at the site.

RANGE - Southwestern Canada south through the western United States, including Idaho (Yensen *et al.* 1977) and into Mexico.

DISTRIBUTION AT INL - This ant is ‘abundant’ at the site, collected

86 times, 7.7 % of all collections. The species is found over most of the site and in all vegetation and soil types (Map 5). The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Most of the nests recorded were found under rocks (36). Six were large crater nests (two were 9 cm in diameter), six were arboreal (nesting in dead *Artemisia tridentata*), and three nests consisted only of entrances (one 0.8 cm diameter, another had two 0.8 cm diameter openings) with no external nest structure present. We observed nocturnal and crepuscular foraging. One nest contained workers tending aphids on the roots of *Chrysothamnus viscidiflorus*. Workers were found on the stems of *Helianthus annuus*. Workers were found midday on *Opuntia polyacantha* on 1 July 1988.

A dealate female (queen) was found under a board on 27 May 1988; one on 29 May 1988 under a rock; one on 30 May 1987 under a rock, and on the same date one under a rock with several larvae; one under a rock on 1 June 1993; two on 8 June 1991 under different rocks; one on 21 June 1989 under a rock; one under a rock on 5 July 1986; and another under a rock in an incipient nest on 13 August 1989.

Nests were found containing a queen and brood on 27 May 1988. Another nest under wood and one in an open area had a queen and larvae present on 8 June 1991. One small nest with minor workers contained two queens and a second nest had one queen on 29 July 1988. Another small nest under a rock had one queen, several larvae and a single minor worker on 21 June 1989. Larvae and alate males were found in a nest on 24 June 1989 and five of six nests at a single locality on 30 September 1989. Alate males and females were found on 13 August 1989, and alate females and brood were found on 30 September 1989. Alate females were found on 10 March 1987. Alate males and larvae were found in nests on 30 and 31 July 1988. Alate males and females and brood were collected in a nest under a rock on 13 April 1989, and another on 29 July 1988.

Alate males were found in a nest on 12 April 1987 and 31 July 1988.

Brood were found in nests on 28 May 1988 (including one in an old *Pogonomyrmex salinus* mound), 30 May 1987, 9 June 1990, 14 June 1994, 23 June 1989, 24 June 1988, 2 and 4 July 1988, 5 July 1986, 7 July 1990 (including sexual brood), and on 8 July 1990.

Pupae only were collected in nests on 1 July 1988. Larvae only were collected in nests on 26 and 29 May 1988, 29 May 1993, and 31 May 1993.

LITERATURE - Snelling & George (1979) found *Camponotus vicinus* in the California deserts from elevations of 2,655 and 6,300 ft (~800 - 1,920 m). In the chaparral area they found mating flights in the spring, especially after rains. In the desert they found a dealated female on the ground in April and alate males in nests during the same month. They found the ant nesting in the soil often at the base of shrubs or rocks. *Camponotus vicinus* tumuli are messy or very irregular craters. Snelling and George found *C. vicinus* foraging to be primarily crepuscular and nocturnal. They report the ant as an omnivore but note that it is especially fond of nectar and honeydew from plants and Hemiptera. A summary of the ecology, foraging life history, morphology, taxonomy and distribution literature is given in Hansen and Klotz (2005).

Wheeler & Wheeler (1986) note that the species is one of the commonest and most widely distributed ants in Nevada. They found it ranging from 3,900 - 9,700 ft (~1,200 - 2,950 m) in elevation in a variety of ecological areas from cool desert to coniferous forest. They found the majority of the nests under stones. They also found them tending scale insects on the roots of *Sarcobatus vermiculatus*.

A mature colony of this species has been estimated at over 100,000 workers (Hansen & Akre 1990, Akre *et al.* 1994). Klotz *et al.* (1999) present current information on carpenter ants in the United States including *Camponotus vicinus*. They note that as many as 41 functional queens have been collected in a single nest of this species. This allows the colony to be larger and to reach maturity sooner than nests of species containing only one queen.

Genus *Formica* Linnaeus - ant

This is a very large Holarctic genus of ants. The genus makes up about 37 % of the Idaho ant taxa and about 46 % (21 species) of the INL ant fauna. It is also the most speciose of the Nearctic ant fauna, about 15 % of the total) hence it has been subdivided into a number of species groups of which five are found in Idaho: *neogagates*, *rufa*, *microgyna*, *fusca*, and *sanguinea* groups. Wheeler (1913) provided a revision of the genus.

fusca group

This group generally contains docile species, though members of populous colonies can become very aggressive. The group was revised by Francoeur (1973).

Formica argentea Wheeler 1912 - silvery

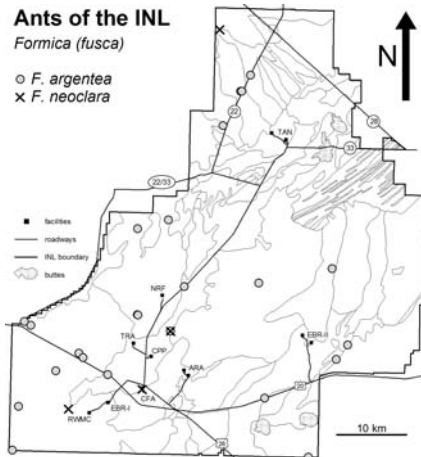
DESCRIPTION - Small to medium-sized, head dark reddish brown, mesosoma and gaster yellowish red varying to head, mesosoma and gaster reddish black, appendages paler. This ant has a silvery luster on the gaster due to pubescence (Fig. 7).

RANGE - Its range is scattered from the eastern United States coast to the Pacific Coast (British Columbia to southern California). Yensen *et al.* (1977) reported the ant from Idaho.

DISTRIBUTION AT INL - This ant is 'common' at the INL with 24 collections scattered over most of the site, especially the central and western parts (Map 6). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Most nests (15) were under rocks. Two nests were of medium-sized craters (8 cm diameter with a 1 cm diameter entrance) in sagebrush steppe vegetation both on and off lava. One nest was in the stream bank of the Big Lost River, in the riparian zone. One nest was under a board. The ant was most common in areas of *Artemisia tridentata*.

One nest collected under a flat rock on 18 April 1988 had a large chamber full of dead insects. A nest found on 31 May 1993 was not active. On 3 June 1993 the species was active and foraging. On 9 June 1991 workers were foraging on *Lupinus* flowers and on *Stanleya viridiflora* flowers 3 July 1988. On 6 July 1986



Map 6. Map of collection locations for the *Formica fusca* group (in part) on the INL.

foraging workers were found on the ground and *Artemisia tridentata*. On 30 September 1989 workers outside the nest were sluggish.

The nests of *F. argentea* at INL had queen numbers varying from one to 16. On 29 May 1988 one queen and larvae were found in a nest under a rock. On 4 July 1986 a nest under a fence post had 16 queens and pupae present. A nest on 30 July 1988 had one queen and pupae present. Two additional nests found on 30 July 1988 had multiple queens, and one with only brood present. On 13 August 1989 a nest contained one queen.

Nests contained eggs and larvae on 18 April 1988, brood on 26 May 1988, brood on 31 May 1993, larvae and pupae on 22 June 1989, and pupae only on 5 July 1986.

LITERATURE - Francoeur (1973) provides the most recent revision of the *fusca* group of *Formica*. Wheeler & Wheeler (1986) found the species throughout Nevada making 109 collections from 100 different localities. The habitats ranged from the cool desert, to riparian, to pinyon-juniper, coniferous forest and alpine. The elevational range was from 4,400 - 11,500 ft (~1,340 - 3,500 m). Most of their records were above 6,000 ft (~1,830 m). Most nests were under stones, some under wood lying on the ground. Several nests were simple entrances with and without mounds of excavated soil around them. The Wheelers found Histeridae (Coleoptera) in one nest and made a collection of the ants tending aphids on *Ribes*.

Formica neoclara Emery 1893 - new bright

DESCRIPTION - Small to medium-sized, ventral portion of head yellowish red and dorsal portion reddish black, mesosoma reddish yellow with dark reddish brown infuscation, gaster black, dull (Fig. 8).

RANGE - From the Yukon Territory through the Dakotas and westward through Idaho (Yensen *et al.* 1977) to the Pacific Coast States and British Columbia.

DISTRIBUTION AT INL - The species is 'rare' at the INL with five collections at four locations (Map 6). The collections were mostly in the south-central part of the site except for a single collection in the extreme northwestern corner (Map 6). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - One nest was under a rock with its entrance about 3 cm from the rock at the base of a grass clump along the Big Lost River. The ants appeared very agitated on disturbance. One nest was found along the dry Birch Creek channel under a discarded metal vehicle wheel. The workers from the nest were collecting honeydew from aphids on *Populus* 7 July 1990. A Third nest was found under debris along the Big Lost River. The remaining two collections were made along paved roads in the Central Facilities Area, one foraging along a road edge on 6 July 1986. Brood was found in nests on 8 June 1991, 1 July 1988, and 7 July 1990. This ant appears to be ruderal in nature at the INL.

LITERATURE - Francoeur (1973) provides the most recent detailed taxonomic information on this species.

Clark & Yensen (1976) studied *F. neoclara* and *Formica obscuriventris clivia* Creighton, along the Snake River in western Idaho. They found it tending the treehopper, *Campylenchia* sp. on *Artemisia dracuncululus*. The droplets of honeydew averaged $0.085 \pm 0.019 \mu\text{L}/\text{drop}$. Estimated honeydew production for this site was $65 \pm 20 \text{ ml}/\text{day}/\text{ha}$ during the summer. The spider *Phidippus clarus* preyed on unattended treehoppers; thus the ants and treehoppers seemed to have a mutualistic association.

Wheeler & Wheeler (1986) note that nests of this ant can be populous in grassland, open woods, and especially in disturbed areas. The external part of the nest often covers a large area (90 - 120 cm x 60 - 90 cm) consisting of a low mass of excavated soil and many entrances. The ants are aphid tenders. Wheeler & Wheeler (1986) collected 17 nests in 12 locations scattered throughout the state from 3,900 - 9,800 ft (~1,189 - 2,987 m) of elevation. Their records come from the cool desert, from riparian habitats and from the coniferous forest. They observed fast moving processions of workers up and down the trunks of cottonwood trees.

Formica subpolita Mayr 1886 - somewhat polished

DESCRIPTION - Small to medium-sized, head yellowish red with dusky red infuscation, mesosoma strong brown, gaster dusky red, head and gaster strongly shining, mesosoma feebly shining (Fig. 9).

RANGE - California and Nevada northward to southern British Columbia (Wheeler & Wheeler 1986) and Idaho (Yensen *et al.* 1977).

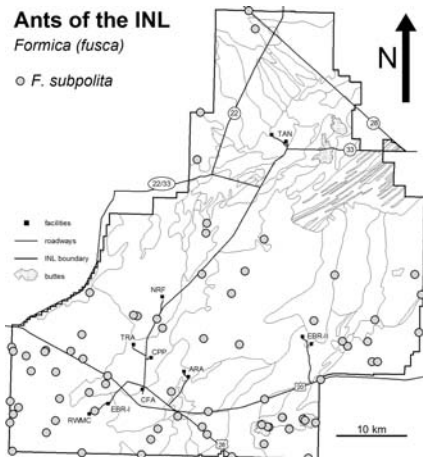
DISTRIBUTION AT INL - This ant is 'abundant' at the INL (119 collections, or 10.7 % of all collections) and found widely across the site, especially in the southern half (Map 7). The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - The ant is often found associated with sagebrush steppe vegetation but is also found with other vegetation and on lava. The nests were primarily under rocks (69). Some nests (10) were of the large crater type (up to 15 cm in diameter). Four nests were simple entrances into the ground with no external nest structure. One nest consisted of a small gravel mound. One nest was under a cover board at RWM on 26 September 1988. The cover boards had been originally placed 10 October 1986. Four of the nests were in clearings of *Pogonomymex salinus*. *Solenopsis molesta* was found in one nest. Five of the nests contained pseudoscorpions. Other arthropods found in association with *F. subpolita* nests were Staphylinidae, Scarabaeidae, Cerambycidae, Chrysomelidae, Hemiptera, Aphididae, and Coccidae.

Polyergus breviceps was raiding a *F. subpolita* nest on 22 June 1988. *Polyergus breviceps* nests were found with *F. subpolita* as slaves on 30 May 1987 (two nests), 4 July 1988, and 31 May 1993.

Ten workers were carrying a living beetle, *Crossidius hirtipes allgewarhrice* LeConte (Cerambycidae) to their nest (30 September 1989). The ants were seen actively foraging around their nests on 31 May 1993 (two nests), 3 July 1988, 6 July 1990 (two nests), 8 July 1990, and 30 September 1989. *Formica subpolita* was observed tending aphids 30 May 1987 and 24 June 1988.

Nests were found with single queens on 13 April 1987 (two nests), 25 May 1988, 29 May 1988 (with larvae), 30 May 1987 (with brood), 31 May 1993 (two nests), 8 June 1991 (with brood), 14 June 1994, 31 July 1988. Two nests



Map 7. Map of collection locations for the *Formica fusca* group (in part) on the INL

were found with two queens each and brood on 8 June 1991. One nest was found to contain six queens and brood on 21 June 1989.

Incipient nests were found on 8 June 1991 (with two queens, small larvae and eggs), dealate females on the ground 2 July 1988 (2), one queen in each nest on the following dates 3 - 4 July 1988, 5 July 1986, 5 July 1990, and 6 July 1990.

Matingswarms were observed on 3 July 1987 and alates were seen emerging from nests 3 July 1988 and 5 July 1990 (two nests). Alate females were found in nests on 22 June 1988 (three nests), 24 June 1989, and under a juniper log 8 July 1990. Alate males were found in nests on 21 June 1989 (with brood), 3 July 1988 (with pupae), and on 5 July 1986. Clearly *F. subpolita* mating takes place on INL during late June and early July. The mated queens quickly establish new nests by early July.

Larvae only were found in nests on 25 May 1988 and 14 June 1994 (two nests). Pupae only were found in nests on 15 June 1994 and 3 July 1986 (along with three large chrysomelid larvae). Sexual pupae were found in a nest on 24 June 1989.

Larvae and pupae were found in nests on 26 May 1988, 29 May 1993, 30 May 1987 (two nests), 31 May 1993, 8 June 1991 (2), and between the dates 14 June 1994, and 30 July 1988.

LITERATURE - Francoeur (1973) provides the most recent revision of this group and summarizes the information known about the taxonomy of *F. subpolita*.

Wheeler & Wheeler (1986) found it abundant across the state of Nevada (204 collections from 108 locations). The collections ranged in elevation from 4,300 - 10,800 ft (~1,310 - 3,290 m). Habitats included the cool desert, cottonwood riparian, pinyon-juniper, coniferous forest, and alpine. Most nests were from under stones and some under other objects on the ground. Many were surmounted by craters (4 - 10 cm in diameter with entrances 4 - 8 mm in diameter) and some by messy mounds of excavated soil. The Wheelers note that some colonies are locally very numerous and that the workers are "timid and fast."

microgyna group

This group of *Formica* is characterized by very small queens (never more than 5.5 mm in total length), which are smaller than the largest worker.

Formica adamsi Wheeler 1909 - surname of C.C. Adams

DESCRIPTION - Medium-sized, head and mesosoma reddish yellow with dark brown infuscation varying to head dark reddish brown with dark brown infuscation, mesosoma dark brown, gaster dark reddish brown, dull (Fig. 10).

RANGE - Michigan to Minnesota; Montana to British Columbia, southward to California and thence eastward to Colorado; also New Mexico (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported the species from Idaho.

DISTRIBUTION AT INL - This species was found at one locality on the INL, in the south-central part (Map 8), making it 'rare' at the site. The species was reported for the site by Allred & Cole (1971) as *Formica whymperei*, but the *adamsi* name has priority (Bolton 1995).

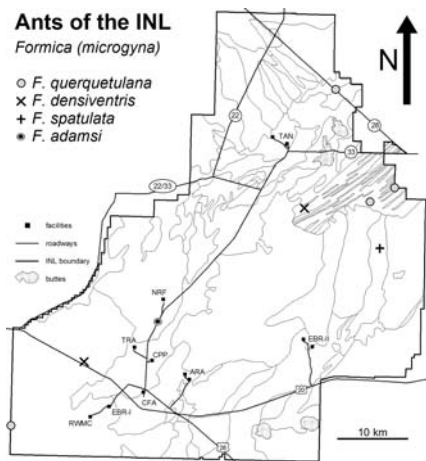
NATURAL HISTORY AT INL - Workers of this ant were found tending aphids on *Artemisia tridentata*. The nest could not be found. The collection locality was along Lincoln Blvd. in the disturbed road shoulder. It is in the

sagebrush steppe off lava vegetation type.

LITERATURE - Wheeler & Wheeler (1986) note that from a summary of the literature, the colonies are rather small and that the nests are usually under stones and logs. They found a single colony in Elko County, Nevada.

Formica densiventris Viereck 1903
- having thick belly

DESCRIPTION - Small to medium-sized, head and mesosoma dark reddish brown with dusky red infuscation, gaster black, dull (Fig. 11).



Map 8. Map of collection locations for the *Formica microgyna* group on the INL.

RANGE - New Mexico, Colorado, Utah, Nevada, California, and Washington (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported the species from Idaho.

DISTRIBUTION AT INL - This is considered a 'rare' species for the INL as we found it at only two locations, one in the north-central and another in the southwestern area of the site (Map 8), making it rare at the site. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - The ant was found nesting in the sagebrush steppe vegetation type, both on and off lava. One nest was a small thatch nest at the base of a living *Artemisia tridentata*. The other collection was made under a rock. The ants were tending aphids on grass roots under the rock.

LITERATURE - Wheeler & Wheeler (1986) found 24 nests at 16 localities scattered throughout the state of Nevada north of the hot desert. The species was found at elevations ranging from 5,500 - 10,000 ft (~1,675 - 3,050 m), in the pinyon-juniper and coniferous forest areas. The Wheelers found that its nests varied from the thatch type to being located under stones or under a prostrate sagebrush trunk.

Formica querquetulana Kennedy & Dennis 1937 - belonging to oak woods

DESCRIPTION - Medium-sized, head and mesosoma reddish yellow with very little to extensive infuscation of dark brown, gaster with each somite very dusky red anteriorly and black posteriorly, dull (Fig. 12).

RANGE - Described from Ohio (Kennedy and Dennis 1937). New England westward to Montana, Nevada, and California (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported the species for Idaho.

