



Formicidae of the Bearpaw Mountains of Montana
by Horace Frederick Borchert

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of
DOCTOR OF PHILOSOPHY in Zoology
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Abstract:

Collections from 450 colonies of ants in the Bearpaw Mountains of north central Montana were made during the summers of 1965 through 1969. More than half of the samples were taken during the summer of 1968. The usual methods of the myrmecologist were employed.

An approximate transect was established on the north-south axis of the mountains by collecting along Beaver, Eagle, and Big Sandy Creeks. These three creeks have their headwaters in the higher elevations of the Bearpaw Mountains. Secondary transects were made by collecting from the sides of the valleys as well as from the valley bottoms. The collecting areas were selected to include various vegetation types.

Thirty-nine species and subspecies of ants were found. The twenty-eight species from the subfamily Formicinae constituted the largest taxonomic category. Myrmicinae was represented by ten species. Dolichoderinae was represented by only one species.

Over half, 55%, of the ant species from the Bearpaw Mountains have distributions that are primarily from western United States. Eighteen percent have distribution ranges that cover most of the United States and southern Canada. Thirteen percent have centers of distribution primarily from northeast United States. Boreal and Holarctic ants each form 5% of the population.

New records on the distribution range for eight taxa were made.

These were: *Myrmica lobicornis lobifrons*, *Manica hunteri*, *Aphaenogaster subterranea Occidentalis*, *Aphaenogaster subterranea Valida*, *Solenopsis molesta validiuscula*, *Lasius biveicovnis microps*, *Formica hewitti*, and *Formica microgyna*.

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Zoology

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ABSTRACT

Collections from 450 colonies of ants in the Bearpaw Mountains of north central Montana were made during the summers of 1965 through 1969. More than half of the samples were taken during the summer of 1968. The usual methods of the myrmecologist were employed.

An approximate transect was established on the north-south axis of the mountains by collecting along Beaver, Eagle, and Big Sandy Creeks. These three creeks have their headwaters in the higher elevations of the Bearpaw Mountains. Secondary transects were made by collecting from the sides of the valleys as well as from the valley bottoms. The collecting areas were selected to include various vegetation types.

Thirty-nine species and subspecies of ants were found. The twenty-eight species from the subfamily Formicinae constituted the largest taxonomic category. Myrmicinae was represented by ten species. Dolichoderinae was represented by only one species.

Over half, 55%, of the ant species from the Bearpaw Mountains have distributions that are primarily from western United States. Eighteen percent have distribution ranges that cover most of the United States and southern Canada. Thirteen percent have centers of distribution primarily from northeast United States. Boreal and Holarctic ants each form 5% of the population.

New records on the distribution range for eight taxa were made. These were: *Myrmica lobicornis lobifrons*, *Manica hunteri*, *Aphaenogaster subterranea occidentalis*, *Aphaenogaster subterranea valida*, *Solenopsis molesta validiuscula*, *Lasius brevicornis microps*, *Formica hewitti*, and *Formica microgyna*.

INTRODUCTION

Colonization of the Bearpaw Mountains by ants probably occurred during the last 10,000 years, since the retreat of the last continental glacier. This glacier pushed against the north slopes of the mountains and then flowed around the east and west sides. During this ice age, the ants and other life that was previously present would have had to retreat southward or face extermination.

The ant species now present in the Bearpaw Mountains and their affinities can be in part inferred from the literature. Creighton (1950) lists the distributions for 585 recognized valid taxonomic entities in North America north of Mexico. He also reports the range of certain taxa as "through Montana" or "to Montana" or "coast to coast in northern United States and southern Canada". The "type localities" for a few species or subspecies has been recorded as "in Montana". The Wheelers (1967) have collected ants in eastern Montana and noted the presence of *Veromessor lobognathus* as a new record for the state. There is no indication from the literature that the ant fauna in the island mountain ranges of the eastern portion of the state has been sampled. It likely was mountains of this type that Creighton (1950) had in mind when he wrote: "Many of the species of *Formica* range widely and have produced numerous geographical races. There are also 'insular' species which occur in isolated mountains of the west." The Bearpaw Mountains south of Havre, Montana, are geologically isolated from the mountainous area to the west and south even though they may not be isolated biologically. Gregg (personal

communication) states that he possesses "specimens only from the mountains in western Montana, and some from the vicinity of Billings".

Since there was no indication in the literature of intensive ant collecting from the mountains of eastern Montana, this investigation was undertaken to:

1. Collect and identify the ant species of the Bearpaw Mountains.
2. Relate the ant species of the area to their overall distribution.
3. Correlate the different ant species with vegetation types.

GENERAL DESCRIPTION OF THE BEARPAW MOUNTAINS

Geology

The Bearpaw Mountains (Fig. 1), one of several isolated mountain uplifts of the Tertiary age in the northern Great Plains of Montana, are about forty miles long on an east-west axis and about thirty-three miles on the north-south axis. Most of the peaks are from 4,000 to 5,000 feet above sea level and several are above 6,000 feet. The highest peak is Old Baldy at an elevation of 6,916 feet. The deformed sedimentary rocks are intruded by dikes, sills, plugs and stocks with volcanic formations on the north and south flanks. A continental ice sheet advanced across the northern portion of the mountains during the late Pleistocene, abutted against the high terrain and covered all the existing valleys below 4200 feet with glacial till. After the retreat of the ice sheet, a drainage system developed on the ground moraine. Locally, parts of the preglacial valleys have been resurrected (Pecora, 1957).

Climate

The climate of the Bearpaws is continental with cold winters and warm summers that are typical of the northern prairies. The nearest official station of the U. S. Weather Bureau is in Havre, about thirty miles north of the Bearpaws. From 1931-1967, the mean temperature for January was 13.9 F. The coldest temperature recorded in Havre was -57°F. in January of 1916. During this thirty-six year period, the month of July shows the highest temperatures with a mean average of 69.6°F. and the highest recorded temperature was 111°F. in August of 1961. The mean annual

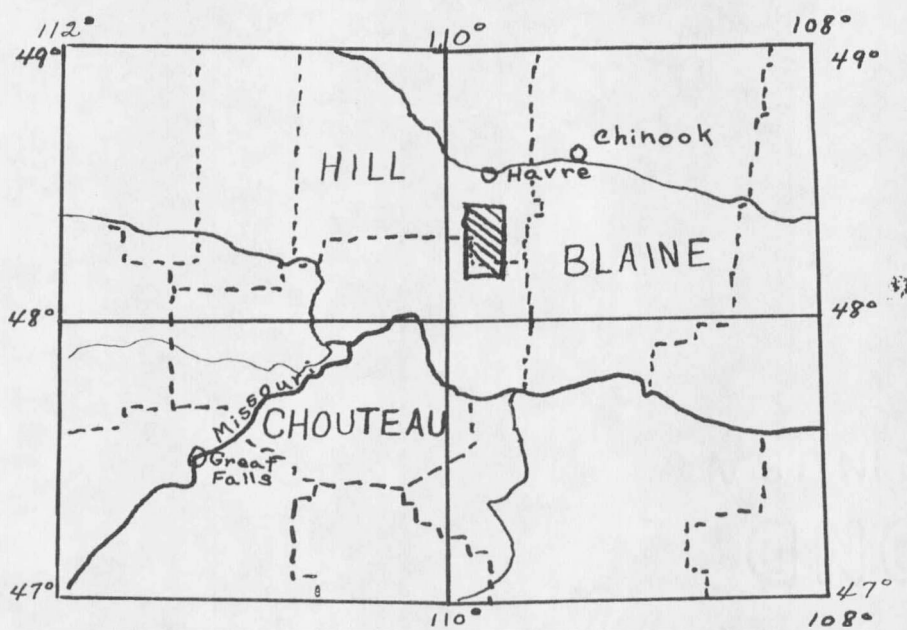


Figure 1. The study area, Bearpaw Mountains, north central Montana.
1" = 50 miles.

precipitation for the 1931-1967 period was 12.78 inches with about half occurring during the months of April through June (U. S. Weather Bureau, 1967).

The climate within the Bearpaws is somewhat milder than that of Havre with the mean average temperature for July of 60°F. The unofficial weather reports from the Bearpaw Ski Bowl gave the winter temperatures near freezing when the temperature in Havre was near 0°F. The annual precipitation in the higher elevations is about seven inches more than that recorded in Havre (Windecker, 1967).

Vegetation

Martinka (1968) recognized seven habitat types in his study of the deer in the Bearpaw Mountains. Walcheck (1969) in his study of the birds along Beaver Creek showed four community types. The ants appear to be primarily limited in distribution by soil conditions and cover, such as rocks or wood for nesting sites, rather than by specific plant groups. Gregg (1963) states, "It is evident that ants are more sensitive to the composite of environmental conditions (climate and biotic) to which they are subjected and to which they must be adapted, and are controlled less by relations with particular plant species or groups of species, than many other groups of insects." In this study four plant complexes which also reflect soil conditions are recognized.

The coniferous forests (Plate VIII) are found on the north-facing slopes at the higher elevations and are dominated by lodgepole pine (*Pinus contorta*), some Douglas fir (*Pseudotsuga taxifolia*) and a few

alpine fir (*Abies lasiocarpa*). The forest floor is covered by a thick mat of leaf litter with very few rocks exposed; consequently, the nesting sites for the ants are primarily associated with wood.

The deciduous trees and shrubs are found along the flood plains of the streams, along the sheltered cuts and on some east slopes. The dominant trees along the flood plains (Plate V) are: willow (*Salix* spp.), thinleaf alder (*Alnus tenuifolia*) and black cottonwood (*Populus trichocarpa*). In a few places in the higher elevations, as along Eagle Creek (Plate IV), some ponderosa pine (*Pinus ponderosa*) and Douglas fir are found. The understory of shrubs is composed of roses (*Rosa* spp.), dogwood (*Cornus stolonifera*), western snowberry (*Symphoricarpos occidentalis*), chokecherry (*Prunus virginiana*), and western serviceberry (*Amelanchier alnifolia*) on the flood plains. The shrubs extend into the protected watershed cuts and along the east slopes (Plate VIII) of intermediate elevations. Aspen (*Populus tremuloides*) clumps are interspersed throughout the forested areas where there are favorable growing conditions.

The bottom meadows found along the flood plains (Plate VI) as clearings in the forests are the more mesic grasslands. The most common grasses are bluegrass (*Poa* spp.) and timothy (*Phleum pratense*) with some bluebunch wheatgrass (*Agropyron spicatum*) and smooth brome grass (*Bromus inermis*). Dandelions (*Taraxacum officinale*), clover (*Trifolium* spp.), asters (*Aster* spp.), horse mint (*Monarda fistulosa*), and stinging nettles (*Urtica dioica*) are typical forbs. The soil is usually moist since it receives the run-off water from the higher areas and the subsurface water moves into the valleys and comes to the surface as seeps and/or springs.

The upland grasses or bunchgrasses are found on the exposed south and west slopes and on the upland areas. The most common grasses are bluebunch wheatgrass, Idaho fescue (*Festuca idahoensis*), blue grama (*Bouteloua gracilis*), bluegrass and cheat grass (*Bromus tectorum*). The most abundant forbs are vetches (*Astragalus spp.*), arrow-leaf balsamroot (*Balsamorhiza sagittata*), fringed sage (*Artemisia frigida*) and western yarrow (*Achillea millefolium*). The club mosses (*Selaginella spp.*) also form an important part of the soil cover. The topsoil is variable from almost bare parent materials to a few inches in depth and it is dry at least part of the summer. Ponderosa pine stands are found on some of the ridge tops.

METHODS AND MATERIALS

To obtain a representative sample of the ants of the Bearpaw Mountains, collecting was done along three drainage systems whose headwaters are in the higher elevation of the range: (1) Beaver Creek draining northward, (2) Big Sandy Creek draining to the west, and (3) Eagle Creek which drains some of the southern portion of the formation. A transect through the higher portions of the Bearpaws was established by following these creek valleys (Fig. 2). A secondary transect was established for each of the collecting areas selected along each of the creek valleys. This was done by walking a relatively straight line across the valley and collecting from most of the spots in which ants are usually found. The seven collecting areas were selected so that representatives of all the various vegetation types would be sampled. Additional collections were made from areas selected at random through the Bearpaws.

The bulk of the 450 collections were made during the summers of 1968 and 1969; however, about 100 colonies were sampled during previous summers starting with 1965.

The usual collecting procedure involved the removal of the nest cover by turning rocks or chopping logs apart and then picking up the ants with curved forceps and placing them in two-dram vials of 85% ethanol. With some of the small subterranean forms it was necessary to remove a shovel-ful of soil, place it on a piece of cloth such as an old sheet, and to wait for the ants to expose themselves when they left the soil.

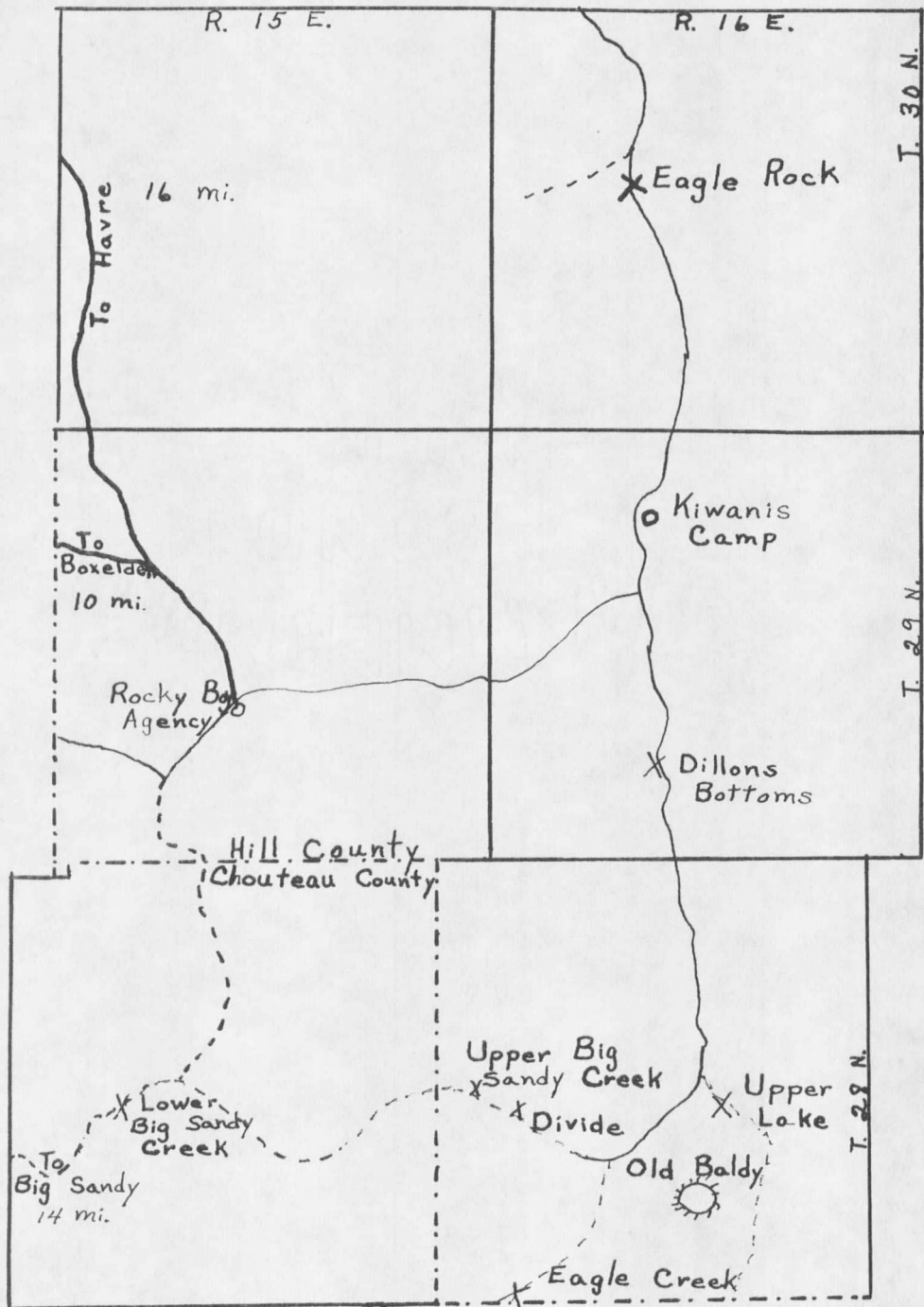


Figure 2. Location of Collecting Sites. 1 cm = 1 mile

 Black top road
 Improved road
 Dirt road

After representatives of a colony were collected, the vial was numbered by placing a slip of paper into it. A corresponding number was written in a field notebook and an entry was made as to the microhabitat, collecting area, date, type of vegetation, and any other notation that was thought to be pertinent.