DISTRIBUTION AT INL - This species was found mostly along the northeastern edge of the INL and a single collection was made along the southwestern border of the site (Map 8). Four collections were made at INL making this species 'rare' at the site. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - This species was found only in areas of sagebrush steppe off lava. Two of the nests were low thatch nests at the base of living *Artemisia tridentata* shrubs. Alate females were collected on 23 June

1989. One nest was under a rock and they exhibited photonegative behavior when the rock was disturbed. One *Solenopsis molesta* worker was found in this nest. When disturbed, the ants moved very rapidly. One collection was made from flying mating swarms, on 2 July 1987 on a sunny, warm morning from 0900-0930 h at PLG (Table 2). The ants were observed mating in the air as they swarmed, then they would drop to the ground to complete the mating process. Winged males were found in a nest on 23 June 1989, and alate males and females were found in a nearby nest on 23 June 1989.

LITERATURE - Kennedy & Dennis (1937) described *Formica querquetulana* from Ohio. They found them in sandy soil often nesting under debris. They noted that the nests are "apparently shallow and have no connection with a water table below."

Wheeler & Wheeler (1986) found three nests in three western Nevada locations. One of their collections was from the alpine at 11,200 ft (~3,415 m).

Formica spatulata Buren 1944 - spatulate form of hairs

DESCRIPTION - Small, surface of head and mesosoma is finely and densely sculptured and opaque and erect hairs on head, mesosoma and gaster are notably spatulate, no erect hairs on antennal scape and a few on the femur (Fig. 13).

RANGE - Minnesota and Iowa west to Montana (Creighton 1950). Yensen *et al.* (1977) did not report this species from Idaho. The INL collection is a new record for Idaho.

DISTRIBUTION AT INL - The species is 'rare' (one collection at one location) on the eastern part of the INL (Map 8). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - This species was found in sagebrush steppe vegetation on lava. The single collection was made under a rock at an elevation of 1490 m. It had a different appearance in the field and we noted that it looked like a different species than what we had previously found at the site. Alate males were collected from this nest (3 July 1989).

LITERATURE - Buren (1944) described the species from nests along the shore of a small lake in Iowa. Creighton (1950) provides the most recent information on the taxonomy of this species. Wheeler & Wheeler (1963)

made two collections in North Dakota. One of the nests was under a stone and mixed with *Formica fusca* along the Red River.

neogagates group

The *neogagates* group of the *Formica* is characterized by containing the smallest species in the genus. The species in this group are often considered “timid” (Wheeler & Wheeler 1986) and are often enslaved by species of the *sanguinea* group of *Formica* and by *Polyergus*.

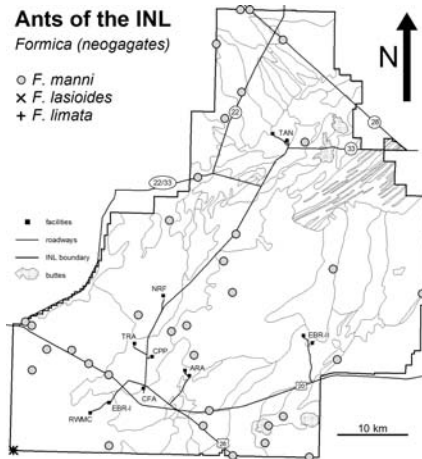
Formica lasioides Emery 1893 - *Lasius* like

DESCRIPTION - Small to large, head red, mesosoma yellowish red with dark brown markings, gaster dark reddish brown anteriorly and black posteriorly, dull (Fig. 14).

RANGE - California (Ward 2005), Nevada, Utah, Colorado and the Dakotas (Wheeler & Wheeler 1986) and Idaho (Yensen *et al.* 1977).

DISTRIBUTION AT INL - This species was ‘rare’ at INL, only found at one locality in the extreme southwestern corner of the site (Map 9). The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - The single collection was made on 31 May



Map 9. Map of collection locations for the *Formica neogagates* group (in part) on the INL.

1993 in sagebrush steppe vegetation at an elevation of 5190 ft (~1600 m). The nest was in the ground at the base of a thatch nest of *Formica obscuripes* which had been constructed around the base of a dead *Artemisia tridentata*. The queen was also collected. *Lasius crypticus* was found in the nest.

LITERATURE - Wheeler & Wheeler (1986) found this species scattered throughout Nevada. Most of their collections were above 6,000 ft (~1829 m) in elevation (range 3,800 - 10,900 ft [~1,150 - 3,350 m]) in habitats ranging from the cool desert to the coniferous

forest. Most nests were under stones but some were exposed with uneven earthworks around the nest entrance. The Wheelers report the ant as rapid-moving and timid, but that they are sometimes aggressive and their bites annoying.

Formica limata Wheeler 1913 - polished

DESCRIPTION - Small to medium-sized, head and gaster black or reddish black, mesosoma dark reddish brown to yellowish red, strongly shining (Fig. 15). This ant can be distinguished from the other members of the *neogagates* group by the fact that it lacks hairs on the pronotum.

RANGE - Minnesota, North Dakota, Colorado, New Mexico, Utah, and Nevada (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported this species from Idaho.

DISTRIBUTION AT INL - This species was 'rare' at the INL being found only at one locality, in the extreme southwestern corner (Map 9). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - The species was found in an area of sagebrush steppe vegetation. A small nest was found at the base of a grass clump. No external nest structure was visible. *Formica vinculans* was found in the nest also. The ants were moving very rapidly on disturbance at midday.

LITERATURE - This species has been reported tending aphids in Colorado (Jones 1929). Wheeler & Wheeler (1963) reported the species from North Dakota and found it mostly nesting under stones in grasslands and woodlands. Wheeler & Wheeler (1986) reported the species in southern Nevada from the hot desert.

Formica manni Wheeler 1913 - surname of William M. Mann

DESCRIPTION - Small to medium-sized, head and mesosoma reddish yellow, gaster reddish black varying to head and mesosoma dark reddish brown, gaster black, shining (Fig. 16).

RANGE - Washington to Utah, Nevada and northern California. Yensen *et al.* (1977) report the species from Idaho.

DISTRIBUTION AT INL - This ant is widely distributed and 'common' at the INL (Map 9). The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Of the 31 collections of this ant the majority of the nests (27) were under rocks. Five of the nests were crater nests (ranging from 4 - 5 to 12 cm in diameter), one a small mound, and one in a dead stump of *Artemisia tridentata*. Four of the nests were located in the clearings of *Pogonomyrmex salinus*. One nest contained termites and it was in an old mound of *P. salinus*, two nests had pseudoscorpions in them, one nest had a Chrysomelidae larva, and in one nest the ants were tending Coccidae on the roots of a grass plant. The nests we found seemed to be small with few individual ants present.

We found *E. manni* as a slave of *Polyergus breviceps* on 10 March 1987. The day was cool, cloudy, and windy. The ants were sluggish and doing nest work and just seen around the nest entrances. On 22 July 1988, a very hot day, the ants were observed to be "extremely rapid moving."

Single queens were found in nests on 10 March 1987, 29 May 1988, 22 June 1988, and 30 May 1993 (with larvae and pupae). Alate males were found in nests on 24 June 1989, 3 July, and 4 July 1986. No nests with alate females were collected. Pupae were collected in a nest on 15 June 1994 and larvae and pupae were collected in nests on 21 June 1989, 22 June 1988, 3 July 1986 (two nests) and 30 July 1988 (two nests).

LITERATURE - Wilson & Brown (1955) provide taxonomic information on this species. They note that the species has been collected from alpine meadows above timberline to lower elevations in desert habitats. They state that the color of the individuals tends to be darker in cooler, moister climates. Wheeler & Wheeler (1986) found the species abundant and widely distributed throughout Nevada north of latitude 38°N in elevations ranging from 3,800 - 8,000 ft (1,158 - 2,438 m; mostly between 4,000 - 7,000 ft [~1,220 - 2,150 m]). They found it in the cool desert and pinyon-juniper areas but not coniferous forest or alpine regions. Half of the nests collected by the Wheelers were under stones while the others were surmounted by craters (5 - 17 cm in diameter) or by uneven excavated earth. They noted that the ant is fast and timid but that some of the populous colonies may be aggressive. They reported it as a slave of *Polyergus breviceps*.

Formica neogagates Emery 1893 - new, jet black

DESCRIPTION - Small to medium-sized, head and gaster very dusky red, mesosoma dark reddish brown varying to head dark red dorsally and strong brown ventrally, mesosoma reddish yellow with strong brown markings, gaster dark reddish brown, strongly shining (Fig. 17).

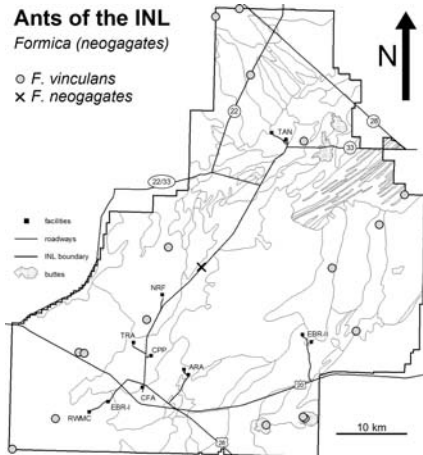
RANGE - Coast to coast in southern Canada and the northern states, with extension in the Appalachian Mountains to North Carolina, in the west from southern Alaska to California, Nevada, Arizona, and New Mexico (Wheeler & Wheeler 1986, Ward 2005). Yensen *et al.* (1977) reported the species from Idaho.

DISTRIBUTION AT INL - The species is known from a single worker collected in the middle of the site and considered 'rare' (Map 10). The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Very little is known about this ant at the INL. The single specimen was collected in a pitfall trap near Lincoln Blvd., at M17 near the center of INL. The area is dominated by sagebrush, *Artemisia tridentata* (off lava).

LITERATURE - Wheeler & Wheeler (1986) found the species to be widely distributed in Nevada except for the northeastern corner. They found it from elevations of 3,900 - 10,000 ft (~1,200 - 3,050 m), but mostly between 4,000 - 8,000 ft (~1,200 - 2,450 m). Most collections were from the cool desert (including riparian habitats) and the pinyon-juniper areas. Two collections were from the coniferous forest and five from the alpine. Nests were either under stones, surmounted by 3 - 12 cm diameter craters or irregular piles of excavated soil.

Myrmecomorphy, the mimicry of an ant species, may provide one fascinating ecological interaction between two INL *Formica* species and a spider. *Micaria* sp. is a mimic of the ant *Formica neogagates*,



Map 10. Map of collection locations for the *Formica neogagates* group (in part) on the INL.

and both species are predators of aphids tended by the thatching ant *Formica obscuripes* (McIver & Stonedahl 1993).

Formica vinculans Wheeler 1913 - to bind

DESCRIPTION - Small (2.5-4.5 mm), shining. Gaster dark brown or black, remainder of ant yellowish-red (Fig. 18). "Thorax is paler than the head and gaster ..." and the "... gastral pilosity is longer and the appressed pubescence is much less sparse than in *F. neogagates*" (Snelling and Buren 1985).

RANGE - Known only from Michigan (Snelling and Buren 1985) and Idaho (present study).

DISTRIBUTION AT INL - The species is found widely distributed and scattered across the INL (Map 10). With 18 collections (at 17 different locations, it just fit into the 'common' category for the site. The species was not reported for the site by Allred & Cole (1971). Finding this species in Idaho and the INL is a significant range extension west from Michigan.

NATURAL HISTORY AT INL - The most common nest type/location was under rocks (7). Two of the nests were medium-sized crater nests. One of the nests was in the clearing of *Pogonomyrmex salinus*. In one nest the ants were found tending aphids on plant roots.

All five of the collections of *Formica gynocrates* at the INL were mixed with *Formica vinculans* present as a slave species, suggesting its relationship with *F. vinculans* is obligate. However, *F. vinculans*' relationship appears facultative, found free of *F. gynocrates* 30 % of the time.

LITERATURE - Snelling & Buren (1985) discuss this slave species (*F. vinculans*) in their treatment of *F. gynocrates*, the host, from Michigan. They note that nests of *F. vinculans* are more populous than those of the closely related *F. neogagates*. They report the nests are always in open, sunny, prairie-like locations utilizing some vegetative debris. They note that when the nests are disturbed the workers "display aggressive alarm."

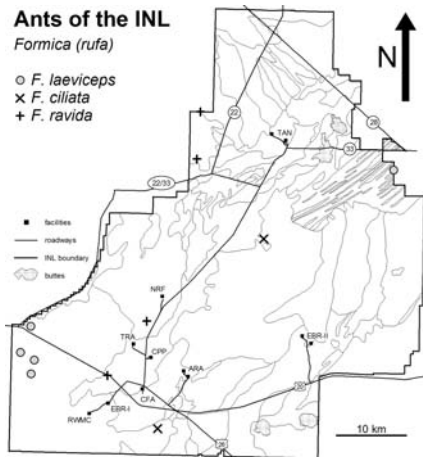
Talbot (1985) states that *F. gynocrates* is restricted to living "where there are numerous nests of its host ant *F. vinculans*." She notes that colonies of this species are usually inconspicuous because workers do not pile up soil around their nest entrances and they do not make bare areas around their nests. Talbot describes the nests of this species as shallow, extending "for some distance just under the surface of the soil." The ant does sometimes build up

small piles of debris around the bases of plants on or near their nests. These structures usually enclose aphids and also serve as aboveground chambers for incubating pupae and as a “loitering place” for alates. Talbot notes that the ants are aphid tenders and are considered “high-temperature” ants, seen foraging at ground surface temperatures of 40.5 °C (~ 105 °F). She noted that *F. vinculans* colonies were the subject of raids of *F. gynocrates* between 24 June and 25 August.

rufa group

MacKay and MacKay (1984) note that the *rufa* group of the genus *Formica* has several species with populous colonies and extensive foraging areas, making them very important in ecosystems. There are eight species in the *rufa* group at the INL and we assume these to be of potential concern for waste management as colonies of this size are likely to impact the soil profile. Yet, in spite of the obvious importance of these ants, MacKay & MacKay (1984) note that the biologies of the more than 20 North American species are “almost unknown.” The common name “wood ants” applies to this group. Creighton (1940) provided a revision of this group as variants of *Formica rufa*.

Formica ciliata Mayr 1870 - provided with eyelid



Map 11. Map of collection locations for the *Formica rufa* group (in part) on the INL.

DESCRIPTION - Small to large, head yellowish red, mesosoma strong brown, gaster dark brown, dull (Fig. 19).

RANGE - Nevada, Utah and Colorado northward to Montana and eastward to Minnesota (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported the species from Idaho.

DISTRIBUTION AT INL - This species is ‘rare’ at the INL, found only at two localities in the central and south-central part of the site (Map 11). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Both collections were from thatch nests in sagebrush steppe vegetation off lava. One collection was a low thatch nest in larva rock, which contained *Formicoxenus hirticornis*, a new host record for this species (Francoeur *et al.* 1985). *Solenopsis molesta* and *Monomorium minimum* were also found in the nest which establishes a new host record for these taxa as well. The second nest was a large thatch nest built next to a living *Artemisia tridentata*. *Monomorium minimum* was also found nesting along the edge and in a thatch nest in basalt rocks. Brood was collected in one nest 21 June 1989.

LITERATURE - Wheeler & Wheeler (1986) found *F. ciliata* at only one location in Nevada, in the central part of the state. They made the collection at 7,100 ft (~2,175 m) elevation in the cool desert. They noted that the thatch nest consisted mostly of chips of bark. The nest was one meter in diameter and located at the base of a dead sagebrush.

Formica laeviceps Creighton 1940 - smooth head

DESCRIPTION - Small to large, head red, mesosoma yellowish red with dark brown markings, gaster dark reddish brown anteriorly and black posteriorly, dull (Fig. 20).

RANGE - Nevada, Utah, Colorado and the Dakotas (Wheeler & Wheeler 1986) and Idaho Yensen *et al.* (1977).

DISTRIBUTION AT INL - The ant is considered 'rare' on the INL with a single collection made at each of five locations (Map 11). Four of the localities are clustered around the southwestern edge and one located on the eastern edge of the INL. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - This ant is found in the sagebrush steppe vegetation type, both on and off lava. Several alate females were collected in flight on 22 June 1988. On the same date a low thatch nest was collected near the base of a *Chrysothamnus viscidiflorus*. Many alate females were found in the nest. One collection consisted of ants from a foraging trail (30 July 1988, 0900 h) but no nest could be found. The nest from the eastern part of the site was a low thatch type also. On 23 June 1989 when the collection was made the nest contained termites and *Formicoxenus hirticornis*, which is a new host record for this ant (Francoeur *et al.* 1985).

LITERATURE - Wheeler & Wheeler (1986) found *F. laeviceps* to be uncommon in Nevada also, making eight collections from seven locations. The elevation for the Nevada collections spanned 4,200 - 7,100 ft (~1,275 - 2,175 m), ranging from the cool desert to coniferous forest. Workers of *F. laeviceps* were found tending aphids on *Artemisia tridentata*.

Formica obscuripes Forel 1886 - obscure foot

DESCRIPTION - Medium-sized to large, head dark brown dorsally and strong brown ventrally, mesosoma dark reddish brown, gaster black varying to head and mesosoma yellowish red, gaster black, dull (Fig. 21).

RANGE - Southern Canada and the northern states from Indiana and Michigan westward to British Columbia and southward to California, Nevada, Utah, Colorado, and New Mexico (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported the species from Idaho.

DISTRIBUTION AT INL - The species is scattered across the site and was found at 10 locations (Map 12), making it 'present' at INL. The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - It appears to be restricted to the sagebrush steppe vegetation type, both on and off lava. These ants constructed large thatch nests at the INL. Several were at the base of dead *Artemisia tridentata*. The ants frequently tended aphids and scale insects on *A. tridentata*. *Formica obscuripes* was listed by Francoeur *et al.* (1985) as a host of *Formicoxenus diversipilosus* and *F. hirticornis*. We carefully searched all *F. obscuripes* nests at the INL and found one nest containing *F. hirticornis*. *Solenopsis molesta* was found living in the thatch nests. Many Coleoptera larvae, small spiders and mites were also found living in the thatch nest material. A pseudoscorpion was collected in the thatch of one nest. Workers were observed foraging on 3 July 1989.

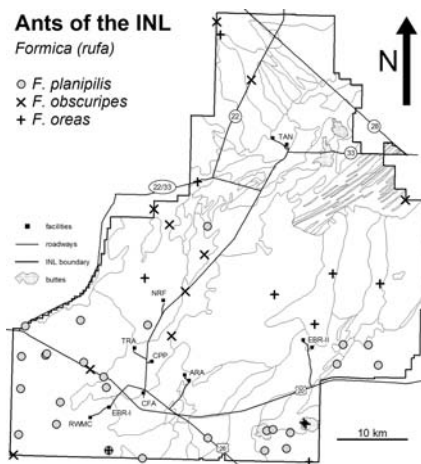
Alate males were on the nest surface 9 June 1991 and alate males and females were found inside a nest on 23 June 1988. Larvae and pupae were collected in nests on 9 June 1991 and 23 June 1988. Pupae only were found in three nests on 23 June 1988.