Upon returning to the laboratory, the soil and other extraneous material that was inadvertently put into the vials was removed and the 'cleaned' ants were placed in vials with fresh 85% ethanol with about 3% glycerol added. Each vial of ants was labeled with the most pertinent collection data and the scientific name of the species.

The ants are social insects and compose the family Formicidae of the order Hymenoptera. The workers are apterous, possess geniculate antennae and an abdominal pedicel of one or two segments. The structure of the abdominal pedicel distinguishes the family as well as the subfamilies. A small hand lens, 10X, is usually a sufficient aid in identification of the genera. Magnification of 100X is needed to see the pectinate spur used in the identification of some genera of Myrmicinae such as *Myrmica*, *Manica* and *Pogonomyrmex*. Most of the identifications were made with the aid of a dissection microscope with 2X and 4X objective lenses and a 10X ocular.

A collection ordinarily consists of the representatives of one species from a single nest; however, a collection could be a single 'stray' that was gathered at a site from which no nests for that species were found. An ideal collection would consist of a number of workers, some of the brood, males, alate females, and dealate females. Most of the collections for this study consist of workers plus any of the other castes found in the

nest. From very populous nests, such as *Formica obscuripes*, it was possible to collect a large number of workers. The number of specimens collected from each nest depended upon the population of the colony and/or the speed with which they escaped into the inner sanctuary of the nest. An attempt was made to get at least ten workers from each nest sampled.

Ants can be collected from spring through autumn. The colonies sampled in the spring were generally smaller than those sampled later in the season. The winter mortality rate could explain this. Brood was found in many of the nests during the latter part of the collecting season, starting with early summer. Late summer and early fall are the best seasons to collect when the winged forms are desired. It was the easiest to collect ants after a rain when the soil was damp and cool for then the ants were in their chambers near the surface and their movements were somewhat sluggish.

Classification of the ants was based upon the keys in The Ants of North America (Creighton, 1950) and The Ants of Colorado (Gregg, 1963) with references to The Ants of North Dakota (Wheeler, 1963).

Dr. Gregg identified and/or verified classifications of specimens that were unfamiliar to me.

SITE DESCRIPTIONS AND RESULTS

Eagle Rock Area

The Eagle Rock collecting area (Plate I) is located in Beaver Creek Park of Hill County in section 16, R. 16 E., T. 30 N. at approximately 3360 feet above sea level. The east bank of the creek continues as a cliff forming the east side of the valley. On the west side of the creek there is a small flood plain that is covered with shrubs, primarily willow and thinleaf alder. A steep bank about ten to fifteen feet high marked the edge of the flood plain. A large number of loose rocks along the bank made an excellent habitat for ants. The remainder of the valley and the east-facing slope was a drier grassland area. An upland grassland about two miles to the west at 3900 feet near the Eagle Rock School was searched for ants.

The parent material of the soil in the Eagle Rock area is variable with alluvium along the stream flood plains and glacial ground moraine in the upland area built upon mafic volcanic rock which outcrops at Eagle Rock (Kerr, 1957). The topsoil is also variable in both depth and texture. Generally, though, the soil is a well drained, dark colored loam with excellent moisture storing capacity (SCS, 1962). The topsoil on the hill-sides appears to be shallow with numerous boulders of glacial origin and outcroppings of bedrock.

The ants found in the bottom flood plain area (Table I) were:

Solenopsis molesta validiuscula, *Formica lasioides*, *F. sanguinea subnuda*, and *F. fusca*. The members of *subnuda* were very numerous and very conspicuous in the area. *F. fusca* individuals were observed on the ground and

TABLE I. The Number of Colonies of each Species Sampled in Relation to the Habitats of the Eagle Rock Area

Species	Upland Grass	Willow- Alder	Bench Grass	East Slope Grass	Under Rock	Wood	Soil	Other
<i>Myrmica</i>								
<i>lobicornis lobifrons</i>	2		6	3	7			4
<i>Solenopsis</i>								
<i>molesta validiuscula</i>	3	2	1		6			
<i>Aphaenogaster</i>								
<i>subterranea valida</i>			2		2			
<i>Tapinoma</i>								
<i>sessile</i>	3		1	3	7			
<i>Lasius</i>								
<i>alienus americanus</i>				1	1			
<i>niger neoniger</i>			5	4	6			3
<i>niger sitkaensis</i>	6				6			
<i>claviger coloradensis</i>			1		1			
<i>latipes</i>	1			1	2			
<i>umbratus aphidicola</i>	3				3			
<i>Formica</i>								
<i>fusca</i>	3	1	2		3	1	2	
<i>fusca argentea</i>			1		1			
<i>lasioides</i>	2	1		2	3			2
<i>puberula</i>	2				1			1
<i>sanguinea subnuda</i>		3	7	1	6	2	1	2
<i>obscuripes</i>			1					1
<i>dakotensis</i>	1							1
Total (17)	26	7	27	15	55	3	3	14

foraging on the vegetation. The other two species were found by turning rocks or other cover so their presence was not evident to the casual observer.

Along the bank and on the bench proved to be the most fruitful area in which to collect ants. The species found in this area were: *Myrmica lobicornis lobifrons*, *Solenopsis molesta validiuscula*, *Aphaenogaster subterranea valida*, *Tapinoma sessile*, *Lasius niger neoniger*, *L. claviger coloradensis*, *Formica sanguinea subnuda*, *F. fusca*, and *F. obscuripes*. Specimens of *F. fusca* and *subnuda* were again the most conspicuous. *M. lobicornis lobifrons* and *L. niger neoniger* colonies were the most numerous and were found by turning rocks or just kicking dry cow chips. The one record for *F. fusca argentea* was taken in this area.

Myrmica lobicornis lobifrons, *Tapinoma sessile* and *Lasius niger neoniger*, the most commonly collected ants from the east-facing slope, were found under rock or cow dung cover. Other species from this site were: *Lasius alienus americanus*, *L. latipes*, *Formica lasioides*, *F. sanguinea subnuda* and *F. fusca*.

The most common ant of the upland grasslands was *Lasius niger sitkaensis*. The presence of *sitkaensis* instead of *neoniger* in this area was somewhat surprising since the latter was taken in the east slope area. The other species collected at this site were: *Myrmica lobicornis lobifrons*, *Solenopsis molesta validiuscula*, *Tapinoma sessile*, *Lasius latipes*, *L. umbratus aphidicola*, *Formica fusca*, *F. lasioides*, *F. dakotensis* and *F. puberula*.

Dillons Bottoms Area

Dillons Bottoms area (Plate II) is in Beaver Creek Park of Hill County section 28, R. 16 E., T. 29 N. at an elevation of 4000 feet above sea level. It is in the vegetation area referred to by Walcheck (1969) as the cottonwood-aspen-willow community. The black cottonwoods form the main cover of the narrow valley. Willows dominate the immediate stream bank area. Quaking aspen groves occur along the valley edge and in the cuts formed by the run-off water. The east side of the valley has rather steep xeric grassland with ponderosa pine on the ridge. A fairly level area above the ridge supports an upland meadow area. The east-facing slope is dominated by the shrubs that are similar to the understory of the valley bottom.