LITERATURE - Clark & Comanor (1972) provide information on mating flights of this ant in Nevada and they review much of the early literature on this species. They found that alate males are the first to emerge from the

nest in the spring (15 April). On 1 May alate females emerged and flew along with the males from the same nest. On 10 May only females emerged and flew. The flights took place when air temperatures ranged from 20.5 - 26.5°C (~67 - 80°F).

Wheeler & Wheeler (1986) found this species scattered throughout Nevada north of the hot desert (latitude 38°N). They made 60 collections from 44 localities ranging from 4,300 - 10,480 ft (~1,300 - 3,200 m) in elevation. Most of their records were from the cool desert, with a few from the pinyon-juniper, coniferous forest and alpine areas. Most nests were of thatch taken from what plant material was available at the locality. Two nests were under stones and one under a log. The species was found tending aphids on nearby vegetation.

Recent ecological and behavioral studies on this ant have been done by McIver in eastern Oregon, including the following: McIver (1987) examined the nature of female-limited mimicry in the myrmecomorphic plant bug *Coquillettia insignis* Uhler. The various instars of this bug are similar in size and appearance to various ant species in their environment. The adult female most closely resembles *F. obscuripes* and *F. fusca*. This mimicry of the ants may help protect the bugs from visual arthropod predators. McIver (1989) explored the protective resemblance in a community of arthropods found



Map 12. Map of collection locations for the *Formica rufa* group (in part) on the INL.

on *Lupinus caudatus* Kellogg. *Coquillettia insignis* seems to mimic *F. obscuripes* on lupine as a protection from spider predation. McIver and Loomis (1993) found that in 20 of 22 nests of *Formica planipilis* and *F. obscuripes* examined, Hemiptera-tending workers of these ants exhibited a significant "size-distance" relation, with the smallest worker ants tending closest to the primary nest. The relationship did not hold for scavengers working over the same areas.

McIver & Steen (1994) investigated the use of secondary nests by *F. obscuripes*. These appear to function as sites

for thermoregulation and a location for transfer of honeydew between foraging and transport workers (chain transport). While their observations did not show excavation to be extensive (35 - 125 cc) at secondary nest sites, the tunneling associated with below ground stem portions and roots is likely to have a significant influence on local soil and plant processes.

McIver *et al.* (1997) describe a supercolony of *F. obscuripes* in the Blue Mountains of Oregon. They determined that the situation was a case of polydomy and that the supercolony was composed of 210 active nests over a small area of second-growth mixed-conifer forest. They estimated the total nest-bound population of the supercolony at 56 million individuals. The number of foraging workers would have to be determined for a total population estimate. Eggs, larvae, and pupae were first encountered near the end of May. Many queens were also present in the supercolony.

Formica oreas Wheeler 1903 - a mountain nymph

DESCRIPTION - Small to large, head clear yellowish red or mostly infuscated with dark reddish brown, mesosoma yellowish red to dark reddish brown, gaster with each somite very dusky red to dark reddish brown anteriorly and black posteriorly. Head moderately shining, mesosoma and gaster dull (Fig. 22).

RANGE - California (Ward 2005), Nevada, Saskatchewan and North Dakota to New Mexico, northwestward to Washington and southern Alberta (Wheeler & Wheeler 1986). Reported from Idaho by Yensen *et al.* (1977).

DISTRIBUTION AT INL - Thirteen collections were made scattered across the site (Map 12), thus it is considered 'present'. The species was reported for the site by Allred & Cole (1971) and Stafford (1987).

NATURAL HISTORY AT INL - The nest types varied: Two of the nests were thatch mounds, one was a mound consisting mostly of gravel, four were under rocks, four in a basalt rock cracks, one in a dead shrub, and two were simple entrances in the ground with no external nest works, and one of those was located at the base of a grass clump.

Workers were foraging midday on 30 May 1987 on East Butte. Large alate females were present in a nest on 14 June 1994. Larvae and pupae were present in a nest on 7 July 1990.

LITERATURE - Stafford (1987) examined the impacts of *Formica oreas* and *Formica obscuriventris* on the arthropod community of big sagebrush at a site adjacent to the INL and a site near the Power Burst Facility. Ant-foraged plants supported significantly fewer defoliating insects and generally had lower densities of fluid feeding insects, compared to ant-excluded plants.

Wheeler & Wheeler (1986) present information on 16 nests of this species from 12 localities in Nevada. The records were widely scattered from the hot desert, to the cool desert and the coniferous forest. Some nests were thatch nests and others were built under or around stones or wood. They reported the workers from several nests tending aphids (one on *Artemisia tridentata*).

Formica planipilis Creighton 1940 - having level, or flat hairs

DESCRIPTION - Small to large, head red with dusky red infuscation to strong brown ventrally and brown dorsally, mesosoma reddish yellow with dark reddish brown infuscation, gaster black or each somite dark reddish brown anteriorly and black posteriorly, head moderately shining, mesosoma and gaster feebly shining (Fig. 23).

RANGE - North Dakota, Wyoming, Colorado, Utah, Nevada, Oregon, Washington, and British Columbia (Wheeler & Wheeler 1986) and Idaho (Yensen *et al.* 1977).

DISTRIBUTION AT INL - The species is 'common' at the site with 29 collections from sagebrush steppe areas off lava, though predominately found in the southern areas of the INL (Map 12). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Most of the nests (23) were thatch mounds. One nest was built in the center of Road T-10 and one in the middle of Road T-21. The thatch mounds ranged from small, low structures to ones that measured 40 cm diameter by 15 cm in height, another was 50 cm diameter by 15 cm tall, and the largest was 75 cm in diameter by 23 cm tall. Five of the nests were located in the base of dead shrubs, one at the base of a dead juniper, and one was an entrance into the ground with no external workings evident. Another nest with no above ground nest structure had multiple entrances in the ground surface. The thatch nests were often host to *Formicoxenus diversipilosus* and *F. hirticornis*. Refer to the discussions of these

two species for more detailed information. *Solenopsis molesta* was frequently ($n = 5$) found living in these thatch nests.

The ants were observed foraging honeydew on 8 June 1991, 23 July 1994, and 30 September 1989 (foraging dead insects). They were observed tending aphids on *Artemisia tridentata*, 8 June 1991 and tending aphids on juniper and *A. tridentata* 4 July 1988.

One queen and callow workers, larvae and pupae were located just below the ground surface in a thatch nest on 5 July 1986. Alate males, females and brood were found in a nest on 8 June 1991, and alate females were found in a nest 4 July 1988. Alate males were collected in nests on 29 May and 22 June 1988. Brood was collected from nests on 28 - 29 May 1988, 8 June 1991 and 24 June 1989. Pupae were found in nests on 26 May and 23 June 1988.

Other arthropods including small spiders, mites, Coleoptera larvae, and pseudoscorpions were common in the thatch nest material.

LITERATURE - Wheeler & Wheeler (1986) made 46 collections of this ant at 29 localities scattered throughout the state of Nevada. They found the ant from 4,800 - 10,200 ft ($\sim 1,450$ - 3,100 m) of elevation (most were found in the 6,000 - 9,000 ft [$\sim 1,825$ - 2,750 m] elevation interval). They ranged from cool desert, pinyon-juniper, to coniferous forest habitats. The Wheelers noted that *F. planipilis* makes extensive use of thatch in the construction of its nests.

McIver & Loomis (1993) found that in 20 of 22 nests of *F. planipilis* and *F. obscuripes* examined, Hemiptera-tending workers of these ants exhibited a significant "size-distance" relation, with the smallest worker ants tending closest to the primary nest. The relationship did not hold for scavengers working over the same areas.

Formica ravida Creighton 1913 - somewhat grey, greyish

DESCRIPTION - Medium-sized to large, head yellowish red, mesosoma reddish yellow, gaster dark reddish brown, dull (Fig. 24).

RANGE - California to Washington, thence eastward to Colorado and the Dakotas (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported the species from Idaho, as *Formica haemorrhoidalis*.

DISTRIBUTION AT INL - We collected this ant species five times on the INL. Two of the collections were along the north western boundary of

the site while another three were made in the south central area (Map 11). Thus this species is considered 'rare' at INL. The species was reported for the site by Allred & Cole (1971), as *F. haemorrhoidalis*.

NATURAL HISTORY AT INL - One nest was a thatch type in a large rocky drainage in juniper woodland vegetation. Another collection was from a column of foraging workers in adjacent sagebrush steppe vegetation off lava. Two more collections were from low thatch mounds and one from under a rock. These collections are all from deep soils in sagebrush steppe vegetation both on and off lava. One collection was within the riparian zone along the Big Lost River.

LITERATURE - MacKay & MacKay (1982) described the coexistence and competitive displacement of *Camponotus laevigatus* by *Formica ravidia* (= *haemorrhoidalis*) in southern California. They found that the nest displacement by *F. ravidia* was common, yet probably due to greater dispersal ability and acceptance of broader nest site characteristics the *C. laevigatus* population appeared to be increasing.

MacKay & MacKay (1983) examined internest movement in *F. ravidia* (= *haemorrhoidalis*) in California. They found that most such movement occurred during the spring. Brood was transported to these new nests. The resulting extension of the foraging range of the ant reduces the distance that food must be transported to the brood.

MacKay & MacKay (1984) found the nests in openings in the forest in southern California. They found nest densities of 5.7 nests/ha (range 1 - 15 nests/ha) for their study site. They found a mean adult worker population of $33,529 \pm 9595$ SE (range 2,024 - 61,000 adult workers per nest). They found that workers foraged 24 hours a day during the foraging season (May to October) and that the foraging radius extended up to 23 m from the nest. Insects and honeydew from aphids were the main food items foraged.

Clark & Comanor (1986) describe the mating flights and provide other natural history notes on this species in northwestern Nevada. They found insects and honeydew were the main forage items. Foraging was diurnal and began at about 10 °C (50 °F, air temperature). Alate activity was observed from 8 to 12 June. Flights were observed midday at air temperatures of 23.5 - 28 °C (74.3 - 82.4 °F) and 34 % relative humidity under calm conditions.

Wheeler & Wheeler (1986) found 40 nests of the species at 26 localities in Nevada, north of the hot desert. The collections ranged in elevation from 4,300 - 8,800 ft (~1,300 - 2,700 m) and were mostly from the cool desert (one riparian) and the pinyon-juniper areas and a single collection from the coniferous forest. The Wheelers found great variation in nest structure and noted that no two were alike. They found them in a variety of thatch nests (of various sizes and shapes and materials), under stones, under plant debris and under old lumber and even a piece of tin roofing. They note the behavior of the species as "fast, aggressive, bite annoying, workers patrolling pine trunks and numerous on the ground; certainly the dominant animal in that habitat."

Formica subnitens Creighton 1940 - almost shining

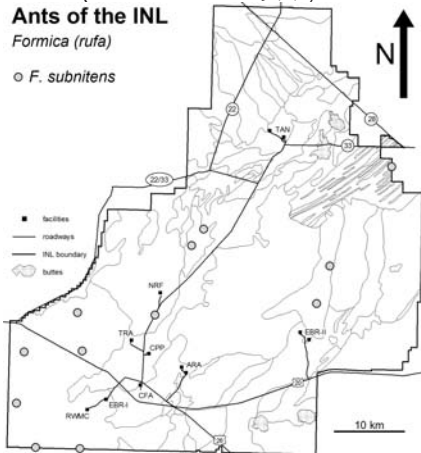
DESCRIPTION - Small to large, head and mesosoma yellowish red, mesosoma with dark reddish brown infuscation, gaster with each somite very dusky red anteriorly and black posteriorly varying to head yellowish red, mesosoma reddish yellow, gaster with each somite dark reddish brown anteriorly and black posteriorly, head feebly shining, mesosoma dull, gaster feebly shining (Fig. 25).

RANGE - North Dakota, Wyoming, Colorado, New Mexico, Nevada, California, Oregon, and British Columbia (Wheeler & Wheeler 1986) and Idaho (Yensen *et al.* 1977).

Ants of the INL

Formica (rufa)

○ *F. subnitens*



DISTRIBUTION AT INL - Fifteen collections were made scattered across the southern part of the site (Map 13), thus the species is considered 'present' at INL. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - This species is found in sagebrush steppe vegetation both on and off lava. Twelve of the nests were thatch mounds. One small thatch mound measured 25 cm diameter by 5 cm tall and another was 30 cm diameter and 10 cm tall. One of the low thatch nests was built in the

Map 13. Map of collection locations for the *Formica rufa* group (in part) on the INL.

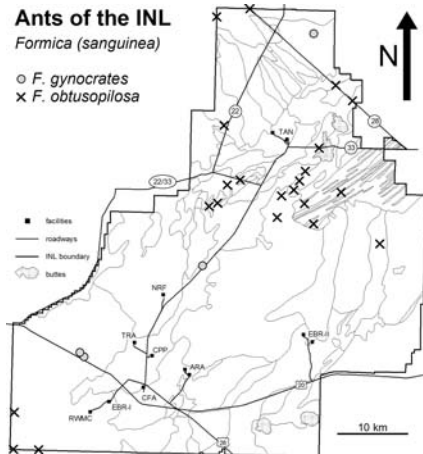
center of Road T-23. Four of the nests were considered arboreal, found in the base of shrubs. The main difference between *Formica subnitens* at INL and elsewhere is in low thatch-type nest structure found here. *Formicoxenus hirticornis* was found in three nests, representing a new host species for the ant (Francoeur *et al.* 1985). *Formicoxenus diversipilosus* was found in one nest, resulting in a new host for this ant as well. *Solenopsis molesta* was also found living in two thatch nests on basalt.

On 28 May 1988 a thatch nest contained “thousands of alate males,” pupae and larvae. On 14 June 1994, one alate female was found in a nest and on 22 June 1988 an alate female was collected in flight. On 29 and 31 May 1993, brood was found in two nests.

On 23 June 1989 a low thatch nest had termites, one Coleoptera (Staphylinidae) (in each of two different nests), and one Coleoptera (Tenebrionidae: *Araeoschizus*).

LITERATURE - Wheeler & Wheeler (1986) state that a literature search shows that this species seems to make little use of thatch with nests composed mostly of soil and detritus. The Wheelers found the species at nine locations in northern Nevada. The ant was found at elevations ranging from 4,600 - 10,500 ft (~1,400 - 3,200 m). The nests were found under stones, composed of soil and gravel with a little plant debris, and one was a “messy pile of thatch

28 by 53 cm piled against a stone.”



Map 14. Map of collection locations for the *Formica sanguinea* group on the INL.

sanguinea group

The species in the *sanguinea* group are all facultative slave makers (species which usually or often have slaves but can survive without them). Members of the *neogagates* and *fusca* groups of *Formica* contain the enslaved species.

Formica gynocrates Snelling & Buren - *gyne* (woman) and *krateo* (rule), in reference to the dulotic habits of the species.

DESCRIPTION - Snelling & Buren (1985) describe the worker of this species as: "Superficially similar to *F. pergandei*, but differing in the shapes of the head and mesosoma, and in the sculpture, especially of the head. This ant is medium-sized, having a total length of 5.2 - 7.6 mm" (Fig. 26).

RANGE - Snelling & Buren (1985) described this species from Michigan and also reported it from North Dakota, Wyoming and Colorado. Yensen *et al.* did not report the species from Idaho and Wheeler & Wheeler (1986) did not find it in Nevada.

DISTRIBUTION AT INL - We consider this species 'rare' at the INL with five collections made at four locations. These collections were scattered across much of the site (except for the southeastern portion, Map 14). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - All five of the collections were mixed with *Formica vinculans* present as a slave species. Two nests were under a rock, two nests had large (one cm diameter) entrances with no external nest works, and one nest could not be located.

Two nests were observed and collected at PLG (Table 2) on 2 July 1987: The first was observed between 1200 - 1300 h. The ground was damp from the previous night's rain and the weather conditions were sunny with an air temperature of 20°C. The nest entrance was near a dead *Artemisia tridentata*. The *F. gynocrates* workers were foraging an area about 10 m from the nest entrance. One worker was carrying a dead *Formica argentea* worker back to the nest and another individual was carrying a dead alate Myrmicinae, presumably for food. *Formica vinculans* workers were doing nest work. The *F. gynocrates* workers were moving very rapidly and climbing the grass vegetation near the nest entrance on disturbance. The second nest was observed from 1230 - 1245 h. The nest was at the base of a living *A. tridentata*. *Formica vinculans* were seen at the nest entrance. The workers were foraging at least 30 m NE of the nest entrance to a nest of *Myrmica* sp. which was at the base of a small *Phlox hoodii*. They were raiding larvae, naked pupae and workers and bringing them back to the nest at a rate of approximately 15/min.

Another nest (7 July 1990, ca. 2000 h) was found conducting a large raid on a *F. vinculans* nest at the base of a small shrub. Larvae and pupae were being carried away by the *F. gynocrates* workers. The ants moved extremely fast upon disturbance.

LITERATURE - Snelling & Buren (1985) described this species from Michigan and also reported it from North Dakota, Wyoming and Colorado. They note that the most commonly associated slave species is *F. vinculans* which they conclude is a valid species and not a synonym of *F. neogagates*. Slaves were always members of the *neogagates* group of *Formica*. Talbot (1985) found the nests in open, prairie-like situations.

Formica obtusopilosa Emery 1893 - blunt hairy

DESCRIPTION - Small to large, head and mesosoma dark reddish brown to yellowish red, gaster black, head and gaster moderately shining, mesosoma dull (Fig. 27).

RANGE - Minnesota to Alberta and southward to Nebraska, Nevada, Utah and New Mexico (Wheeler & Wheeler 1986). The species was reported from Idaho by Yensen *et al.* (1977).

DISTRIBUTION AT INL - The species is 'common' at the INL, with 34 collections, and is found mostly in the northern part, but is also found in the extreme southwestern corner of the site (Map 14). The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - *Formica obtusopilosa* is considered a facultative slave-maker. This ant is found in both sagebrush steppe and salt desert shrub areas. Their nests are most commonly found in open areas with soils consisting of hard but sometimes sandy or alkaline surfaces. The most common nest type for this ant at the INL is a large crater nest ($n = 13$). Craters ranged from 8 - 20 cm in diameter with their entrances ranging from 0.8 - 1.8 cm in diameter. Three of the nests consisted of an entrance with no external structure and six of the nests were found under rocks. Three of the nests were found in the clearings of *Pogonomyrmex salinus*. These ants forage during the day time and move very rapidly. Workers were sometimes found on the flowers and flower buds of *Opuntia polyacantha*. One nest was in the base of a living *O. polyacantha* stem with pupae inside a chamber. One nest collected on 31 July 1988 had a chamber full of insect chitin. One nest had a live beetle larva inside.

Workers were actively foraging 3 July 1989, 5 July 1986, 6 July 1986, and 29 July 1988. On 1 July 1989 workers were collecting dead *P. salinus* workers and taking them into the nest. We described their behavior on these forag-

ing dates: 31 May 1993 “fast moving”, 28 May 1988 “very fast,” 9 June 1991 “very active, hard to collect,” 23 June 1988 “extremely rapid running, very fast,” and on 28 May 1988 we noted that the workers at two different nests were “fast moving”.

We collected a dealate female on ground 30 September 1989, presumably searching for a nesting place. We collected alate males in a nest on 31 July 1988 indicating that this species mates later in the season than most of the ants at the site. We found one queen on 28 May 1988 and 4 queens in a single nest on 31 July 1988.

We found pupae in a nest on 28 May 1988, larvae in a nest on 2 June 1993, and brood on 21 June 1989 and 6 July 1989 (2 different nests.)

LITERATURE - Wilson & Brown (1955) provide detailed taxonomic information on this species. Snelling & Buren (1985) provide the most current keys and information on the *sanguinea* group of *Formica*.

Wheeler & Wheeler (1986) found this species widely scattered throughout Nevada. They collected 45 records from 29 locations at elevations ranging from 3,900 - 9,000 ft (~1,200 - 2,750 m). Habitats ranged from the cool desert to the pinyon-juniper areas. About a third of the nests were under stones. Of the exposed nests some were surmounted by craters (5 - 19 cm in diameter), others by messy piles of excavated soil, and a few consisted of just an entrance hole in the ground. Workers were found to be fast, timid and erratic in their movements. In populous colonies they were aggressive. The Wheelers found *Formica fusca* as slaves in two nests.

Genus *Lasius* Fabricius - hairy

Lasius is a Holarctic and Oriental genus. Wheeler & Wheeler (1986) state that in North America north of latitude 35 the members of this genus are among the most common ants. Wilson (1955) notes that the genus is “probably best known for its conspicuous nuptial flights, its habit of tending and transporting homopterous insects, and the temporary parasitic behavior of some of its species.”

Lasius is now considered to include the Nearctic subgenus *Acanthomyops*, which until recently was treated at generic rank (Ward 2005). The ants of this subgenus are subterranean and rarely seen on the ground surface. The food is mostly honeydew from Hemiptera (root aphids and coccids). When the nest

is disturbed or a worker is crushed, a strong odor of citronella is produced. Wing (1968) revised the genus.

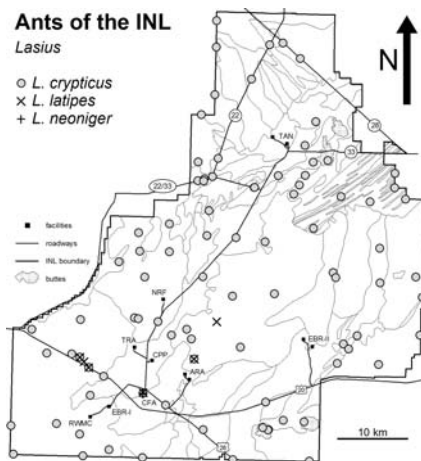
Lasius crypticus Wilson 1955 - hidden

DESCRIPTION - Small, concolorous dark reddish brown, dull (Fig. 28). This species can easily be distinguished from *Lasius neoniger* at the INL by the absence of standing hairs on the scape and tibiae.

RANGE - Alberta and North Dakota to New Mexico and westward to the Pacific (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported this species from Idaho.

DISTRIBUTION AT INL - This ant is 'abundant' at the INL, being found in all habitats, making up a total of 10.8 % of all collections (Map 15). The species was reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - In many areas *L. crypticus* nests are dense. The majority of the nests found (79) were under rocks. Nineteen were small craters (2.5 - 4 cm diameter, up to 15 cm), often in sandy soil. One nest was found under dry cow dung. One nest was a small entrance into the ground with no external nest structure. Six of the nests were found in the clearings



Map 15. Map of collection locations for *Lasius* on the INL.

of *Pogonomyrmex salinus*. One nest was found under a rock in close association with *Myrmica* sp. *Lasius crypticus* was collect in a nest of *Formica lasioides* on 31 May 1993 in sagebrush steppe vegetation, adjacent to a nest of *Formica obscuripes*. *Solenopsis molesta* was found in several nests. A variety of arthropods were found in the nests of *L. crypticus*: pseudoscorpions, mites, Staphylinidae, Scarabaeidae, Hemiptera and Isoptera. This ant was often noted as the "most abundant ant at location." Foraging was observed late afternoon 23 June 1988.

Brood, alate males and females were collected in nests on 30 May 1987 (two nests), 26 May 1988 and 28 May 1988 (3), larvae and pupae 24 June 1989, 6 July 1990, alates 29 - 30 July 1988

and 13 August 1989. Alate males were found on 13 August 1989 (two nests), and an alate female on 13 August 1989, in a nest under a rock.

Larvae were collected in nests on 29 May 1993, 31 May 1993 (two nests), 21 June 1989, 24 June 1989, and 1 June 1993. Pupae were collected on 28 May 1988, 1 June 1993, 15 June 1994, 2 July 1988, 23 - 24 June 1988, 5 July 1986 (five nests), and 6 July 1990.

LITERATURE - Wilson (1955) first recognized this species as distinct and described it. The species is most abundant in prairies and tends to replace *L. neoniger* in the most dry, exposed situations. In southern Idaho it was found thriving in a short-grass prairie-semidesert transition. At Cascade, Idaho, it was found in dry willow-poplar woods.

Wheeler & Wheeler (1986) made 24 collections at 21 locations from 3,900 - 8,100 ft (~1,200 - 2,475 m) in elevation in Nevada. They found it widely scattered north of the 38th parallel in the cool desert, riparian areas, the pinyon-juniper and coniferous forest habitats with nest craters ranging from 2.5 to 10 cm in diameter. The Wheelers found *L. crypticus* tending mealybugs on salt grass roots.

Lasius (Acanthomyops) latipes (Walsh 1862) - broad foot

DESCRIPTION - The worker is small, about 2.5 mm (Fig. 29 A). Head is a strong brown, mesosoma brownish yellow, and gaster strong brown to brownish yellow and shining. The "beta" female is larger, about 8 mm. The femora and tibiae resemble flattened plates; the scape is strongly thickened toward the distal end (Fig. 29 B). The beta female is illustrated because it might be very difficult for the non-myrmecologist to identify. It is the most different looking caste within an ant species found at the INL.

RANGE - Coast to coast from southern Canada through the northern United States (Wing 1968) including Idaho (Yensen *et al.* 1977).

DISTRIBUTION AT INL - This species is considered 'present' over INL, but is locally common in the south-central area (Map 15). The nesting sites were located in areas of sagebrush steppe both on and off lava. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - All 12 nests collected at the site were under large rocks. At all four general locations where nests were found, this was the dominant species, found under most rocks examined. Some of the

nests were very populous. Two of the nests were found containing numerous scale insects (Coccoidea), one on 30 September 1989. On disturbance, the ants would carry the scale insects into their tunnels.

Alate males were found in a nest on 21 June 1989 (three different nests) and 13 August 1989. Brood were present in nests on 29 May 1988 and 21 June 1989.

LITERATURE - Wing (1968) revised this genus and provided the most detailed information about this species. He reported about an equal mix of nest types (under stones vs. without immediate cover). Wing (1968) summarized available information and found workers and alates present from June through September, alates from June through October, and dealate queens from July through November.

Wheeler & Wheeler (1986) found the species in Nevada from 4,800 - 6,400 ft (~1,450 - 1,950 m) elevation. The nests were found in the pinyon-juniper biome and the cool desert. The ants were found tending mealybugs (Hemiptera, Pseudococcidae). One nest was in the clearing of *Pogonomyrmex occidentalis*.

Lasius neoniger Emery 1893 - new black

DESCRIPTION - Small, dark reddish brown, moderately shining (Fig. 30). This species can easily be distinguished from *Lasius crypticus* at the INL by the presence of standing hairs on the scape and tibiae.

RANGE - Southern Maine across southern Canada, southward to California and New Mexico and across Oklahoma to Florida (Wheeler & Wheeler 1986). Yensen *et al.* (1977) report this ant from Idaho.

DISTRIBUTION AT INL - This species has only been found at one location at INL, the Central Facilities Area (Map 15), and hence is considered 'rare'. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - This ant appears to be ruderal at the INL with nests being found along the edge of concrete sidewalks bearing small craters. The ant was actively foraging on 15 July 1995 at 0930 h.

LITERATURE - Wilson (1955) provides the most recent revision of *Lasius*. The major distribution of this species is in the eastern and Midwestern United States. Wilson notes that the species nests almost exclusively in

open areas, under stones or in open soil with craters. The ants feed on both insect food and nectar.

Wheeler & Wheeler (1986) note that this ant may become a pest around structures and lawns. They made 16 collections from 11 localities widely scattered throughout Nevada. These locations were in the cool desert, hot desert, and coniferous forest. One nest was found under a stone and another surmounted by a messy crater of sand.

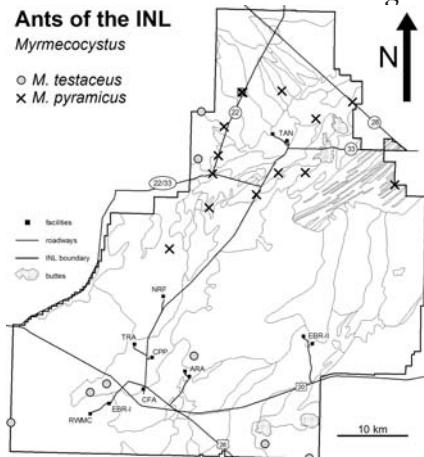
Genus *Myrmecocystus* Wesmael - ant bladder

This is a small genus of North American ants. They are frequently found in arid areas and are commonly known as honey pot ants. This common name stems from their habit of gathering nectar and other liquid foods which are stored in the nest by a 'replete' caste, workers which hold the liquid in greatly distended crops. Both of the INL species belong to the subgenus *Myrmecocystus*. Snelling (1976) recently revised the genus and provides a good review of what is known about these interesting ants.

Myrmecocystus pyramicus Smith 1951 - pyramid, pertaining to Pyramid Lake, Nevada

DESCRIPTION - Small to medium-sized, concolorous yellow varying to bicolored, strongly shining (Fig. 31).

RANGE - Southeastern Oregon, southern Idaho, and northern Nevada (Wheeler & Wheeler 1986). Yensen *et al.* (1977) reported this species from Idaho.



DISTRIBUTION AT INL - This species was found in the northern portion of the site (Map 16). Fifteen collections were made from 14 locations, thus the species is considered 'present' at the site. The species was not reported by Allred & Cole (1971).

NATURAL HISTORY AT INL - Of the 15 nests collected at the site, 13 were

Map 16. Map of collection locations for crater nests and one had an entrance into *Myrmecocystus* on the INL.

visible. The craters ranged from 5 - 15 cm diameter with the entrances ~ 1 x 1 to 1 x 2 cm diameter. These ants seem to prefer sandy to clay type soils and nest in open areas, although one was found nesting at the base of a shrub. Two were nesting within the clearings of *Pogonomyrmex salinus*. A beetle (Scarabaeidae) was found in one nest. The nests usually contained polymorphic workers. We collected this species in sagebrush steppe vegetation both on and off lava and in sagebrush-winterfat areas.

Pupae were found in nests on 3 July 1986 (at a depth of 10 cm), 5 July (8 - 15 cm deep) and on 6 July 1986. Larvae, pupae (including sexual pupae) and one alate male were collected in a nest on 5 July 1987. Replete workers were found in a nest on 30 May 1993.

LITERATURE - Snelling (1976) revised the genus and provides most useful information on this species. He reported this Great Basin species has been collected in areas of Great Basin sagebrush, sagebrush steppe, and salt-bush-greasewood desert. In Idaho Snelling found nests at elevations ranging from 2,350 - 5,400 ft (~700 - 1,650 m). Foraging is mostly nocturnal with workers sometimes active outside the nest at midday on overcast days. The ants forage nectar from flowers and extrafloral nectaries, as well as from aphids and pseudococcids. They are also general scavengers. He notes that repletes have been recovered from nests in Idaho.

Wheeler & Wheeler (1986) made 27 collections at 20 locations north of the 38th parallel in Nevada. All collections were in the cool desert. They found that the craters ranged in size from 5 - 14 cm in diameter (average 9 cm diameter). One species of the tenebrionid beetle (*Araeoschizus*) was collected from a nest in Humboldt County.

Myrmecocystus testaceus Emery 1893 - brownish yellow

DESCRIPTION - Medium-sized, head and mesoma yellow, gaster brownish yellow, eyes black, shining (Fig. 32).

RANGE - Southern Washington to Baja California and eastward to Utah, Nevada (Wheeler & Wheeler 1986) and Idaho (Yensen *et al.* 1977).

DISTRIBUTION AT INL - This species was found mostly in the southern part of the INL though was also represented along the northwestern edge (Map 16). Ten collections were made which places this species in the

mesosoma red, gaster very dusky red. Head and mesosoma dull, gaster feebly shining (Fig. 33).

RANGE - Midwestern and western United States and Canada. Yensen *et al.* (1977) reported the species from Idaho.

DISTRIBUTION AT INL - The occurrence of *Polyergus breviceps* at the INL is 'present', with a total of eight nest collections made. We collected the species at scattered locations in the southern and central parts of the INL (Map 17). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - *Polyergus breviceps* is probably one of the most interesting ants at the INL. We found raiding columns of the species at several locations late in the day. The ants were taking the pupae of nests of *Formica subpolita* (*fusca* group) on three occasions and of *Formica manni* (*neogagates* group) on one occasion. All eight nests found at the INL contained *Formica* slaves. One of the nests was a cratered nest, one had an entrance with no external nest structure, two nests on East Butte were found under large rocks, and one was at the base of a large *Artemisia tridentata* shrub.

LITERATURE - Wheeler (1968) discussed taxonomic issues and Topoff (1997, 1999) and Topoff & Zimmerli (1993, 1994) give a good summary of what is known about the natural history of these animals. In brief, *Polyergus* ants make a raid into a *Formica* nest, stealing pupae that they bring back to their nest to rear or eat. *Polyergus* queens mate at this time. The newly mated queen fights her way to the *Formica* queen and kills her. By licking the dying queen, the *Polyergus* queen acquires chemicals that allow her to control the *Formica* workers. The *Formica* workers then will tend her eggs as well of those of the deceased queen. The *P. breviceps* queen and workers cannot live without the *Formica* workers.

SUBFAMILY MYRMICINAE - THE MYRMICINES

This subfamily is a large group of ants with varied habits and behavior. It can be distinguished on the INL by the pedicel consisting of two somites.

Genus *Aphaenogaster* Mayr - without shiny belly

This is a fairly large genus of ants found nearly worldwide. The New World fauna is in need of revision (MacKay & Vinson 1989). Wheeler & Wheeler (1986) present the best keys to western United States species. Two species are known from Idaho (Yensen *et al.* 1977); one is known from the INL.

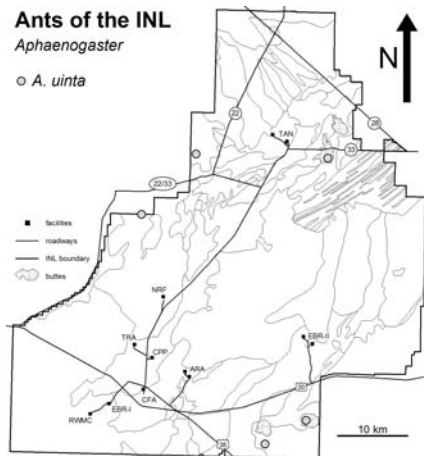
Aphaenogaster uinta Wheeler 1917 - Uinta Mountains in Utah

DESCRIPTION - Worker small to medium-sized. Bicolored with head and mesosoma yellowish red and gaster gray to head and mesosoma red and gaster dusky red. The gaster appears black in the field. The entire body is shining with the gaster strongly shining (Fig. 34).

RANGE - California (Ward 2005), Nevada, Colorado, southern Idaho and southern Utah. Yensen *et al.* (1977) reported the species from Idaho (as *unita* [sic.]).

DISTRIBUTION AT INL - With six collections of this ant being made at five locations it is considered 'present' for the INL. These records were in the northern and extreme SE corner of the INL (Map 18). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - The majority of the nests were found under rocks (six) and one was a crater nest in the open. The nests built under rock were mostly in the juniper woodland vegetation at the southeast corner of the site, on the northwest side of East Butte at an elevation of 1859 m. The queen and larvae were present in a nest collected 30 May 1987. Nests



Map 18. Map of collection locations for *Aphaenogaster uinta* on the INL.

of this species were also on rocky hills (limestone to the northwest and basalt to the southeast) elevated above much of the site. Many alate females and males as well as brood were present on 8 July 1990 at the northwest locality. Two collections were made in sagebrush steppe on lava, one of those on Circular Butte. Alate males and worker pupae were found here on 2 July 1988. *Solenopsis molesta* was found in one nest.

LITERATURE - The majority of the nests found by Wheeler & Wheeler (1986) in Nevada were also under rocks.

About half of the collections made in Nevada were in the pinyon-juniper biome with most of the rest being found

in the cool desert. Wheeler & Wheeler (1986) reported a mating flight on 13 July.

Genus *Formicoxenus* Mayr - ant guest

The genus *Formicoxenus* is a Holarctic genus with few species of small, slow moving ants. The genus consists of seven species, five from North America (Francoeur *et al.* 1985). The only place they have been found at the INL is in the nests of the thatch ants (*Formica*, *rufa* group). The genus has recently been revised by Francoeur *et al.* 1989. Two species are known from Idaho (Yensen *et al.* 1977) (as *Temnothorax* in part) and from the INL.

Formicoxenus diversipilosus (Smith 1939) - different hairs

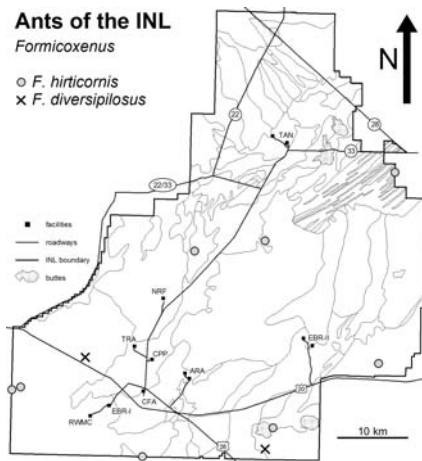
DESCRIPTION - Small ant with erect hairs on scapes long, slender, and pointed. Orange yellow color (Fig. 35).

RANGE - This species is known from northern California, Washington, Wyoming and Idaho (Yensen *et al.* 1977) (as *Leptothorax* in part).