Terrace gravel forms the parent material of the soil on the east side of the valley with alluvium along the valley bottom. The west side of the valley has primarily Mafic volcanic bedrock (Pecora, 1957). The soil texture and depth is correlated to the topography with deep well drained loamy soils along the creek flood plain and shallow loam with outcroppings of bedrock on the steeper slopes (SCS, 1962).

The ants found along the south edge of the upland meadow site (Table II) were: *Myrmica lobicornis lobifrons*, *Solenopsis molesta validiuscula*, *Lasius niger neoniger*, *L. n. sitkaensis*, *L. latipes*, *Camponotus vicinus*, *Formica rubicunda*, *F. microgyna*, *F. lasioides*, and *F. fusca*. The nest of *C. vicinus* contained the dead workers of *M. l. lobifrons* whose dry brittle bodies remained barely identifiable. The species with the largest number of nests found were *S. m. validiuscula* and *L. latipes* with four and three

TABLE II. The Number of Colonies of each Species Sampled in Relation to the Habitats of the Dillons Bottoms Area

	South- west Slope	Bottom Forest	East Slope	Under Rock	Wood	Other
<i>Myrmica</i>						
<i>lobicornis lobifrons</i>	2			2		
<i>schenki emeryana</i>		2	1	3		
<i>brevinodis sulcinodoides</i>	1			1		
<i>Solenopsis</i>						
<i>molesta validiuscula</i>	4			4		
<i>Aphaenogaster</i>						
<i>subterranea valida</i>			1	1		
<i>Leptothorax</i>						
<i>rugatulus</i>			2	2		
<i>Tapinoma</i>						
<i>sessile</i>			1	1		
<i>Lasius</i>						
<i>niger neoniger</i>	4		1	5		
<i>niger sitkaensis</i>	4	8	3	10	4	1
<i>alienus americanus</i>	1			1		
<i>brevicornis microps</i>	1					1
<i>claviger coloradensis</i>			1	1		
<i>latipes</i>	3			3		
<i>Camponotus</i>						
<i>vicinus</i>	1		1	2		
<i>Formica</i>						
<i>fusca</i>	1	2	1	2	1	1
<i>altipetens</i>	1					1
<i>hewitti</i>		1			1	
<i>lasioides</i>	2			2		
<i>sanguinea subnuda</i>		3	1	1	2	1
<i>microgyna</i>	1			1		
<i>rubicunda</i>	1			1		
Total (21)	27	16	13	43	8	5

nests respectively.

The ants found in the upland meadow site, which was cut for hay during 1968, that overlooks the valley from the east were: *Lasius alienus americanus*, *L. niger neoniger*, *L. n. sitkaensis* and *Formica altipetens*. All of these were found under rocks or cow dung.

From the shrub covered east-facing slope, the following species were collected: *Myrmica schenki emeryana*, *Leptothorax rugatulus*, *Aphaenogaster subterranea valida*, *Tapinoma sessile*, *Lasius niger neoniger*, *L. niger sitkaensis*, *L. claviger coloradensis*, *Camponotus vicinus*, *Formica fusca*, and *F. sanguinea subnuda*. The most commonly collected species with three of the thirteen colonies from the site was *sitkaensis*.

One-half of the sixteen colonies of ants found in the cottonwood grove along the valley floor were *Lasius niger sitkaensis*. The most conspicuous ant or those most commonly seen by casual observation in the area, though, was *Formica sanguinea subnuda*. Only three colonies of this species were actually sampled. Other ant species found at this site were: *Myrmica schenki emeryana*, *Formica fusca*, and *F. hewitti*.

Upper Beaver Creek Lake Area

The Upper Beaver Creek Lake collecting area (Plate III) is in the Rocky Boy Indian Reservation near the corrals of the Montana State Experiment Station located in Hill County section 23, R. 16 E., T. 28 N. at an elevation of 4720 feet above sea level. The north and east-facing slopes have a cover of conifers. A site within the conifer stand on a southeastern slope was a drier grassland. The valley floor was a mesic meadow

with willows along the stream banks. The south and west slopes were among the drier grasslands.

The parent material for the soil is Mafic volcanic rock (Pecora, 1957) that has developed into a medium textured, moderately deep, moderately permeable Chernozem soil. The forested area has shallow, medium textured Chernozem soil (B. I. A., 1966).

Myrmica schenki emeryana was found most often in the conifer area (Table III). The drier grassland area within the conifers yielded more species with *emeryana* common here also. The other species from the clearing in the conifer area were: *Lasius subumbratus*, *Manica hunteri*, *Formica fusca* and *F. sanguinea subnuda*.

Only two species were found in the meadow grasses along the valley floor. These were *Myrmica brevinodis sulcinodoides* and *Lasius brevicornis microps*. Just why there were so few ants found in this area can only be postulated. A combination of factors could serve to limit the number of ants in the area. The valley in this area is narrow and there are springs near by. A high water table would tend to limit the number of species since few ant species can live in cool wet soil. The roads and the dam have eliminated some nesting sites and there were few rocks or other cover for nests.

The ant species found on the drier grassland of the west slope were: *Myrmica schenki emeryana*, *Tapinoma sessile*, *Lasius niger neoniger*, *L. n. sitkaensis*, *Formica sanguinea subnuda*, *F. fusca* and *F. neorufibarbis*. Four of the thirteen colonies sampled in the site were *neoniger* colonies. They were heavily populated colonies under the cover of large rocks. The

TABLE III. The Number of Colonies of each Species Sampled in Relation to the Habitats of the Upper Beaver Creek Area

	East Slope Forest	Meadow Bottom	West Slope Grass	Rock	Wood	Soil	Other
<i>Myrmica</i>							
<i>schenki emeryana</i>	14		1	7	6		2
<i>brevinodis sulcinodoides</i>		1		1			
<i>Manica</i>							
<i>hunteri</i>	2			2			
<i>Tapinoma</i>							
<i>sessile</i>			1	1			
<i>Lasius</i>							
<i>niger neoniger</i>			4	2	1		1
<i>niger sitkaensis</i>			2	1			1
<i>subumbratus</i>	5			5			
<i>brevicornis microps</i>		1					1
<i>Formica</i>							
<i>fusca</i>	2		2	1	2	1	
<i>neorufibarbis</i>			1		1		
<i>sanguinea subnuda</i>	5		2	2	5		
Total (11)	28	2	13	22	15	1	5

two colonies of *subnuda* contained *F. fusca* as slaves.

Eagle Creek Area

Eagle Creek drains the southwest portion of the Bearpaw Mountains and has its source at the base of Old Baldy, the highest peak in the formation. The collecting area (Plate IV) was along the bottom of the valley at the intersection of Chouteau County section 5, R. 16 E., T. 28 N. and sections 32 and 33 R. 16 E., T. 27 N. of Hill County at an elevation from 4600 to 4800 feet. The valley floor supported a growth of conifers and some black cottonwood and willows. The clearings were mesic meadows. Drier grasslands were found in the clearing along the south exposures.

Mafic volcanic rock forms the parent material for the soil with alluvium on the creek flood plain (Pecora, 1957). The flood plain has areas with shallow gravel soils with little topsoil and other areas with fine textured deep black soils. The steeper slopes have shallow brown soil strewn with rock fragments.