DISTRIBUTION AT INL - Two nests of this ant were found at the INL in the southern part of the site (Map 19), making it 'rare' at INL. One collection was made in sagebrush steppe on lava and one in juniper woodland. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - This species was only found within

the thatch nests of the *Formica rufa* group, *Formica planipilis* and *Formica subnitens*. These represent new host records for the species (Francoeur *et al.* 1985). The *Formica planipilis* host nest was a small, low thatch in and around the base of a living *Artemisia tridentata* with *Juniperus osteosperma* nearby. *Formicoxenus diversipilosus* was found in the host nest at a depth of 20 cm below the ground level. They were common here. Larvae were found on 26 May 1988. The *Formica subnitens* nest was also a low (10 cm high) thatch nest built at the base of



Map 19. Map of collection locations for *Formicoxenus* on the INL.

a dead *Artemisia tridentata*. *Formicoxenus diversipilosus* was found in the central part of the host thatch.

LITERATURE - Alpert & Akre (1973) published the most extensive study of the distribution, abundance and behavior of *Formicoxenus diversipilosus*. They collected the species from the eight major physiographic areas in Washington. It was never collected living alone but was always collected with *Formica obscuripes*. Laboratory studies found that it was unable to survive without its host. Brood was reared separately from the host brood, although the adults moved freely throughout the host nest. Alpert & Akre (1973) also found *Formicoxenus diversipilosus* obtained regurgitated food from their hosts either directly from a worker or more often from two workers as they exchanged food. Francoeur *et al.* (1985) reported the hosts of this species as *Formica obscuripes*, *F. ravida* (= *haemorrhoidalis*), and *F. integroides*. They also provide the most current taxonomic information on the species.

Formicoxenus hirticornis (Emery 1895) - having a hairy horn

DESCRIPTION - Small ant with erect hairs on scape short, stout, and blunt. Orange yellow color (Fig. 36).

RANGE - This species is known from Colorado, North Dakota, South Dakota, and Idaho (Yensen *et al.* 1977) (as *Leptothorax*).

DISTRIBUTION AT INL - This species is considered 'present' for the INL with nine colonies scattered across the INL, except for the extreme northern part of the site (Map 19). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - *Formicoxenus hirticornis* is a minute species that is known only from the thatch nests of the *rufa* group of *Formica*. *Formica planipilis* was the most common host (five). One colony each were found in the thatch nests of *Formica ciliata*, *F. laeviceps*, and *F. subnitens*. These represent new host records for this species (Francoeur *et al.* 1985). It is fairly difficult to collect since it is a tiny ant and we have found it only in small populations within the large and complex thatch nests of the *rufa* group of *Formica*.

Formicoxenus hirticornis was found in a *Formica planipilis* nest just below the ground surface; larvae were present 26 May 1988; one *Formicoxenus hirticornis* nest was found on 4 July 1988 in a large thatch nest just below

ground surface with alate females; two other colonies were each found in a small thatch and a large thatch nest of *Formica planipilis*. The *Formica ciliata* host was a low thatch nest in lava rock, with brood present on 21 July 1989. The *F. subnitens* host nest was a low thatch in sandy soil. The *F. laeviceps* host nest was also a low thatch type.

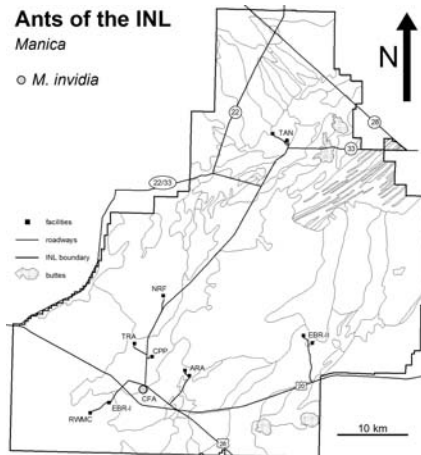
LITERATURE - Francoeur *et al.* (1985) reported this species from nests of *Formica obscuripes*.

Genus *Manica* Jurine - mad

The genus *Manica* is small and confined to the Holarctic. Four species are known from North America (Wheeler & Wheeler 1970). Two species are known from Idaho (Yensen *et al.* 1977). At the INL it is represented by a single, medium-sized species, *M. invidia*.

Manica invidia Bolton 1995 - hostile

DESCRIPTION - Small to medium-sized, worker 3.5 - 6.5 mm. Concolorous yellowish red to dark reddish brown. Head and mesosoma dull, gaster strongly shining (Fig. 37). At the INL this ant could be confused with *Pogonomyrmex salinus*. They can easily be differentiated in the field by the presence of the small crater type nest and different behavior (slower movements) compared to the large mounds and faster movements of *Pogonomyrmex*. The



Map 20. Map of collection locations for *Manica invidia* on the INL.

easiest way to distinguish between these two species is the lack of a psammophore and propodeal spines in *M. invidia* which are present in *P. salinus*. This separation can be made with the unaided eye or very low magnification.

RANGE - California east to New Mexico, Colorado, Wyoming and South Dakota, northwestward into British Columbia and Alberta (one record from Alaska). Known from Idaho (Yensen *et al.* 1977 as *Manica mutica*).

DISTRIBUTION AT INL - The species has been found only at the Central

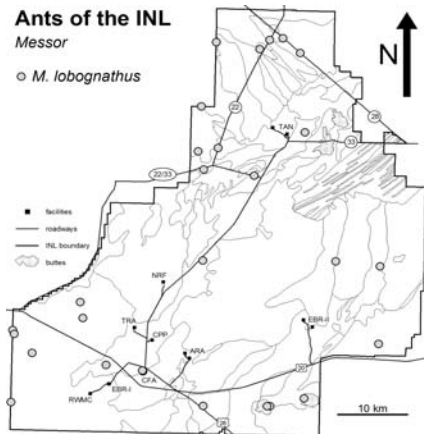
Facilities Area in the southern part of the site (Map 20), making it 'rare' at INL. The species was reported from the INL by Allred & Cole (1971) as *Manica mutica*.

NATURAL HISTORY AT INL - Both collections were made from small crater nests along street and road edges. Here the soil is compacted and covered by gravel. This ant appears to be ruderal in nature at the INL. Workers were foraging and doing nest work at 1800 h on 6 July 1986.

LITERATURE - Bolton (1995) lists the current taxonomic status of this ant. Wheeler & Wheeler (1970) wrote an excellent summary of the natural history of this ant genus. They report that the food of *Manica* is unknown. *Manica* has a mildly painful sting (much less than that of *Pogonomyrmex*). The Wheelers found the species nesting mostly in open disturbed areas. A nuptial flight occurred in Nevada on 20 September. The nests had low numbers of workers (73, 98, and 388 for three that were censused). They note that the habits of this ant may make it a minor local pest. Wheeler & Wheeler (1986) found this species widely distributed throughout northern Nevada from elevations of 3,400 to 8,000 ft (~1,050 - 2,450 m).

Genus *Messor* Forel - reaper

The genus *Messor* is a large genus of seed-harvesting ants found in the Holarctic, Afrotropical, and Oriental regions. *Veromessor* was a New World counterpart to *Messor*, but has been synonymized with *Messor* by Bolton (1982). One species is known from Idaho (Yensen *et al.* 1977).



Map 21. Map of collection locations for *Messor lobognathus* on the INL.

Messor lobognathus Andrews 1916
 - a rounded projection jaw

DESCRIPTION - Worker is medium-sized. Concolorous yellowish red varying to head and mesosoma dark red, each gastric somite red anteriorly and with a band of dark reddish brown posteriorly. Head and mesosoma dull, gaster strongly shining (Fig. 38). At the

INL, this ant is the easiest to confuse with *P. salinus*. It can be differentiated from *P. salinus* by its nesting habits (under rocks and larger crater nests vs. large mounds) and the slower, nocturnal behavior vs. the faster, diurnal behavior of *Pogonomyrmex*. In side view, it can be easily distinguished from *Pogonomyrmex* by its presence of a “saddle back”, the dorsum of the mesosoma is lower behind the metanotal suture (Fig. 38).

RANGE - North and South Dakota, Montana, Colorado, Idaho (Yensen *et al.* 1977) Utah and Nevada.

DISTRIBUTION AT INL - The ant is ‘common’ at INL. We found this species widely distributed (41 collections) over the site (Map 21). The ants were found primarily in the sagebrush steppe on lava, but also the sagebrush steppe off lava, the salt desert shrub, and juniper woodlands (Anderson *et al.* 1996). The species was reported from the INL by Allred & Cole (1971).

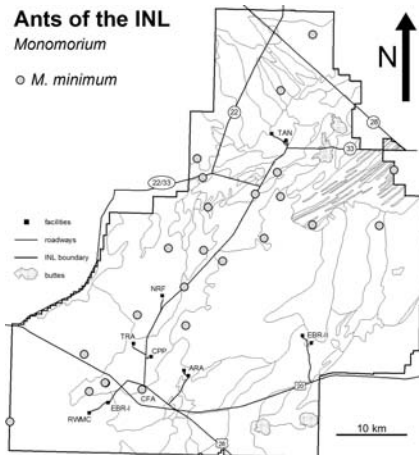
NATURAL HISTORY AT INL - Most (21) of the nests were found under large rocks. Evidence of a *M. lobognathus* nest was often present in the form of coarse sand or fine gravel particles piled around at least one edge of the rock. These particles are coarser than those excavated and placed on the *P. salinus* mounds. Twelve of the nests were medium sized (10 - 15 cm diameter) crater nests. These were often covered with the coarse rock particles. At one northern site (JUN, Table 2) the crater was covered with small branches and scales of *Juniperus osteosperma*. At least one nest had no visible external nest workings, just an entrance into the ground. Nine of the nests were located in the clearings of *P. salinus*, sometimes very near the mounds. Ten of the nests (mostly those under rocks) had numerous chambers of plant seeds. The most abundant seed was that of Indian ricegrass, (*Achnatherum hymenoides* (Roemer & J.A. Schultes) Barkworth), 448 seeds in the chambers of one nest (7 July 1990). Larvae were found in a nest 27 May 1988. Callow workers and brood (pupae and larvae) were found in several nests 22 - 23 June 1988. Many nests on 7 - 8 July 1990 contained larvae, pupae, seeds and some alate males and females. *Blapstinus barri* Boddy (Coleoptera: Tenebrionidae) was found in a single nest. Its relationship with the ants is unknown but it may well have been feeding on the plant materials in the nest. One nest was adjacent to a *Myrmica* sp. nest.

The two seed harvester ant species, *M. lobognathus* and *P. salinus*, seem to coexist by partitioning their foraging on a temporal basis: *M. lobognathus*

forages at night and *P. salinus* during the day. The *M. lobognathus* nests we found seemed to be comprised of small populations.

LITERATURE - Andrews (1916) published the original description of *M. lobognathus*. Bolton (1982) is the most current taxonomic reference for the genus. Gregg (1955) and Wheeler & Wheeler (1956, 1959, 1965, 1967, 1986, 1989) summarize what is known about this ant species: They consider it a rare ant, discuss its distribution from southern Nevada to southwestern North Dakota, give its range in elevation from 2,500 to 7,000 ft (~750 - 2,100 m), and list its characteristic habitat as the pinyon-juniper biome (a semi-arid environment). The Wheelers found *M. lobognathus* on steep treeless south-facing slopes of bare soil in the Dakotas. Under large rocks in fine soils and in coarser soils they found a small mound around the entrance. The workers are aggressive and bite tenaciously, yet the sting is vestigial. The seeds of three grasses are harvested in the Dakotas (*Achnatherum hymenoides*, *Stipa comata*, and *Stipa viridula*). The Wheelers spent years searching for the species and recorded it from 20 locations across the western United States, including the Allred & Cole (1971) record. They state that it is a mimic of *Pogonomyrmex salinus*. We tested this idea and found no evidence of shared

cuticular chemistry (exocrine secretions) between these two species (do Nascimento *et al.* 1993). However, mimicry is still a viable hypothesis given the striking morphological similarities.



Map 22. Map of collection locations for *Monomorium minimum* on the INL.

Genus *Monomorium* Mayr - single part

Monomorium is a large genus of ants found world wide. There has been little biological information recorded for most species of *Monomorium* (DuBois 1986). Two species are known from Idaho (Yensen *et al.* 1977), one being found at INL (see below). *Monomorium*

pharaonis is a widespread, introduced species and is a common inhabitant of buildings (Smith 1965), but has not been found at INL.

Monomorium minimum (Buckley 1867) - very small

DESCRIPTION - Minute, concolorous black and strongly shining (Fig. 39). This species and *Solenopsis molesta* are the smallest species on the INL, with minor workers of *Pheidole pilifera* running a close second.

RANGE - This is a common species found in Canada and the lower 48 states and Mexico (Wheeler & Wheeler 1986), though it is rare over much of the Pacific Northwest. Yensen *et al.* (1977) report it for Idaho.

DISTRIBUTION AT INL - We found this ant to be 'common' at the site (Map 22). The species was reported from the INL by Allred & Cole (1971).

NATURAL HISTORY AT INL - Most (17) of the nests were very small (3 - 4 cm diameter) craters. Five nests were found under rocks and one nest had no external structure, just an entrance into the ground. One nest was found along a road edge. This ant seems to prefer finer textured soils for nesting. Some of the nests were extremely populous. One nest also contained *Solenopsis molesta*. One nest was found mixed in a low thatch nest of *Formica ciliata* in basalt rocks, along with *Formicoxenus hirticornis* and *Solenopsis molesta*. The ant was occasionally found in flowers, especially of *Opuntia polyacantha*; one example was on 23 June 1988. On 31 May 1987 workers were found tending aphids on *Eriogonum*. On 29 July 1988 alate males and females were found swarming on top of a hill in the northwestern part of the site. A large queen was found at a depth of 5 cm on 28 May 1988 and brood was found in another nest on the same date. A queen and sexual larvae were found at a depth of 3 cm on 2 June 1993. Larvae were present in a nest on 22 May 1987 and 31 May 1993. The ants were seen foraging above ground over the summer months.

LITERATURE - DuBois (1986) recently revised the genus *Monomorium* and provided a summary of what is known about the biology of the individual species including a diagram of a nest cross-section. DuBois (1986) reports that most nests are shallow (less than 10 cm in depth). Wheeler & Wheeler (1986) present information for Nevada and note that the ant can be a common household pest feeding on mainly foodstuffs. Thompson (1990) includes *M. minimum* in his review of United States pest ant species because of their potentially extensive nest workings marring property. They

note that the food of the ant consists of honeydew, insects and plant secretions. Wheeler & Wheeler (1986) found the ant nesting in a wide range of elevations (1,800 - 8,000 ft [~ 550 - 2,400 m]) and habitats. They note that the ant is timid but that the workers move fast. They found a single colony containing 31 queens in Nevada.

Genus *Myrmica* Latreille - ant

This is a large genus of Holarctic and Oriental ants (~ 150 spp.). Species in this genus are carnivorous but will also feed on Hemiptera and plant liquids. *Myrmica* are medium-sized ants (Fig. 40) and vary in color from reds to browns. André Francoeur is currently revising a couple of the species groups within *Myrmica*. Eleven species were reported from Idaho (Yensen *et al.* 1977).

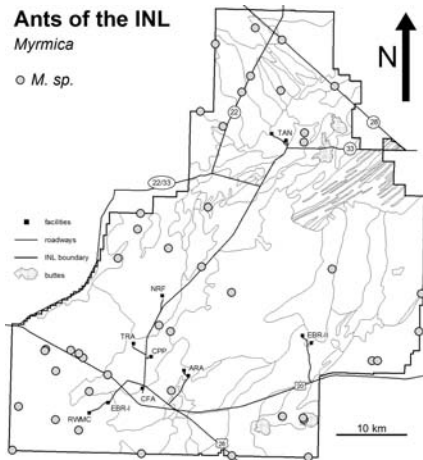
Myrmica sp.

The survey of INL has provided numerous colony series of an apparently undescribed species of *Myrmica* which appears to be the only member of this genus on the reservation.

DESCRIPTION - Medium-sized, light to dark brownish-red, gaster smooth and shining (Fig. 40). Propodeal spines straight and projecting upwards at $\sim 45^\circ$. Erect body hairs moderately abundant and long. Gastric pubescence very sparse. Alitrunk strongly and deeply striated. Petiole and

postpetiole rugose. Head rugose with dorsum of reticulated rugae. The species is similar in overall appearance to *Messor* and *Pogonomyrmex* but is smaller and more rugose.

RANGE - This is an Idaho and western United States species found infrequently in warm habitats (Jackson *et al.* 1991). Presently known from Idaho, Montana, Nevada, Oregon, Utah, Washington in USA and British Columbia in Canada. This ant should also be found in Arizona, California, New Mexico, Wyoming and Southern Alberta. Collection records



Map 23. Map of collection locations for *Myrmica* sp. on the INL.

indicate this ant lives also in semi-xerophilous prairie-like sagebrush habitats and open rather dry coniferous forest of the upper Sonora zone in mountains. Foragers have been collected on *Atriplex confertifolia*, *Agropyron cristatum*, *Pterysia terebinthina*, *Balsamorhiza sagitta* and *Pinus* sp. Collecting altitudes include 880 m in Oregon, 1,465 - 2,380 m in Idaho, 1,870 m in Montana, 1,935 - 2 129 m in Utah, 1,935 - 3,134 m in Nevada. Nest are dug in mineral soils, uncovered or under rock.

DISTRIBUTION AT INL - *Myrmica* sp. is 'common' at INL (52 collections). The species is found over most of the site and is found in all major habitats and vegetation types (Map 23). The species was reported from the INL by Allred & Cole (1971) as *Myrmica lobicornis* and voucher specimens were deposited in CAFR. *Myrmica* sp. is rarely found in traditional institutional collections, then either not identified or placed in *M. americana*, *M. discontinua*, *M. lobicornis fracticornis*, *M. lobifrons* or *M. tahoensis*.

NATURAL HISTORY AT INL - The species was found in all of the major soil and vegetation types at the site. This species appears to have diffuse foraging habits, but the use of bait cards and pitfall traps showed that the species was very abundant even when obvious nests could not be found. A total of 17 of its nests were found under rocks. Two of the nests were crater type, and two were entrances with no external nest structure visible. Several of the nests were under shrubs (usually *Artemisia tridentata* but also *Chrysothamnus viscidiflorus*) and grass clumps (especially *Elymus elymoides*), where workers were often tending root aphids. In these situations the nest entrances can be obscured by plant litter. Several nests were found under boards as well as the cover blocks we placed at study plots. On 1 and 2 July 1988 workers were found on the pads of *Opuntia polyacantha*. Brood was found in nests on 30 May 1987, 30 May 1993, 21 and 22 June 1989, and 30 September 1989. A queen was found at a depth of 10 cm on 30 May 1993. An incipient queen was found in a nest under a rock on 5 July 1986. An alate female was collected on a grass stem on 25 September 1988. Alate females and males were collected on East Butte on 8 and 22 September 1989 where they were swarming. One nest under a rock was found to be in close association with *Lasius crypticus* and one nest was adjacent to a *Messor lobognathus* nest.

LITERATURE - Pheromone content of mandibular, poison and Dufour glands was determined by Jackson *et al.* (1991). This chemotaxonomic study

of the species (specimens from INL) showed it to be distinctive from the other 14 described North American *Myrmica* and that it has some similarities with European species of *Myrmica*. Wheeler & Wheeler (1986) give information on nine Nevada species of *Myrmica* for comparison. They report *Myrmica* as a montane genus, preferring damp localities in coniferous forests above 6,000 ft (~1,850 m) and nesting chiefly under stones.

Genus *Pheidole* Westwood - thrifty

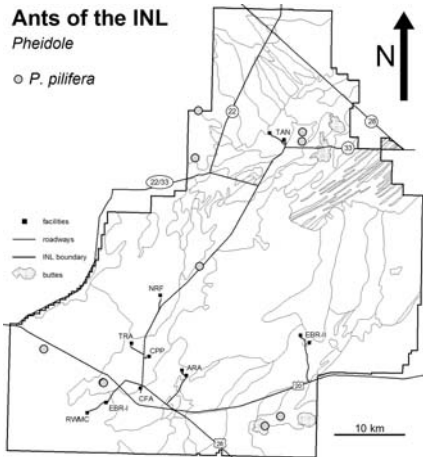
The genus *Pheidole* is one of the largest ant genera in the world and is found world wide. New World *Pheidole* are granivores, carnivores and/or scavengers, though the INL species is considered granivorous guild (Wilson 2003). They are characterized by a dimorphic worker caste with major workers having extremely large heads. The genus has recently been revised for the New World fauna (Wilson 2003). Two species are known from Idaho (Yensen *et al.* 1977).

Pheidole pilifera (Roger 1863) - bearing hair

DESCRIPTION - Major worker: Small (Fig. 41 A). Reddish yellow to darker reddish black. Head and gaster strongly shining. Minor worker: Minute, approximately 1.5 mm (Fig. 41 B). Similar color. Head and mesosoma dull, gaster strongly shining. Very similar in size to the two smallest species on the INL, *Solenopsis molesta* and *Monomorium minimum*. Minor workers of this species at the INL are hard to distinguish from the workers of *Monomorium*.

RANGE - Most of the United States, including Idaho (Yensen *et al.* 1977), except for the extreme Pacific Northwest. We had a difficult time finding this species on the INL, probably due to their small colony, nest, and body size.

DISTRIBUTION AT INL - The species was not reported for the site by Allred & Cole (1971). The ant was



Map 24. Map of collection locations for *Pheidole pilifera* on the INL.

found scattered across the site (Map 24), and is considered 'present' at INL. Initially, it was difficult to identify because we did not find major workers until later in the study and at only one locality. This association of major and minor workers allowed us to recognize minor workers from pitfall and bait samples as well as other nest series from which majors were absent. Wilson (2003) points out that majors rarely leave the nest while minors are the "shy" foragers.

NATURAL HISTORY AT INL - Two of the nests were small craters (1 of 4 cm diameter), one of them was on the edge of a *Pogonomyrmex salinus* clearing. One nest was found under a rock and one was a simple entrance with no external nest structure. One collection was made under a wood block placed out as an artificial nesting site. Another collection of workers was made from *Opuntia polyacantha*. Brood was found in a nest at a depth of 10 cm on 2 June 1993. This was in an area of coarse gravel soil in an old flood plain of the Big Lost River in sagebrush steppe on lava. *Pheidole pilifera* minor workers were actively foraging the morning of 8 June 1991, and major workers were found at a depth of 4 cm on this date.

LITERATURE - Gregg (1958) gave a key to the species known from the United States, and Wilson (2003) has recently revised the genus. Nests are of the crater type in exposed soil and ants store seeds in their nest chambers (Wilson 2003). Wheeler & Wheeler (1986) found the species scattered over much of Nevada except for the northwest. They collected the species from 3,400 - 7,000 ft (~1,050 - 2,150 m) elevation in hot desert to cool desert to pinyon-juniper habitats. All of the nests they found were in exposed terrain. Six of the Nevada nests were found under stones and nine were surmounted by small craters (2.5 - 6 cm in diameter). Mating flights for eastern populations are reported for early to mid July (Wilson 2003). Thompson (1990) indicates members of *Pheidole* can be pest ant species in the United States since they may invade dwellings for food.

Genus *Pogonomyrmex* Mayr - bearded ant

This large group of seed harvesting ants is found in the Nearctic and Neotropical regions. It is one of the most conspicuous and important ants in the western United States. The genus has recently been reviewed by Taber (1998). Two species are known from Idaho (Yensen *et al.* 1977).

Pogonomyrmex salinus Olsen 1934 - salty

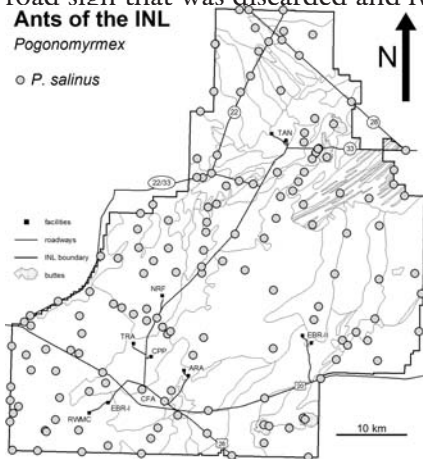
DESCRIPTION - Medium-sized ant, 5.0 - 7.0 mm, and mostly reddish in color (Fig. 42). Queens only slightly larger than workers.

RANGE - From southwestern Canada into Washington, and Montana south through Oregon, Wyoming, Nevada, Utah and northern California and Arizona. Yensen *et al.* (1977) reported the species in Idaho as *Pogonomyrmex owyhee* (in part).

DISTRIBUTION AT INL - This ant is the most 'abundant', visible species at the site and we report 193 nest collections (17.3 % of all ant collections at the site) (Map 25). The species is found in all vegetation and soil types at the site. Allred & Cole (1971) reported the species from the site as *Pogonomyrmex owyhee*.

NATURAL HISTORY AT INL - The mounds and associated clearings of this species are a dominant feature of the INL landscape as they are in much of southern Idaho and other parts of the western United States. They are visible from both roads and highways and from the air. The gravel mound nest type was the most common (154 = 80 %). Nineteen of the nests were low mounds or gravel disks, five the nests were found under rocks, five had entrances with no external nest structure and one nest was a mound of soil with no visible gravel. A few nests were found under boards, fence posts and even a metal road sign that was discarded and lying on the soil. One nest consisted of a double mound similar to that reported by Clark (1993) for a related species, *Pogonomyrmex occidentalis*, in Utah.

During the summer months when air temperatures increase, *P. salinus* become bimodal in activity. This species is diurnal so is not usually active in the early morning, late evening, and night. At the following specific summer dates and times, we found *Pogonomyrmex salinus* in their nests but inactive outside their nests: 28 May 1988 (1245 h); 29 May 1988 (0845 h); 8 June 1991 (1900 h);



Map 25. Map of collection locations for *Pogonomyrmex salinus* on the INL.

9 June 1991 (0745 h); 23 June 1988 (1400 and 1430 h); 29 July 0930 and 1100 h, and 31 July 1988 (1215 h, along with the field note that it was hot). On 3 July 1986 (1420 h) and on 6 July 1990 (0700 h) workers were found doing nest maintenance.

Worker activity in the form of foraging was observed and recorded on the following dates: 29 May 1987 (1900 h) (2); 29 May 1988 (1200 h); 29 May 1993 (1300 h) and (1630 h); 30 May 1987 (1800 h); 30 May 1993 (1000 h); 31 May 1993 (1000 h) seeds, (1245 h) seeds, and (1930 h); 2 June 1993 (1100 h) and (1800 h); 8 June 1991 (1230 h) (2), (1530 h), (1600 h), (1900 h), and (2000 h); 9 June 1991 (1030 h), (1430 h), and (1530 h); 15 June (1945 h); 23 June 1988 (1000 h) (2) grass seeds, and (1630 h); 24 June 1988 (1000 h), 3 July 1988 (2) grass seeds; 5 July 1990 (2030 h); 6 July 1990 (0815, 0900, 1130 h) grass seeds, (1130 h) including dead *Formica*; 7 July 1990 (1045 h), (1400 h) nearly inactive, and (1600 h) seeds; 8 July 1990 (1100 h) seeds; 22 July 1994 (1900, 1950 h); 23 July 1994 (1200 h); and 31 August (1725 h) (2).

Queens (dealate females) were found on 28 May 1988 at a depth of 3 - 5 cm in the mound (2); on 31 May 1993 in the center of a nest with eggs and a few workers; on 2 June 1993 in the apex of a mound; on 3 July 1989 under a rock; on 5 July 1986 in a mound; on 11 August 1989 in the soil at 3 cm depth, an incipient nest; and a female was found digging an incipient nest on 13 August 1989.

Reproductive activity at INL started in early July and continued through the middle of August, depending on the year: Alate callow females were found in a nest on 3 July 1989; and again on 5 July 1986; and alate males and females were found in a nest on 11 August 1989. Swarming (alate male and females mating) were recorded on 19 July 1989 at the Experimental Farm and on top of East Butte (1000 - 1030 h); 21 July 1994 at the Main Gate; and 31 July 1988 on top of Coyote Butte (1100 h).

Brood was found in *Pogonomyrmex salinus* nests mostly in early summer, on the following dates: eggs were found on 31 May 1993. Larvae and naked pupae were found on both 14 June 1994 (2) and 5 July 1986. Larvae only were found on 14 June 1994 at a depth of five cm (2); and 13 August 1989 (2). Larvae and pupae were found in nests 8 June 1991; 21 June 1989 (2); 23 June 1989 (5); 22 June 1988; 23 June 1988 (3); 2 July 1988 (3); 3 July 1988 (2);

3 July 1989 (3); 5 July 1986; 5 July 1990; and 29 July 1988. Pupae only were found on 2 July 1988 (2); 5 July 1990 (2); and 29 July 1988. Callow workers were found on 2 July 1988, 3 July 1988 (2) and on 11 August 1989.

We found several species of ants using the *Pogonomyrmex* clearings as nesting sites, including *Pheidole pilifera*, *Messor lobognathus*, *Formica subpolita* and *Solenopsis molesta*. *Camponotus vicinus* was found nesting in an abandoned mound of *P. salinus* while *Camponotus hyatti* was found nesting in the stem of a dead shrub in a *P. salinus* mound.

Pogonomyrmex salinus is important because it is so numerous at the INL (Blom *et al.* 1991a) and because it has such a significant impact on its environment (Blom 1990). It has also been shown to have implications for waste management at the site (Blom 1990, Blom *et al.* 1991b, 1994). These ants have been shown by Blom (1990) and Blom *et al.* (1991b) to concentrate radioactive materials in their nest soils and may bring waste materials to the surface. In addition, their excavations have been shown to influence soil water balance with further potential to redistribute buried waste materials (Blom *et al.* 1994). After spring snow melt and before resumption of ant activity we often observed extensive mammal excavation into mounds of *P. salinus*. It may be that seed caches in the ant nest are providing a wintertime resource for the rodents and as a consequence inciting additional soil turnover (Clark & Comanor 1973).

LITERATURE - There is much literature on this ant and harvester ants in general. Cole (1968) gave the first comprehensive treatise on the North American *Pogonomyrmex*. Lavigne and Rogers (1974) summarized the literature of *P. occidentalis* and *P. salinus* (= *owyheeii*). Shattuck (1987) reviewed the *occidentalis* complex and determined that *P. owyheeii* is a synonym of *P. salinus*. Wheeler & Wheeler (1986) note that *P. salinus* is probably the most common ant throughout its range. They note that it is the "cool desert" ant of Nevada. They found it from elevations of 3,300 - 8,200 ft (~1,000 - 2,500 m) and found it all over the state except for the extreme southern part. Most recently, Taber (1998) has summarized the status of the genus in the Americas and provided information on emigration, foraging behavior, habitats and distribution, mimicry of, nest closure, nest population, overwintering, pest status and predators of the species. Thompson (1990) includes *Pogonomyrmex* in his review of pest ant species of the United States for their powerful

venomous sting, the intrusion of their large nest areas and seed harvesting habits especially affecting rangelands.

At the INL, Blom (1990) investigated *P. salinus* and its potential impacts on radioactive waste disposal (providing a literature review as well). Several papers have discussed the impacts of radioactive waste disposal, invertebrate intrusion into waste disposal areas and the use of biobarriers to exclude *P. salinus* from digging into those wastes (Markham 1987, Blom 1991, Blom & Johnson 1995, Johnson & Blom 1995, Johnson & Blom 1996, Gaglio *et al.* 1997, and Gaglio *et al.* 1998a, 1998b, 1998c).

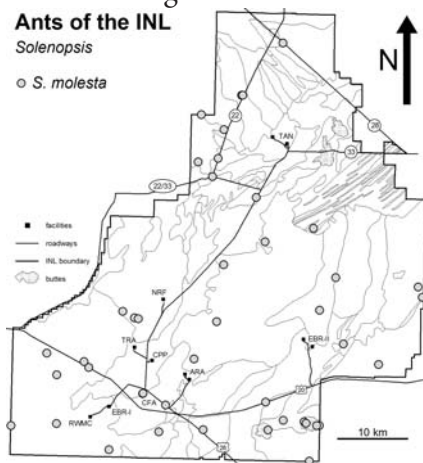
Other literature concerning this species at the INL include Blom *et al.* 1991b, and Blom *et al.* 1994, Clark & Blom (1988), Clark & Blom (1989), Laundré (1990), Nowak *et al.* (1990), Reynolds (1991), Blom *et al.* (1991a), Clark & Blom (1991), Blom *et al.* (1992), Clark & Blom (1992a, 1992b), do Nascimento *et al.* (1993), Blom *et al.* (1994), and Blom & Johnson (1995). Karr & Kimberling (2003) predicted that *Pogonomyrmex* would increase in relative abundance on human disturbance, though their research did not substantiate this prediction.

Genus *Solenopsis* Westwood - channel appearance

This is a large world wide genus known as “fire ants.” The genus may be the best known because of publicity surrounding the “red imported fire ant.” Much of the genus is in need of revision (MacKay and Vinson 1989). One species is known from Idaho (Yensen *et al.* 1977).

Solenopsis molesta (Say 1836) -
annoying, the thief ant.

DESCRIPTION - Minute. This species and *Monomorium minimum* are the smallest species on the INL, with minor workers of *Pheidole pilifera* running a close second. Light yellowish color varying to pale brown. Strongly shining (Fig. 43). Queens much larger than workers.



Map 26. Map of collection locations for *Solenopsis molesta* on the INL.

RANGE - Canada south throughout the United States and into Mexico. Known from Idaho (Yensen *et al.* 1977).

DISTRIBUTION AT INL - This ant is 'common' at the INL (we have made 50 nest collections) and found scattered across the site. Does not appear restricted to specific habitats (Map 26). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - The nests were found mostly (31) under rocks. One nest was found under a large board lying on the soil surface. Several nests were under cover boards at GHN and JUN. Twelve of the nests were mixed with other species, including *Aphaenogaster uinta*, *Pogonomyrmex salinus* (both in the active and inactive mound nests, and nesting in the clearings around the mound), *Formica subpolita*, *F. planipilis*, *F. ciliata*, *F. subnitens*, *F. querquetulana*, *Monomorium minimum*, and *Lasius crypticus*. A nest was found at the base of *Achnatherum hymenoides*.

On 5 July 1986 a nest containing pupae and eggs and three queens was found under a rock. On 30 May 1987 two nests were found under a rock with pupae and larvae and a second nest with brood and a single queen. On 26 May 1988 a nest was found with brood and multiple (eight) queens under a rock. On 28 May 1988 a nest was found with a single queen under rock. On 21 and 24 June 1989 nests were found with brood (2), larvae and pupae (1), and larvae (2) under rocks, respectively. On 5 July 1990 a nest containing pupae, including sexual pupae, was found under a rock. On 8 June 1991 two large nests with brood were collected under large rocks. On 1 June 1993 a nest was found under a rock with brood present. On 14 June 1994 a nest was found under a large rock with brood including naked sexual pupae, with a second nest found the same day having brood present. On 15 June 1994 a nest was found under a small rock with brood and one queen. An incipient nest (containing one dealate female, queen) was found under a rock on 29 September 1989.

LITERATURE - The literature on *Solenopsis* is very large because of the importance of the red imported fire ant (Rhoades 1977, Lofgren & Vander Meer 1986, Porter 1997), with a recent review by Taber (2000) but information on *Solenopsis molesta* seems scarce. *Solenopsis molesta* is called the 'thief ant', because of its habit of nesting in the walls separating the chambers and

galleries in the nests of larger ant species. From these host ants it robs food and brood. The ant may also nest on its own, usually under rocks.

Smith (1965) summarized what we know about the biology of these species and noted that it is one of the most common species of house-infesting ants. Because of their very small size they can enter food containers and cabinets that exclude larger ants. Thompson (1990) includes *S. molesta* in her review of pest ant species of the United States, indicating that they may invade homes in search of food especially during hot weather. Colonies may contain hundreds to a few thousand individuals. Workers are omnivorous, feeding on dead and live insects, plant seeds, household foods, and honeydew produced by Hemiptera. Mating flights have been observed from July into early fall.

Wheeler & Wheeler (1986) found the species common and widely scattered in Nevada. They found them ranging from 2,000 to 8,000 ft (~600 - 2,450 m) in elevation. Habitats ranged from the hot desert to the cool desert, riparian, pinyon-juniper biome and coniferous forest. They reported the species nesting under stones as well as with *Myrmecocystus*, *Pogonomyrmex*, *Messor*, *Pheidole pilifera*, and *Camponotus vicinus*.

Genus *Stenamamma* Westwood - narrow connection

This is a small genus of small Neotropical, Holarctic, Oriental, and Indo-Australian carnivorous ants. Because of their small size and cryptic habits, they are seldom collected. Three species are known from Idaho (Yensen *et al.* 1977), one from the INL.

Stenamamma smithi Cole 1966 - surname of Marion R. Smith

DESCRIPTION - Small, yellow to dark red. Head and mesosoma dull, gaster strongly shining (Fig. 44).

RANGE - California (Ward 2005), Utah, Nevada (Snelling 1973), and Idaho (Yensen *et al.* 1977).