Twelve species of ants were found in the sixty-two colonies sampled (Table IV). Even though they were not the most commonly collected species, *Formica fusca*, *F. sanguinea subnuda*, and *Camponotus herculeanus* were the most conspicuous ants in the area. These ants forage above the ground, form fairly large colonies, and the individual ants are relatively large. The most frequently collected species were *Lasius niger sitkaensis* with fourteen colonies and *Myrmica schenki emeryana* with thirteen colonies. Colonies of these two species were found on the drier hillsides and along the valley bottom in both the meadows and the forests. Other ants

TABLE IV. The Number of Colonies of each Species Sampled in Relation to the Habitats of the Eagle Creek Area

Species	Hillside Clearing	Bottom Meadow	Bottom Forest	Rocks	Wood	Soil	Other
<i>Myrmica</i>							
<i>schenki emeryana</i>	2	2	9	6	6		1
<i>lobicornis lobifrons</i>	1	1	6	4	4		
<i>Leptothorax</i>							
<i>canadensis</i>			1		1		
<i>rugatulus</i>			1		1		
<i>Manica</i>							
<i>hunteri</i>	1			1			
<i>Lasius</i>							
<i>niger sitkaensis</i>	1	5	8	7	5		2
<i>subumbratus</i>		1	1		2		
<i>Camponotus</i>							
<i>herculeanus</i>			4		3		1
<i>Formica</i>							
<i>fusca</i>	2	2	4		5	2	1
<i>neorufibarbis</i>			3	1	1		1
<i>lasioides</i>			1	1			
<i>sanguinea subnuda</i>		2	4		6		
Total (12)	7	13	42	20	34	2	6

collected in the area were: *Myrmica lobicornis lobifrons*, *Leptothorax canadensis*, *L. rugatulus*, *Manica hunteri*, *Lasius subumbratus*, *Formica neorufibarbis*, and *F. lasioides*. The *hunteri* colony was found in an open area of a southeasterly slope under a small rock. The rest of the species were found primarily in the forested area with scattered nests in the clearings.

Lower Big Sandy Creek Area

Two areas along Big Sandy Creek were sampled with occasional collections made in random areas. The lower Big Sandy area (Plate V) is in Chouteau County section 17, R. 15 E., T. 28 N. at an elevation of 3900 feet. This site is on the Rocky Boy Indian Reservation at the base of Mount Centennial.

The vegetation is transitional between the conifers and the deciduous trees. The north-facing slope has a mixture of trees with ponderosa pine near the top of the ridge and aspen and hawthorne near the bottom. Tall grasses and forbs covered the remainder of the area. The valley bottom has a dense stand of willow near the creek and in the slightly higher areas there are ponderosa pine, Douglas fir, aspen and grasses. The south-facing slopes of Mount Centennial have ponderosa pine on the ridges with aspen on the east-facing slopes of the cuts and the other areas were drier grasslands.

Pediment gravel and alluvium form the parent materials for the soil of the Lower Big Sandy collecting area (Stewart, 1957). The Chernozem soil of the area is medium textured and most of it is deep (B. I. A.,

1966). The top of the ridges has outcroppings of bedrock. The south slopes have a number of rocks on the surface but the north slopes have deep soils with very few loose rocks to form cover for the ant nests.

Thirteen species of ants were found in the twenty-nine colonies sampled (Table V). *Lasius niger neoniger* colonies were found under rocks among the grasses at the top of the ridge along the south side of the collecting area. The lower north-facing slope yielded *Myrmica schenki emeryana*, *Formica sanguinea subnuda*, *F. fusca*, and *F. obscuripes*. Four out of the ten colonies from the valley bottom were *Myrmica schenki emeryana*. The other species from the valley bottom were: *Lasius niger sitkaensis*, *Camponotus herculeanus*, *Formica sanguinea subnuda*, *F. altipetens*, *F. neorufibarbis* and *F. dakotensis*. Colonies of *Myrmica lobicornis lobifrons*, *Lasius niger neoniger*, *L. brevicornis microps*, *Camponotus vicinus*, *Formica altipetens*, *F. fusca*, and *F. obscuripes* were found on the south-facing slope.

Upper Big Sandy Creek Area

Collections were made in the vicinity of the vermiculite mine along Big Sandy Creek. Designated as the Upper Big Sandy Creek area (Plate VI), it lies within the Rocky Boy Indian Reservation in Hill County section 19 R. 16 E., T. 28 N. at an elevation of 5000 feet above sea level. The north slope of the area is covered by a lodgepole pine stand. The valley bottom is a meadow with a few scattered willow clumps. The south-facing slopes are drier grasslands.

TABLE V. The Number of Colonies of each Species Sampled in Relation to the Habitats of the Lower Big Sandy Area

Species	North Slope	Bottom	South Slope	Under Rock	Wood	Thatch	Soil or Other
<i>Myrmica</i>							
<i>lobicornis lobifrons</i>			1				1
<i>schenki emeryana</i>	1	4		2	3		
<i>Lasius</i>							
<i>niger neoniger</i>	3		1	4			
<i>niger sitkaensis</i>		1		1			
<i>brevicornis microps</i>			1	1			
<i>Camponotus</i>							
<i>herculeanus</i>		1			1		
<i>vicinus</i>			1	1			
<i>Formica</i>							
<i>fusca</i>	2		2	1			3
<i>neorufibarbis</i>		1			1		
<i>altipetens</i>		1	1	1	1		
<i>sanguinea subnuda</i>	4	1			5		
<i>dakotensis</i>		1			1		
<i>obscuripes</i>	1		1	1		1	
Total (13)	11	10	8	12	12	1	4

The bedrock of the collecting area is porphyritic potassic syenite with alluvium along the creek bed (Pecora, 1957). Chernozem soils are typical throughout the area but the depth of topsoil varies with the slope. The shallowest soils are on the south slopes; moderately deep soils are on the north slopes; deepest soils are along the valley floor (B. I. A., 1966).

Seven colonies of ants were found on the north-facing slope with four species (Table VI). These were: *Myrmica lobicornis lobifrons*, *Lasius niger sitkaensis*, *Camponotus vicinus* and *Formica neorufibarbis*. The small number of ants found in this area could in part be attributed to the fact that there are few rocks and little fallen wood to furnish the cover for the nests.

From the grass covered meadow along the valley bottom, twenty-six colonies with eight species were collected. The most common species were *Lasius niger sitkaensis* and *Formica fusca*. Other species found in the meadow area were: *Myrmica lobicornis lobifrons*, *M. schenki emeryana*, *Tapinoma sessile*, *Lasius niger neoniger*, *L. subumbratus*, *Formica sanguinea subnuda*, and *F. obscuripes*.

Ten species in fourteen colonies were found on the south-facing slope. *Manica hunteri* was the most frequently collected species with three colonies, followed by *Formica fusca* with two colonies. One colony for each of the following species was found: *Aphaenogaster subterranea occidentalis*, *Tapinoma sessile*, *Lasius niger neoniger*, *L. claviger coloradensis*, *Formica cinerea lepida*, *F. subpolita ficticia*, *F. criniventris* and *F. obscuripes*.

TABLE VI. The Number of Colonies of each Species Sampled in Relation to the Habitats of the Upper Big Sandy Area

Species	North Slope	Bottom	South Slope	Under Rock	Wood	Soil	Thatch
<i>Myrmica</i>							
<i>lobicornis lobifrons</i>	3	3		6			
<i>schenki emeryana</i>		1		1			
<i>Manica hunteri</i>			3	3			
<i>Aphaenogaster</i>							
<i>subterranea occidentalis</i>			1	1			
<i>Tapinoma sessile</i>		1	1	2			
<i>Lasius</i>							
<i>niger neoniger</i>		1		1			
<i>niger sitkaensis</i>	1	10		11			
<i>subumbratus</i>		1		1			
<i>claviger coloradensis</i>			1	1			
<i>Camponotus vicinus</i>	1				1		
<i>Formica</i>							
<i>fusca</i>		7	2	7		2	
<i>neorufibarbis</i>	2			1	1		
<i>subpolita ficticia</i>			1	1			
<i>cinera lepida</i>			1	1			
<i>criniventris</i>			1	1			
<i>obscuripes</i>		2	1	1			2
<i>sanguinea subnuda</i>			2	2			
Total (17)	7	26	14	41	2	2	2

Divide Area

The collecting area (Plate VII) on the divide between Beaver Creek and Big Sandy Creek is located in Hill County section 20, R. 16 E., T. 28 N. at an elevation of 5600-5800 feet. The north slope supports a lodgepole pine forest that grades into grasslands near the pass. The top of the mountain overlooking the pass from the north has extensive club moss cover with some wheatgrass. The exposed south slope has a sparse cover of bunchgrass, primarily wheatgrass.