DISTRIBUTION AT INL - We found the species at one locality at the INL, (BCD, Table 2) (Map 27), and it is considered 'rare' at the site. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - *Stenamamma smithi* is a very small and cryptic species. We have only collected a few individuals twice at the same location (BCD). First individuals were discovered in an ethylene glycol pit-

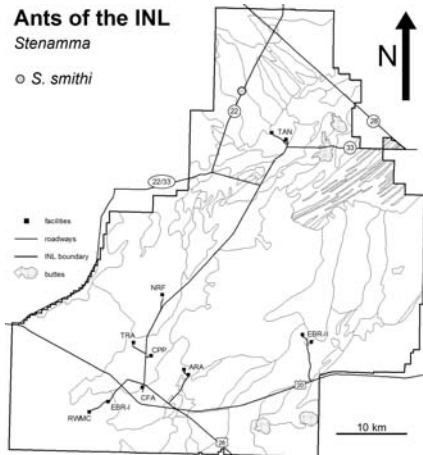
fall trap and then subsequently we were able to locate a nest entrance 60 cm from the pitfall location. The nest was a simple hole in the ground ~ 1 cm in diameter with a very small amount of fine soil scattered to one side. Seven workers were collected foraging out from the nest and around the ground underneath *Artemisia tridentata* shrubs. It is the rarest ant on the site.

LITERATURE - Smith (1957) provides the most recent revision of this genus, Cole (1966) described *S. smithi* from the Nevada Test Site and Snelling (1973) provides the most recent study of western United States species including *S. smithi*. Wheeler & Wheeler (1986) collected only two specimens of this species in Nevada, at two separate locations along the western border of the state. One was found in the coniferous forest biome and the other in the cool desert. They note that the ants are carnivorous and occur in small colonies. Their movement is sluggish and timid and they are rarely seen outside the nest.

Genus *Temnothorax* - cut thorax

This large world-wide genus consists of small ants that nest in wood and soil. Three species have been found at the INL. The genus can be easily confused with the closely related genus *Formicoxenus*. Six species are known from Idaho (Yensen *et al.* 1977).

Temnothorax nevadensis Wheeler 1903 - from Nevada



Map 27. Map of collection locations for *Stenamma smithi* on the INL.

DESCRIPTION - Small, reddish gray to black, head and mesosoma dull, gaster shining, antennae 12-segmented (Fig. 45).

RANGE - Western Montana through Idaho (Yensen *et al.* 1977) to Washington and southward to southern California as *Leptothorax*.

DISTRIBUTION AT INL - Eighteen collections were made (Map 28). We found it widely scattered across the southern part of the site with two collections in the extreme northern

portion of the INL. This ant is 'common' at INL. It was primarily associated with sagebrush steppe vegetation both on and off lava. The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Most of the nests were found under rocks. Two of the nests had small external craters. One nest consisted of an entrance into the ground with no external nest structure and one was in a mud crack with no other external structure present. Larvae were present in nests on 31 May 1993, 8 June 1991, and pupae were present on 28 and 30 May 1987. One individual was collected on a flower bud of *Opuntia polyacantha* presumably foraging for nectar.

LITERATURE - Wheeler & Wheeler (1986) found the species widely distributed in Nevada, but mostly at higher elevations (6,000-8,000 ft [~1,800 - 2,400 m]). They found most nests under stones. MacKay (2000) provides more information on this species including reports of it being found in oak woodlands and leaf litter. MacKay suggests the species may be involved in plesiobiosis since it had been reported nesting at the entrance of other ant species.

Temnothorax rugatulus Emery 1895 - wrinkled somewhat

DESCRIPTION - Small, reddish black to reddish brown, head and mesosoma dull, gaster strongly shining, antennae 11-segmented. The reddish color differentiates this species from the other two *Temnothorax* species found at the INL (Fig. 46).

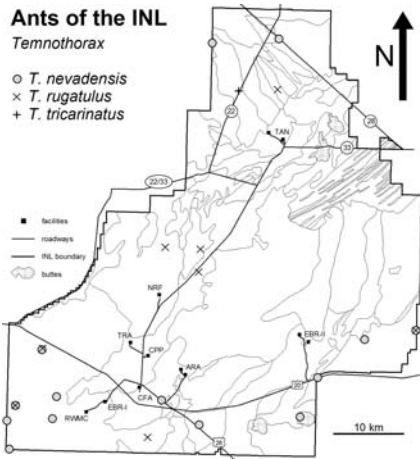
RANGE - From the Dakotas to British Columbia and southward to western Texas, New Mexico, Arizona, and California. It is known from Idaho (Yensen *et al.* 1977) as *Leptothorax*.

DISTRIBUTION AT INL - This ant is considered 'present' for the INL with eight collections widely scattered over the site (Map 28). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - The collections of this ant were made in areas dominated by big sagebrush, *Artemisia tridentata* (Anderson *et al.* 1996). We consider the species arboreal on the site as it was found mostly in the stems and roots of both alive and dead *A. tridentata*. A queen was collected at a depth of 5 cm on 30 May 1993 in a dead sagebrush stem. We also found

Ants of the INL

Temnothorax
 ○ *T. nevadensis*
 × *T. rugatulus*
 + *T. tricarinatus*



Map 28. Map of collection locations for *Temnothorax* on the INL.

them nesting near a *Formica planipilis* colony and entering the thatch nest.

LITERATURE-Wheeler & Wheeler (1986) found *T. rugatulus* widely scattered in northern Nevada. Most records were from higher elevations (6,000 to 7,000 ft [$\sim 1,800 - 2,100$ m]) in conifer forests. They found five nests under stones and eight in rotten wood. The Wheelers commented that this ant is a slow-moving species. Möglich (1978) found *T. rugatulus* nesting under rocks in an oak-juniper forest in the Chiricahua Mountains of Arizona. The nests usually contained one queen and had an average

of 109 workers per nest. Möglich (1978) determined that several species of *Temnothorax* (including *rugatulus*) have small colonies which nest in fragile locations, thus they depend on frequent nest emigrations when the ecological conditions are no longer favorable. Simply moving the rock covering the nest several times constituted enough disturbance to induce nest emigrations. These relocations are accomplished by what is called "tandem running," where one ant leads another to the new nest site.

Rüppell *et al.* (1998) studied size-dimorphism in queens of this ant in North American forests separated by desert areas. They found two different sizes of queens (two queen morphs), one near the size of the workers and one about twice as big as their workers. The size of the queens were highly correlated with that of their daughters (workers). Microgyny may be an alternative reproductive tactic which reduces the costs of the colony investment into queens.

Temnothorax tricarinatus Emery 1895 - three keeled

DESCRIPTION - Small, concolorous black, head and mesosoma moderately shining, gaster strongly shining, antennae 12-segmented. The solid, dark black color of these ants will serve to differentiate them from the others at the site (Fig. 47).

RANGE - From the Dakotas and Iowa southwestward through Idaho (Yensen *et al.* 1977) to Arizona and Nevada as *Leptothorax*.

DISTRIBUTION AT INL - The species is considered 'rare' being found at only one location (the Birch Creek site, Table 2) in the northern part of the INL in the Birch Creek watershed (Map 28). The species was not reported for the site by Allred & Cole (1971).

NATURAL HISTORY AT INL - Known from a single collection of three workers under a wood block; no nest was found. This site is on recent alluvium dominated by *Artemisia tridentata* (Table 2).

LITERATURE - Wheeler & Wheeler (1986) made six collections of this ant at five locations in central Nevada. All of their collections were of stray workers and they report "we know nothing of their nests." MacKay (2000) summarizes the literature concerning this species and notes that its nests are usually found under rocks in meadows and forests. This species seems to do well in disturbed sites and their nests are small and monogynous. Males have been reported in nests from July to September.

CONCLUSIONS

We found a moderately rich ant fauna for the cool desert on the INL, which is predominately sagebrush steppe. Including corrections to the taxonomy of species reported from the site, this investigation increased the number of known taxa by 270 %. It is difficult to speculate how complete this species enumeration is for the INL since our methodology does not permit use of accumulation curves. The 46 species on the INL seem to us a very rich fauna given the relatively small size of the INL and moderately high elevation and latitude. It is likely the diversity of soils (parent materials) and vegetative communities within the reservation's boundaries may contribute to a greater than expected biodiversity. Still, we expect there may be additional taxa to be found (e.g. *Crematogaster*, *Brachymyrmex*). The Wheelers (Wheeler & Wheeler 1986) classified about 3/4 of Nevada as cool desert and recorded 88 species in this biome. While this number is nearly twice that found on the INL we assume much of the disparity is due to the lower latitudes of the Nevada deserts and the exponentially larger area surveyed.

Our methodology permitted sampling over much of the INL across all the seasons, however many areas could benefit from more thorough investigation.

Additionally, use of systematic and quantitative methodologies will be helpful to gain a better estimate of the ant diversity within the reservation boundary. This research and checklist lays the ground work for such investigations.

There is much to learn concerning the ant fauna (as well as all arthropods) at the INL. Future directions for research should include:

- 1) More detailed ecological studies. Fundamental information for most taxa, such as colony size (individuals per colony) and colony densities over the various communities is needed. Another basic component to the autecology of the ants of the site would include nest depth, volume and configuration for edaphic species would could have direct implications for waste management concerns. An example would include the undescribed species *Myrmica* which is common at the site yet little is known of its biology and role in the ecology.

- 2) Additional collection and ecological studies on the “rare” ants collected (*Temnothorax tricarinatus*, *Stenamma smithi*). These may be some of the most interesting ants at the site, as very little is known about their biology, ecology, and natural history. Studies focused on these taxa are likely to render insights for better understanding the biotic communities in which they exist. We have provided information to allow for systematic collections in certain areas to search for these ants in the future. This has the potential for adding valuable new scientific knowledge.

- 3) Relationships with fire. Fire is a natural event at the INL although the fire regime has been altered by man. What is the potential role of ant community in the area’s fire ecology, especially for community persistence and post-fire recovery? Fire ecology of ants has not been adequately studied over a large geographic area.

Glossary

- Abundant.** Ants found in all or nearly all habitats and sites (greater than 68 collections in this study).
- Acidopore.** In the subfamily Formicinae, the circular exit of the poison gland formed by the margin of the terminal gastral sternite.
- Adnate.** Adjoining, adhering or growing together, closely connected.
- Alate.** Winged female or male ant.
- Alitrunk.** The thorax and first abdominal segment (they are fused). Same as mesosoma.
- Brood.** The immature members of a colony collectively, including eggs, larvae, and pupae.
- Carina.** Elevated ridge on the body surface.
- Caste.** The various forms of adult individuals among social insects, such as major workers, minor workers, females, males, etc.
- Cloacal orifice.** Opening to the common chamber into which the anus and the gonopore open; rectum.
- Clypeus.** That part of the lower front of the head to which the labrum is attached.
- Clypeal fossa.** A small pit on the face of some ants, located between the clypeus and gena.
- Common.** Ants found in most habitats over much of the site (18 - 52 collections in this study).
- Concolorous.** Of a uniform color.
- Crater nest.** A circular nest built up around a central entrance into the ground.
- Dulotic.** The case where parasitic ant species raid the nests of another species, capture brood (usually in the form of pupae), and rear them as enslaved nestmates.
- Gaster.** The terminal major body part of ants, excluding the petiole and (when present) the postpetiole.
- Geniculate.** Elbowed or abruptly bent (antenna).
- Gena.** The “cheek” of the head, located between the compound eye and antennal insertion.
- Infuscation (infuscated).** Smoky gray-brown, with a blackish tinge; darkened.

Inquiline. A socially parasitic species that spends the entire life cycle in the nests of its host species.

Large. Ants greater than 4 mm in length.

Mandible(s). Jaw(s) of an ant.

Mesonotum. The upper surface of the second or middle thoracic ring.

Mesosoma. See alitrunk.

Mesometasternal. The middle of the underside of the metathorax.

Metasternum. The underside of the metathorax.

Microgyny (microgyne). In species with two sizes of queens, the smaller of the forms.

Minute. Less than 2 mm in total length, the smallest ants.

Myrmecophilous. Ant-loving. These organisms (ant-guests or myrmecophiles) live in the nest with the host ant for a variety of reasons.

Occipital border. Not an accurate term, but used here and historically to refer to the top of ant's head when viewing the full frontal 'face' as in Fig. 1 (lower panel).

Ocelli. Simple eyes of adults located near the center line of the dorsal surface of the head, usually in a group of three.

Pectinate. Comb-like.

Pedicel. The one or two somites between the mesosoma and the gaster which are much reduced and bear either a node or scale.

Petiole (petiolar). The second abdominal segment and the first segment of the waist.

Pilose. Covered with long, distinct flexible hairs.

Plesiobiosis. The close proximity of two or more nests accompanied by little or no direct communication between the inhabiting colonies.

Postpetiole. In certain ants, the second segment of the waist. It is the third abdominal segment.

Present. Ants found six to 15 times in this study.

Pronotum. The upper or dorsal surface of the prothorax.

Propodeum. Last segment of the mesosoma, actually first segment of abdomen fused to the thorax.

Psammophore. The fringe of long hairs on the posterior surface of the head of some seed harvester ants and *Myrmecocystus*.

Pubescence. Short, fine hairs, typically forming a second layer beneath the pilosity, or longer, coarser hairs.

Punctate. Referring to a surface bearing fine punctures.

Rare. Ants found five times or less during this study.

Ruderal. A species inhabiting disturbed places, along road edges, in rubbish.

Rugae. Wrinkles running approximately in parallel.

Scape. The long basal joint in geniculate antennae.

Sexuals. Members of the ant colony that are capable of participating in sexual reproduction. Usually these individuals will be winged (alate) at some time during their adult lives. Males and queens are the principal sexual castes.

Small. Total length between 2 and 4 mm.

Somite. The body segment of an adult insect.

Spur. A spine-like appendage, often paired and/or pectinate, at the end of the tibia.

Tandem running. A form of communication used by the workers of certain ant species during exploration or recruitment, in which an individual follows closely behind another, frequently contacting the abdomen of the leader with her antennae.

Thatch nests. Mound nests constructed of plant material as well as soil and fine gravel. Typical of many *Formica* (*rufa* group) ants.

Tibia. The fourth division of the leg (between the femur and tarsus).

Tumulus (pl. Tumuli). A heap of earth placed around a nest entrance. A hill or mound of earth.

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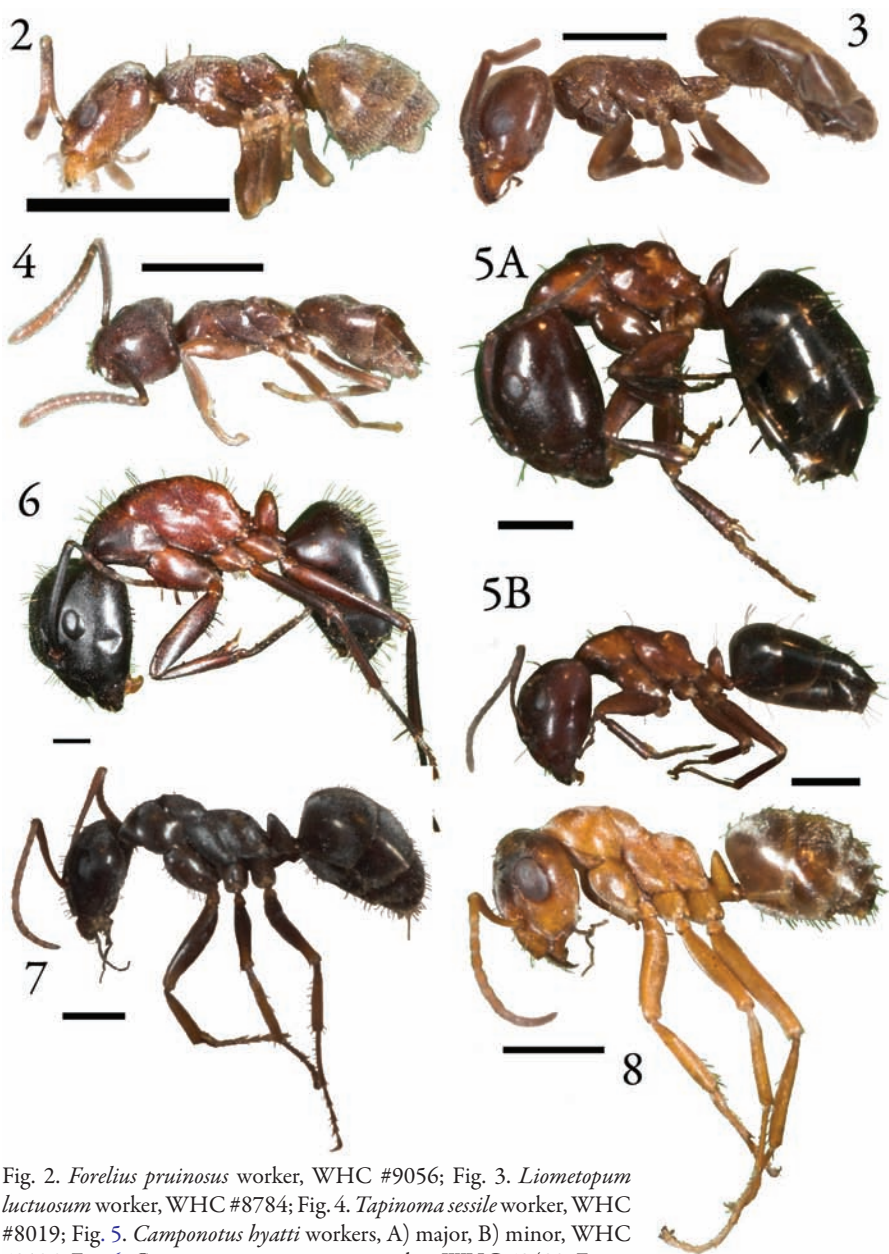


Fig. 2. *Forelius pruinosus* worker, WHC #9056; Fig. 3. *Liometopum luctuosum* worker, WHC #8784; Fig. 4. *Tapinoma sessile* worker, WHC #8019; Fig. 5. *Camponotus hyatti* workers, A) major, B) minor, WHC #9135; Fig. 6. *Camponotus vicinus* major worker, WHC #9490; Fig. 7. *Formica argentea* worker, WHC #9503; Fig. 8. *Formica neoclara* worker, WHC #9004. All scale bars = 1 mm.

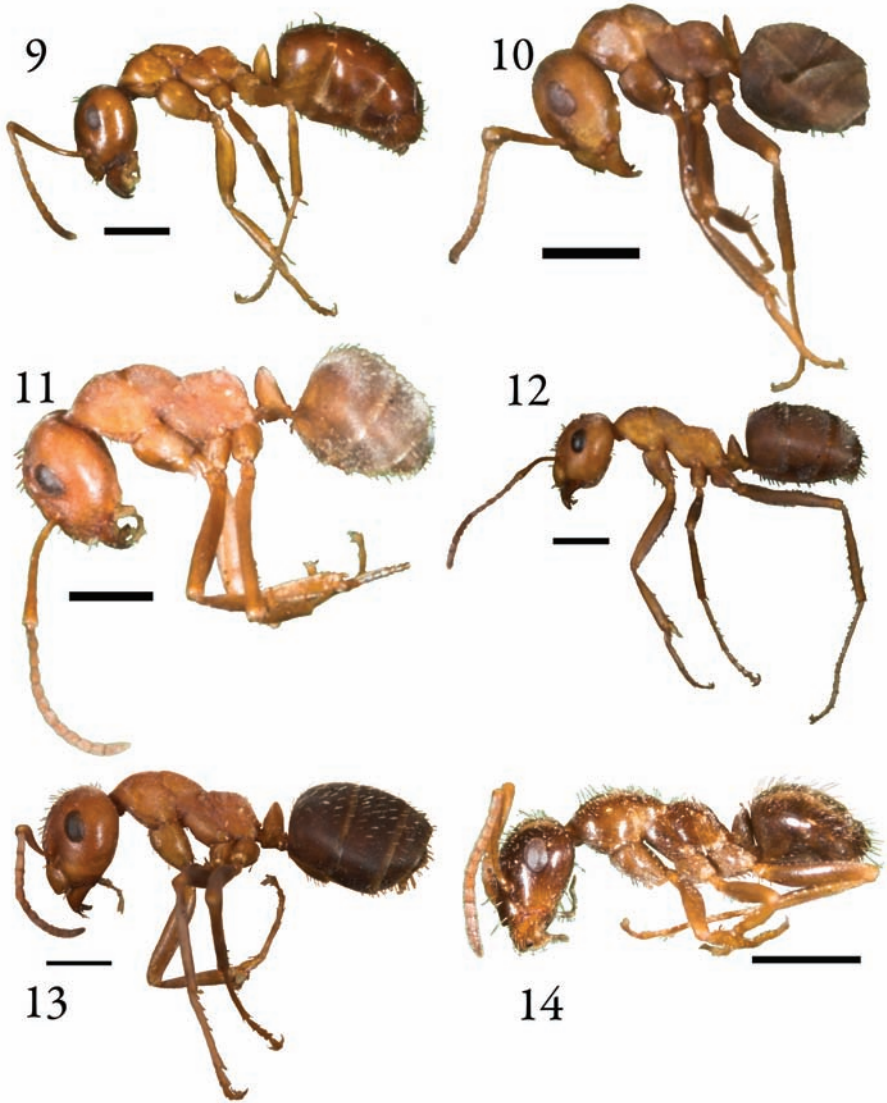


Fig. 9. *Formica subpolita* worker, WHC #8376; Fig. 10. *Formica adamsi* worker, WHC #8968; Fig. 11. *Formica densiventris* worker, WHC #8289; Fig. 12. *Formica querquetulana* worker, WHC #8756; Fig. 13. *Formica spatulata* worker, WHC #8818; Fig. 14. *Formica lasioides* worker, WHC #9376. All scale bars = 1 mm.

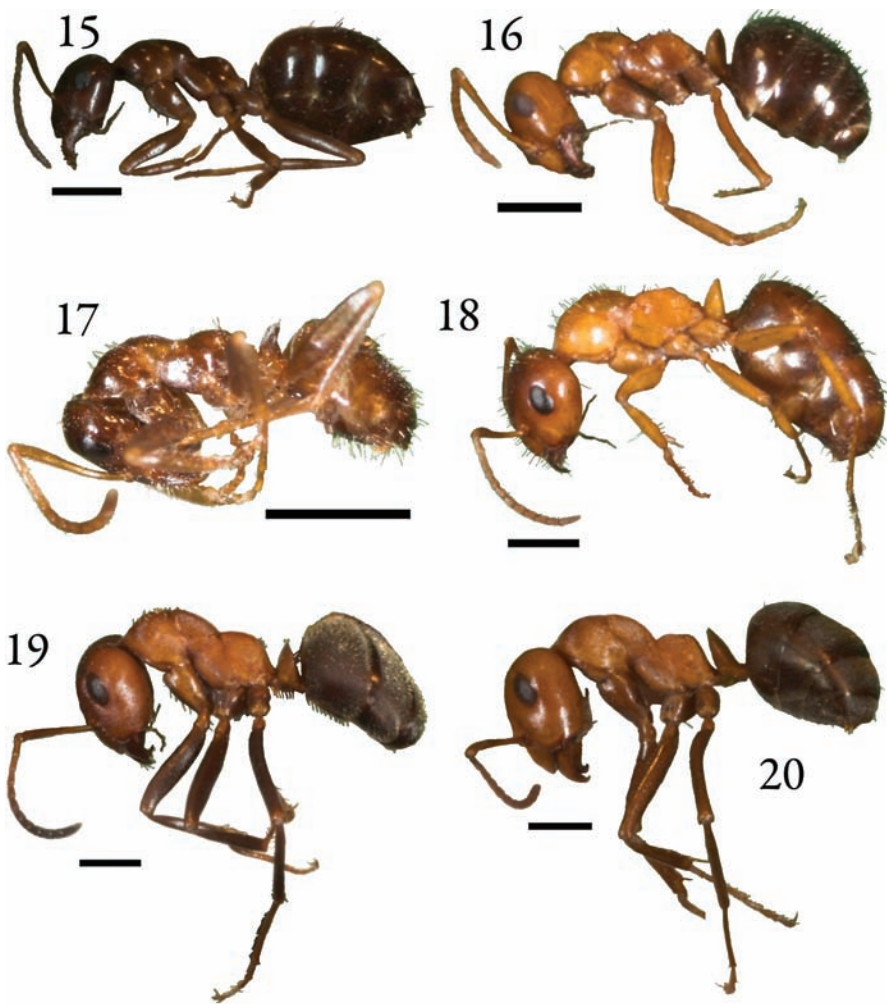


Fig. 15. *Formica limata* worker, WHC #9368; Fig. 16. *Formica manni* worker, WHC #8260; Fig. 17. *Formica neogagates* worker, PEB #10,024; Fig. 18. *Formica vinculans* worker, WHC #8782; Fig. 19. *Formica ciliata* worker, WHC #9105; Fig. 20. *Formica laeviceps* worker, WHC #8378. All scale bars = 1 mm.



Fig. 21. *Formica obscuripes* worker, WHC #8426; Fig. 22. *Formica oreas* worker, WHC #8220; Fig. 23. *Formica planipilis* worker, WHC #8317; Fig. 24. *Formica ravidula* worker, WHC #8255; Fig. 25. *Formica subnitens* worker, WHC #8982; Fig. 26. *Formica gynocrates* worker, WHC #9014. All scale bars = 1 mm.

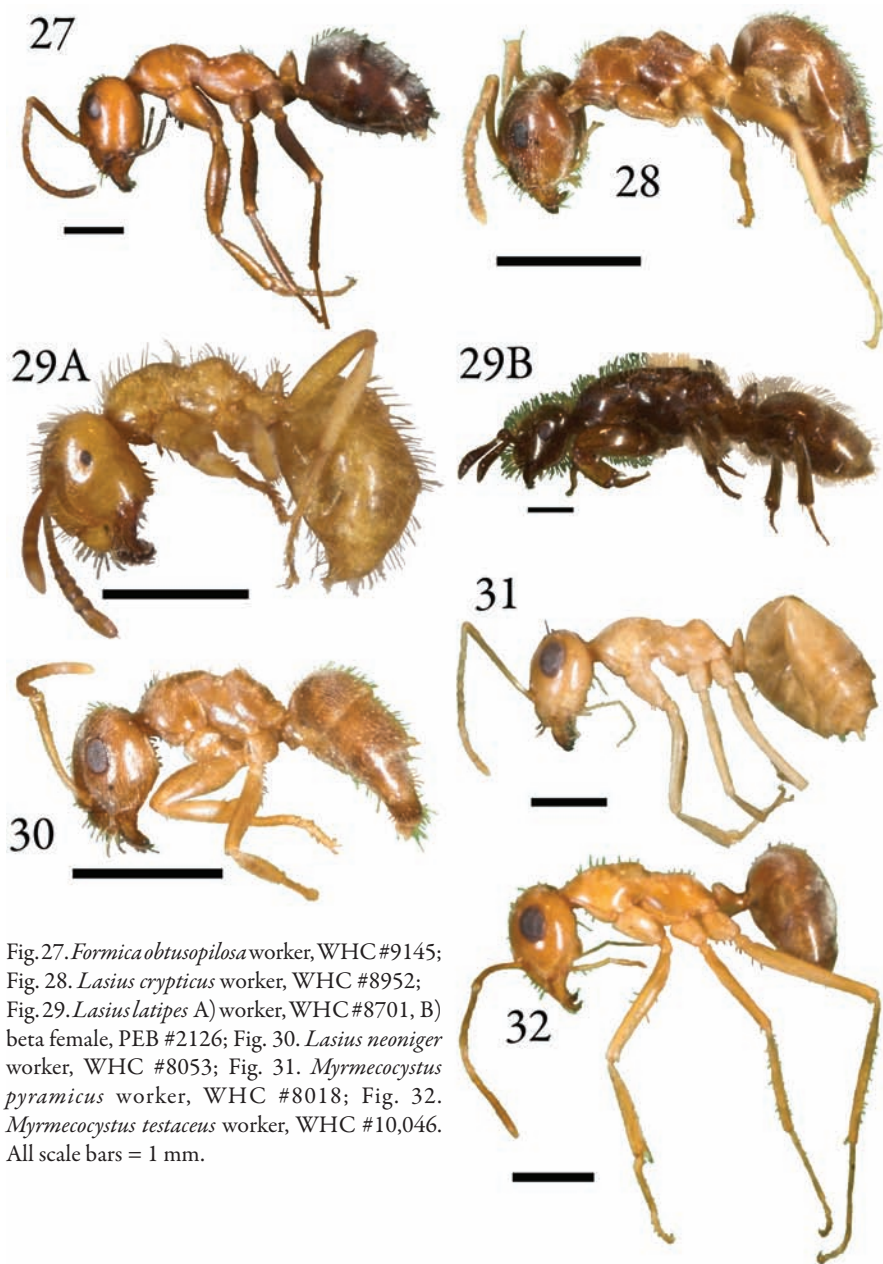


Fig. 27. *Formica obtusopilosa* worker, WHC #9145;
 Fig. 28. *Lasius crypticus* worker, WHC #8952;
 Fig. 29. *Lasius latipes* A) worker, WHC #8701, B)
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 All scale bars = 1 mm.

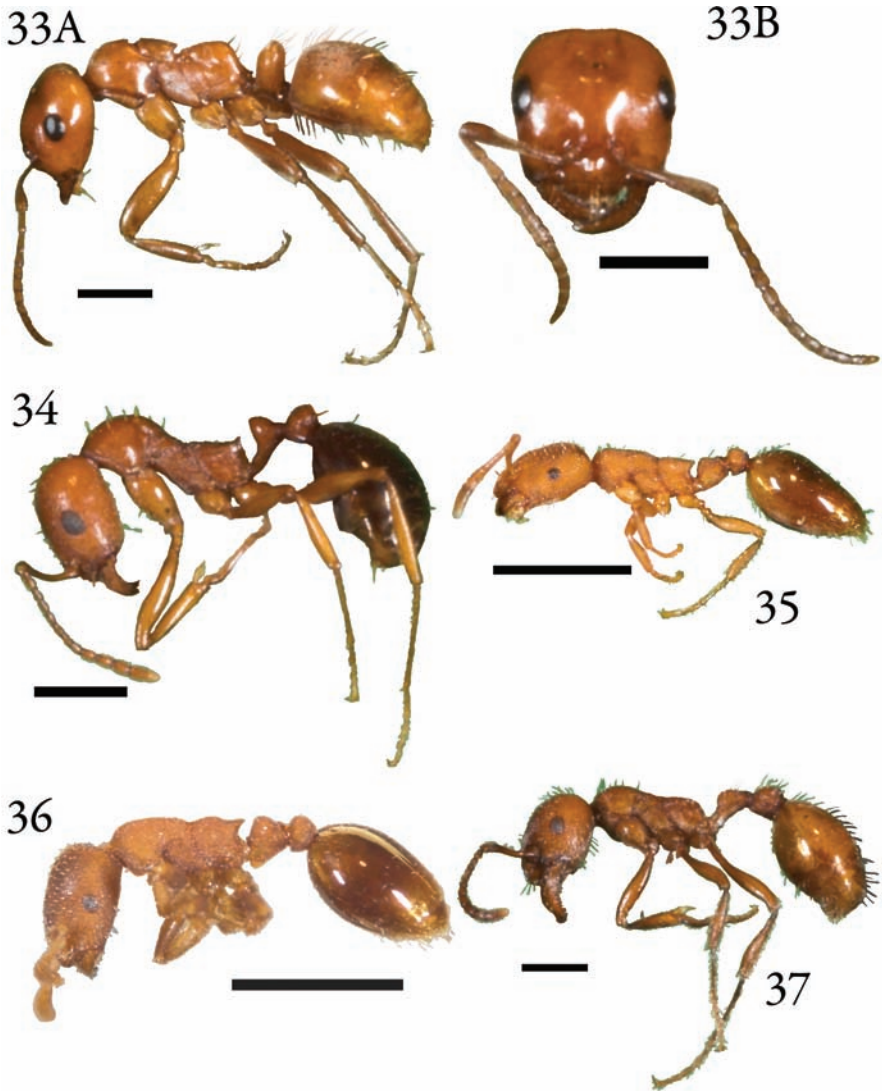


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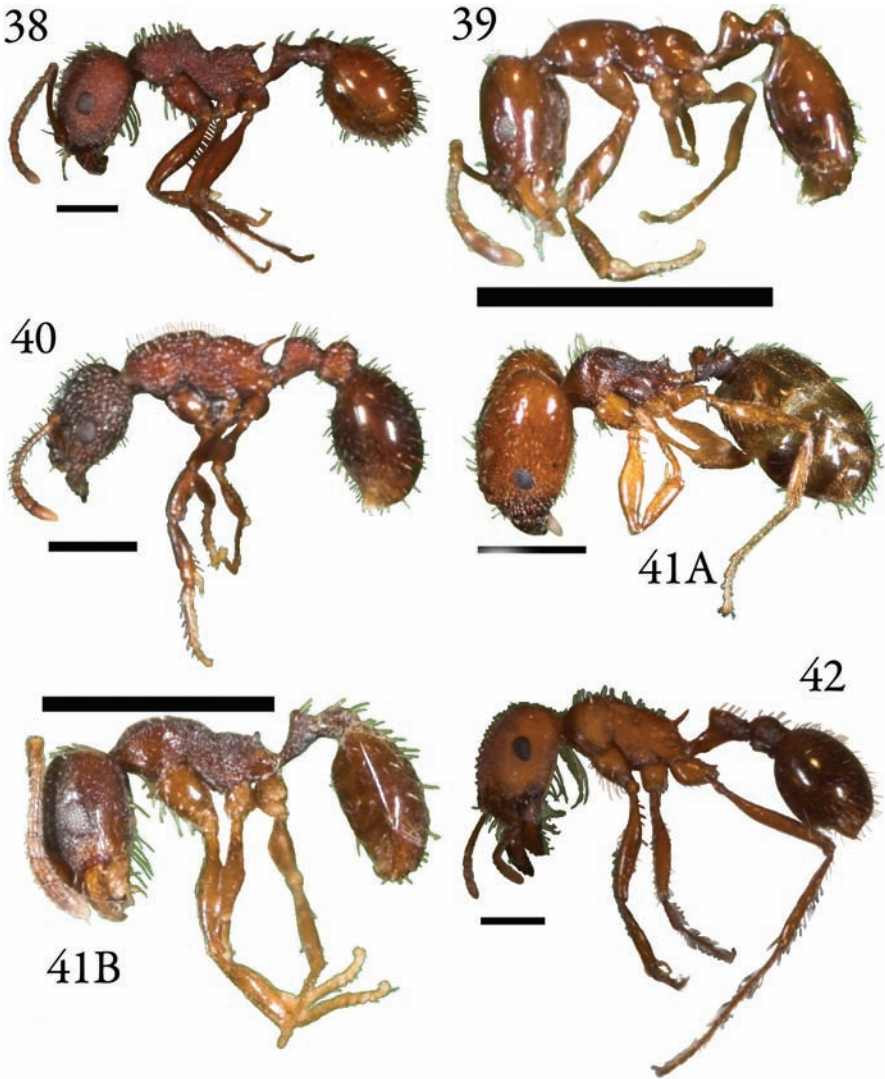


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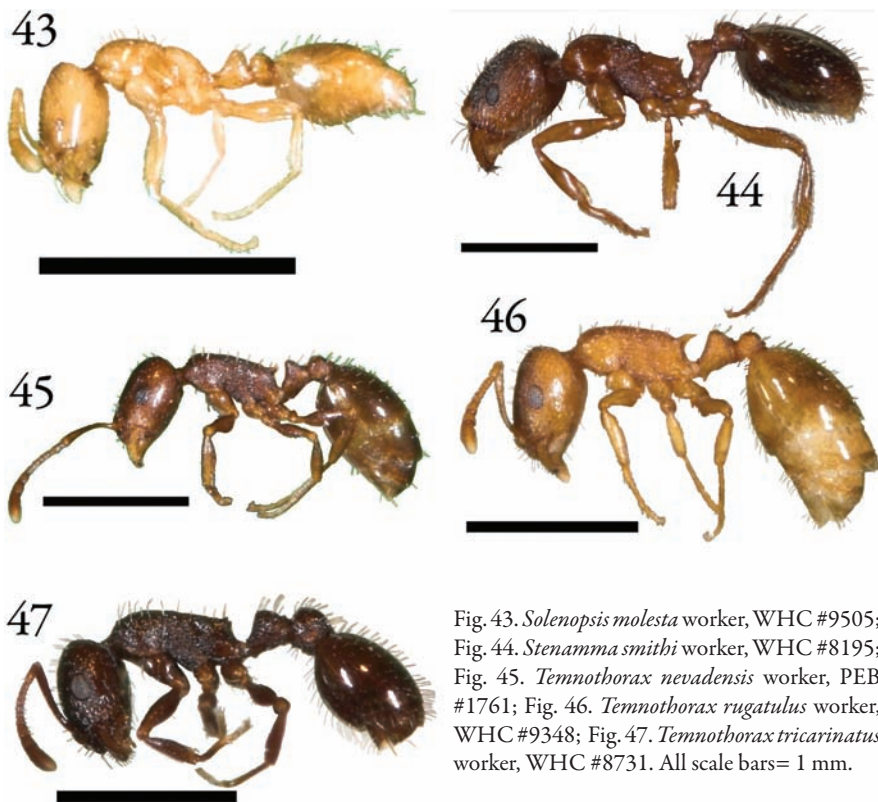


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