The site has shonkinitic rock as the bedrock (Pecora, 1957). The soil is shallow on the south slope and pass areas with numerous boulders and outcropping bedrock. The north slope soil is much thicker and darker with little exposed rock material (B. I. A., 1966).

Within the lodgepole pine forest only four species of ants were found (Table VII). *Camponotus herculeanus* was the most conspicuous ant in the area for they forage on the surface of the ground and on the vegetation. Three colonies were found but individual ants were observed running among the leaf litter. *Myrmica lobicornis lobifrons* and *Myrmica sahlenki emeryana* colonies were found under rocks primarily on the east side of the cover. *Formica neorufibarbis* colonies were found under wood at the edge of the forest where it grades into the lower grasslands.

The most numerous species found on the grass covered ridge on the pass area was *Lasius niger neoniger* with six colonies sampled. The most commonly observed species in the area was *Formica fusca* with four colonies sampled. The two *F. obscuripes* colonies sampled were under rocks without

TABLE VII. The Number of Colonies of each Species Sampled in Relation to the Habitats of the Big Sandy-Beaver Creek Divide Area

Species	North Slope Forest	Grass Ridge	Mt. Top & S. Slope	Under Rock	Wood	Soil	Other
<i>Myrmica</i>							
<i>lobicornis lobifrons</i>	1			1			
<i>schenki emeryana</i>	3			3			
<i>Manica</i>							
<i>hunteri</i>		3	1	4			
<i>Solenopsis</i>							
<i>molesta validiuscula</i>			1	1			
<i>Lasius</i>							
<i>niger neoniger</i>		6	5	10			1
<i>Camponotus</i>							
<i>herculeanus</i>	3				3		
<i>Formica</i>							
<i>fusca</i>		4		2	1	1	
<i>neorufibarbis</i>	2			2			
<i>integra haemorrhoidalis</i>			1		1		
<i>obscuripes</i>		2		2			
<i>spatulata</i>			2	2			
<i>dakotensis</i> (var.)			1	1			
Total (12)	9	15	11	28	5	1	1

thatch in association. The lack of wood material in the area could be an explanation for the absence of the typical thatch mound. It is also possible that they were newly established colonies that as yet did not have time to construct the mound. Four colonies of *Manica hunteri*, one of *Formica integra haemorrhoidalis* and one of *F. dakotensis* were found during the investigation. The one colony of *Solenopsis molesta validiscula* was found in association with a *F. obscuripes* nest.

Five colonies of *Lasius niger neoniger* were found on the exposed south slope and mountain top areas under rocks or cow dung for the most common species. *Formica spatulata* colonies were also found on the mountain top and on the south slope area. One colony of *F. dakotensis* was found under a rock on the mountain top and one colony of *Manica hunteri* was found on the south slope.

DISCUSSION

Subfamily Myrmicinae

The presence of *Myrmica brevinodis sulcinodoides* Emery could be postulated for its range extends from the Dakotas to New Mexico and through the Rocky Mountains to the Pacific Coast and then northward through British Columbia and Alberta to Alaska (Gregg, 1963). The small colony from the Upper Beaver Creek Lake area was found under a small rock. The largest colony for this species was found under a large rock by a cottonwood tree that was near a very small stream on section 20, R. 16 E., T. 27 N. at 4100 feet elevation. The members of the latter colony had a tibial spur that is atypical for the pectinate spur characteristic of the genus. Specimens from this colony were identified by Dr. Gregg. Three of the four colonies represented in this collection were found on the valley bottom where the soil would seldom become dry. The site of the other nest was unrecorded.

Myrmica lobicornis lobifrons Pergande colonies were found in all of the collecting areas from sites that were slightly more exposed to sunlight than the sites in which *M. schenki emeryana* was usually found. Most of the thirty colonies of *lobifrons* were found under rocks with a few colonies under the cover of sticks or cow manure. The presence of this subspecies in north central Montana was previously unrecorded. The known range was given as in the mountains of Arizona, New Mexico, Colorado and Utah, north to Alaska (Gregg, 1963). The subspecies *fracticornis* Emery, which was reported from all portions of North Dakota (Wheeler,

1963), was not found during this investigation. Sixteen of the twenty-five colonies sampled were taken from grasslands and eight from the deciduous forest of the valley bottoms.

Twenty-one of the forty-six colonies of *Myrmica schenki emeryana* Forel were found in the coniferous forest areas and eighteen colonies were found in other forest types. This ant seems to prefer to nest in cool moist areas under some type cover, primarily rocks or wood. A few of the colonies were found in and under rotten wood, one under the bark of an old tree stump and two under cow dung. When the nests were found on the north-facing slopes, the colonies were typically on the eastern side of the cover. The possibility of a relationship of the nest site location to the heating effects of the sun on the rocks could be a topic for future investigation. There appears to be a positive relationship between the nest site and the heating effects of the sun on the rocks. The presence of this species in the Bearpaw Mountains is within the known range which extends from Newfoundland to Georgia and west to the Rocky Mountains (Gregg, 1963).

Ten colonies of *Manica hunteri* (Wheeler) were found in the higher exposed grasslands of the Bearpaws at an elevation of 4700 feet in the Upper Lake area to 5600 feet in the Divide collecting area. The species' presence in the Bearpaws extends the known range from the mountain ranges of northeastern Nevada to southwestern Montana (Creighton, 1963) to include the mountains of north central Montana. The nests that were found at an elevation of 4700 feet mean that Creighton's statement that *hunteri* prefers to nest at considerable elevations is valid but the portion of the statement

that it seems to never descend below 7000 feet even in the northern part of the range will have to be modified to include the new records of this species from northern Montana.

Pogonomyrmex occidentalis (Cresson) was found in the short grass prairie region of the southeastern Bearpaws. This species, which is commonly known as the "western harvester ant", builds conspicuous gravel mounds that can be observed while driving along the trails. Only three of the mounds were sampled. This species is characteristic of the western plains with its range from southwestern North Dakota to central Oklahoma, west to Arizona, Nevada, eastern Oregon and Washington and southern British Columbia (Gregg, 1963). Its presence in the Bearpaws is within the known range.

The presence of *Aphaenogaster subterranea occidentalis* Emery in the Bearpaw Mountains is completely unexpected since this is the western subspecies of *subterranea*. The area of intergradation between the two subspecies was recorded as in southern British Columbia, eastern Washington, northern Idaho, and western Montana (Creighton, 1950). The eastern limits to the range of *occidentalis* was reported by Creighton (1950) as in mountains of Utah and Nevada. In the northern part of the range, the eastern limits were given as being in western Montana. About forty workers plus brood were taken from the one colony found under a rock in the Upper Big Sandy collecting area on the southerly exposed grass covered slope. Gregg (personal communication) wrote, "I have confirmed your identification of *Aph. occidentalis* by comparing it to specimens unquestionably belonging to

occidentalis and to *valida*. It fits the former very well in both color and size, but not in supposed distribution. *Occidentalis* is thought by Creighton not to get as far east as central Montana. However, you are in an area of intergradation between the two subspecies, and it is possible the overlap may be quite broad. It is clear that we need to know more about the distribution of these ants, and that means to obtain many more records, especially in the Washington, Idaho, Montana region". The workers from this colony were less than 4.5 mm in length and piceous brown in color. The workers of *valida* exceed 6 mm in length and are castaneous brown in color.

The known range of *Aphaenogaster subterranea valida* Wheeler will have to be extended to include the area of north central Montana since three colonies of this species were found along Beaver Creek of the Bearpaws. These colonies were all under rocks in drier grass covered areas consistent with Creighton's (1950) statement that the nests are usually found in dry fully exposed situations. This subspecies has been considered as the eastern form of the species. The range was in the Rocky Mountain region from central Colorado north to British Columbia and west to the mountains of Utah (Creighton, 1950).

Eighteen nests of the little thief-ant, *Solenopsis molesta validiuscula* Emery, were found during this study. The nests were under rocks in the grasslands of the Eagle Rock, Dillons Bottoms and Divide collecting areas. The thief-ants are so named for they frequently live in separate chambers within the nests of other ants and feed on the larva and pupa of the host species. They also invade the homes of man in search of food.

During this investigation they were taken in association with *Tapinoma sessile*, *Lasius niger neoniger*, *L. n. sitkaensis*, *L. umbratus aphidicola*, *Camponotus vicinus*, *Formica rubicunda*, *F. microgyna* and *F. obscuripes*. The subspecies *validiuscula* was given as the western form of the species. Its range was known to extend from the Pacific Coast States eastward to Idaho, Colorado and New Mexico (Gregg, 1963). The typical *S. molesta* (Say) has been reported to be in southwestern North Dakota (Wheeler, 1963). The new records from the Bearpaw Mountains extends the known range of *validiuscula* to include the mountains of north central Montana.

Seven nests of *Leptothorax canadensis* Provancher were found under the cover of rocks and wood. All were taken from forested areas of both the conifers and deciduous trees. The presence of this species in the Bearpaws was expected from the known range of coast to coast in Canada and northern United States, with southern extensions into the Rocky Mountains to New Mexico (Gregg, 1963).

Two of the three colonies of *Leptothorax rugatulus* Emery were found on the shrub covered east slope of the Dillons Bottoms collecting area. The remaining colony was taken from under a rotten log in the Eagle Creek area. The species was known from the Rocky Mountains, Sierra Nevada and Cascade ranges and as far east as the Black Hills of South Dakota (Gregg, 1963). Its presence in the Bearpaws does not extend the known range.

Subfamily Dolichoderinae

The only member of the Dolichoderinae found in the course of this study was *Tapinoma sessile* (Say). Colonies were found primarily in the

grasslands of both meadow and upland areas typically under some cover, usually rocks. The absence of the species in the forest areas is unexpected for this common ant. Gregg (1963) found *sessile* in all of the vegetation types of Colorado from the subalpine forests to the sagebrush deserts. The range for the species is throughout southern Canada and in all parts of the United States except the southwest desert area (Gregg, 1963).

Subfamily Formicinae

The presence of *Lasius alienus americanus* Emery in the Bearpaws was expected from the range as given by Gregg (1963) as southern Canada and all of the United States except southern Florida, Texas, and arid sections of the southwest. Only two colonies were found during this study with one nest found under a rock on the upland meadow area in the Dillons Bottoms region and the other on a grass covered southeast exposed slope in the Eagle Rock area.

Forty-seven colonies of *Lasius niger neoniger* Emery were found with representatives from the drier grasslands in all of the collecting areas except Eagle Creek. Along Eagle Creek the collecting was confined to the coniferous forest, which may account for the absence of *neoniger* from this area. The nests were covered by some type of movable material such as rocks, sticks, and cow dung. Crater mounds which are typical of the species were noted in the vicinity of some of the overturned rocks and assumed to be the work of the ants. Some of the colonies found under large rocks in the Upper Beaver Creek Lake area and on the exposed south

slope of the Divide area contained very large numbers of individuals; however, no concrete estimate of the actual numbers was made. It is difficult to comprehend how such a large number of ants could be sustained by tending aphids that feed on the sparse cover of bunchgrasses growing in the area. The known range for *neoniger* is given as southern Canada and eastern United States, except Florida and the Gulf Coast, west to the Rocky Mountains (Gregg, 1963). The Bearpaws are within this range.

Lasius niger sitkaensis Pergande colonies were found more often than those of any other species of ants present in the Bearpaw Mountains with a total of fifty-nine records. The nests were found under various cover types, primarily rocks or wood, in areas where the soil was relatively moist. One large colony of *sitkaensis* in the Eagle Creek area from under and in a rotten board was probably being displaced by an equally large number of *L. subumbratus*. This is reported to be the way in which *subumbratus* establishes a new colony (Wheeler, 1963). When the nest was uncovered, the bright yellow *subumbratus* workers were the most conspicuous but after a few minutes of collecting and observing, the darker *sitkaensis* workers were more obvious. Workers of both species were carrying brood apparently into the same chambers.

The distribution of *sitkaensis* is essentially western and boreal extending from Nova Scotia across northern United States and southern Canada to the Pacific Coast, north to southern Alaska, and south through the Rocky Mountains, Great Basin and the mountains of California; an isolated population in the Black Mountains of North Carolina. From the distributions of the two subspecies of *niger* we could expect to find an

area of intergradation in the northern United States and in the Rocky Mountains (Gregg, 1963). Accordingly, this region of intergradation could include the Bearpaw Mountains; however, on the basis of my collection of one hundred seven colonies of the *niger* subspecies, with fifty-nine colonies of *sitkaensis* and forty-eight colonies of *neoniger*, the intergradation is not evident. The two taxa can be separated on the basis of the morphological characters and also on the basis of their habitat. *L. niger neoniger* was typically collected in the drier grasslands while *sitkaensis* was most often found in the more mesic areas. On the basis of this study, these two subspecies could be elevated to full species rank, as Wilson (1955) has done, but this would overlook their relationship to the Palearctic *niger*. The relationship to the old world form is considered to be significant by both Creighton and Gregg. The true relationship between the two nearctic forms can be resolved if or when their reproductive relationship is demonstrated.

Lasius (Chthonolasius) brevicornis microps Wheeler being present in three of the collecting areas shows that the range of the species extends slightly farther east than previously reported. Gregg (1963) gives the range as Alberta south to Colorado and westward to California. The colonies were found along the bottom meadow of the Upper Beaver Creek Lake area, on a west slope among shrubs and grass in the Dillons Bottoms area, and near the top of a small ridge north of Big Sandy Creek in the lower collecting area.

Lasius (Chthonolasius) subumbratus Viereck is represented in this study by seven colonies with one from the meadow of Upper Big Sandy, four

from the southeast slope of the Upper Beaver Creek Lake area, and two from the flood plain area of Eagle Creek. All of the colonies were found under the cover of rocks or wood. A large colony from Eagle Creek was found in association with a colony of *Lasius niger sitkaensis* which was probably serving as a host species for *subumbratus*. Since the range of *subumbratus* extends from eastern and southern Canada, northern New England, west to the Rocky Mountains and the mountains of Utah and Arizona (Gregg, 1963), its presence in the Bearpaws does not change the known range of the species.

Four records of *Lasius umbratus aphidicola* (Walsh) were collected from the upland grasslands of the Eagle Rock area plus one colony from outside the main collecting area. All of them were taken from under rocks. The known range for this species is from Nova Scotia and New Brunswick south to the Gulf States, and westward through the United States to the Rocky Mountains (Gregg, 1963). The Bearpaw Mountains are within the known range.

Lasius (Acanthomyops) claviger coloradensis Wheeler nests were found three times during this study. All of the colonies were under rocks but each was in a different collecting area. The nests from Upper Big Sandy and Eagle Rock were in the drier grasslands while the nest from Dillons Bottoms was on the east slope shrub area. This is the species recorded by Wing (1968) as *Acanthomyops coloradensis* Wheeler for which he lists the range as from New Mexico, Colorado, and Utah north to Manitoba and west to Alberta and Oregon. His distribution map shows that *coloradensis* is also present eastward through North Dakota. The area of north central Montana

is within the previously published range.

Lasius (Acanthomyops) latipes (Walsh) representatives were found five times during this study. Three of the records were from under rocks in the Dillons Bottoms area from a southerly exposed slope. The other collections were made on an east slope near Eagle Rock and from an upland grassland west of Eagle Rock. This species is distributed from coast to coast in southern Canada and northern United States with southern extensions into the Rocky and Appalachian Mountains (Gregg, 1963) so its presence in Montana was expected.

Camponotus herculeanus (Linnaeus) has a Holarctic distribution. In North America it is found from Alaska through Canada to the East Coast of the United States. Extensions of the range follow the Eastern mountains southward to Pennsylvania, southward in the Rocky Mountains to New Mexico and southward in the Cascade Mountains to Oregon (Gregg, 1963). Along Eagle Creek it was a very conspicuous ant in the heavily forested area where old tree stumps and fallen logs furnished ideal nesting sites. It was also found in the forested areas of the Big Sandy Creek sites. One of the eight collections was made of the ants foraging among aphids (Aphidae) that were feeding on willows.

Camponotus (Tanaemyrmex) vicinus Mayr is a western species found from South Dakota to Oklahoma and west through the Rocky Mountain region to the Pacific Coast from British Columbia south into the Highlands of Mexico. Six of the eight colonies found in the Bearpaw Mountains were under rocks in open areas with trees or shrubs near by. The other two colonies were found in association with wood. This was expected in

accordance with Gregg's (1963) statement that these large ants prefer to nest in open forest areas under rocks and that they use wood products in exceptional cases.

Since the genus *Formica* Linnaeus contain more species than any other genera of Formicidae found in North America north of Mexico, it is not surprising that over 47%, 18 of 38, of the species collected and 36%, 145 of 450, of the colonies collected during this study are in this genus. The genus is divided for taxonomic reasons into four subgenera which in turn may be divided into groups. Three of the four subgenera are represented in the collections from the Bearpaw Mountains.

Formica (*Proformica*) *lasioides* Emery colonies were unearthed eleven times in four areas. Four of the records were taken from under cover of rocks or cow dung in the Eagle Rock collecting area. Two records were made from the upland grasslands west of Eagle Rock. Two records come from under small rocks on a south-facing ridge in the Dillons Bottoms area and three come from grasslands in the Eagle Creek drainage system but not at the collection sites within the coniferous forests. Instead, they were found serving as hosts for *Formica rubicunda*, *F. wheeleri* and *Solenopsis molesta validiuscula* or at least under the same rocks as these species were found. The known range of *Lasioides* extends from coast to coast in southern Canada and northern United States (Gregg, 1963) so the records from the Bearpaws are within the known distribution area.

The single record of *Formica* (*Raptiformica*) *obtusopilosa* Emery comes from a colony found in section 8, T. 26 N., R. 18 E. of Blaine County. The area was on a slight south-facing slope covered by a sparse growth of

bunchgrasses and club mosses with ponderosa pine on the ridges. The entrance of the obscure nest was located at the base of a clump of bunchgrass. The species' presence in the Bearpaws does not alter the known range of the species which extends from northern New Mexico to Alberta and east to Minnesota and Nebraska (Gregg, 1963). The Wheelers (1963) report *obtusopilosa* from only the western half of North Dakota.

The *Formica* (*Raptiformica*) *rubicunda* Emery nest that was found contained slaves of *F. lasioides*. This nest was under a rock on a south-facing slope grassland. The nests are usually found in open woodland areas under the cover of a variety of materials, particularly rotten logs (Creighton, 1950). Wheeler (1963) found thirteen of forty-nine colonies under rocks and only two under wood. The range of *rubicunda* extends from southern Ontario and the New England States west to Colorado so its presence in the Bearpaw Mountains is within these known limits.

With fifty-one colonies recorded, *Formica* (*Raptiformica*) *sanguinea subnuda* Emery was the most conspicuous ant in all of the collecting areas except the Divide area. Not only do they forage above the ground, but also the individuals are very aggressive and their bites are painful to tender skin. It was second only to *Lasius niger sitkaensis* in the frequency in which colonies were sampled. All of the members of the *Raptiformica* are considered as slave makers. During this study the slave species for *subnuda* were *F. fusca*, *F. neorufibarbis* and *F. lasioides*. The nests of *subnuda* were most frequently observed in association with wood, as logs, stumps, sticks and boards. They also used most any other type of material for cover for they were found under rocks, dirt lumps, and

discarded beverage cans as well as in craters without any cover. The species *sanguinea* is Holarctic in distribution with the Nearctic subspecies of *subnuda*. The subspecies *subnuda* ranges from coast to coast in Canada and in the United States, from Virginia to Newfoundland in the east and from New Mexico and Arizona to Alaska in the western mountains (Creighton, 1950).

The colonies of *Formica* (*Raptiformica*) *puberula* Emery were found in the upland grasslands of the Eagle Rock area. The most populous colony was with a colony of *F. fusca* in an earth mound. The other colony which was under a rock appeared to be much smaller and without slaves. The range for *puberula* was reported as extending from western Texas and New Mexico north to Montana and west to the Pacific coast with an extension into British Columbia (Gregg, 1963).

Seven species and/or subspecies of the *fusca* group of the subgenus *Formica* were found during this study, but only *F. fusca* with forty-four colonies sampled, and *F. neorufibarbis* with thirteen colonies in this collection can be considered as being common to the area. Less than five colonies for each of the remaining five species of this group were found.

Three colonies of *Formica altipetens* Wheeler were recorded from the Bearpaws. One of the colonies was in and under cow dung in the Dillons Bottoms area and the other two were found in the Lower Big Sandy collecting area under a rock and under a stick. The Bearpaws are within the known range which extends from British Columbia through the Rocky Mountains to Mexico, and from the Pacific Coast east through North Dakota (Wheeler, 1963).

Two nests of *Formica cinerea lepida* Wheeler were found in the cottonwood forest complex along Beaver Creek and one nest along Upper Big Sandy Creek. All three nests were under rocks. This western ant is found in Saskatchewan and western Dakotas to the Pacific Coast and south in the Rocky Mountains to New Mexico and Texas, and through California into Lower California (Gregg, 1963). The Bearpaws are within its known range.

The Holarctic *Formica fusca* Linnaeus were found in all of the collecting areas. The collections were made from forty colonies of *fusca*. The usual practice of myrmecologists in not collecting from all colonies of *fusca* in the immediate area was followed; hence, the number of records is not a true indication of the abundance of this species. If all the *fusca* individuals were collected, there would be little time left for the care and identification of the less common species. One colony of the subspecies *argentea* Wheeler was found in the Eagle Rock area under a rock. The specimen differed from the typical *fusca* to such a degree that I could not classify them as the typical *fusca*. Gregg (personal communication), referred to the specimen as "not the most typical for *argentea*" but he nevertheless classified them as such. The specimens were more brown than black as in the typical *fusca* but they lack the pubescence that is typical for *argentea*. Creighton (1950) treated *argentea* as a synonym of *fusca* with the differences as being variations within the species. Gregg (1963) justifies *argentea* as a taxon:

"It is conceivable that such a broadly dispersed species as *fusca*, and one whose populations are so adaptable to environmental change, could have suffered a fragmentation of its tremendous range during the late glaciation in such a way as to isolate a portion of it in the western and southwestern United States, thereby giving a chance

for the accumulation of traits now diagnostic for *argentea*. If the recession of the ice and amelioration of the climate occurred before the advent of full reproductive isolation, it is quite possible that the differentiated *argentea* was free to intermingle and breed with the typical *fusca* from an eastern refugium as both reoccupied glaciated (or at least glacial-influenced) territory, with the result that we now see extensive mass hybridization between the two forms and deep interpenetration of each into the range of the other."

The range of *fusca* in North America is from Newfoundland to Alaska and the entire northern United States with southern extensions in the eastern mountains to North Carolina and Tennessee and in the western mountains to New Mexico, Arizona and California. The range of the *argentea* is more western than that of the typical *fusca* but extends from the New England States to the West Coast and all of western United States from New Mexico and California to Washington and Montana (Gregg, 1963).

Formica hewitti Wheeler is represented by only one record in the collection from the Bearpaw Mountains. This was found in the cottonwood area along Beaver Creek under a small stone in 1966. The known range for the species was given as the mountains of Colorado, Utah and eastern Nevada north to British Columbia and Alberta (Gregg, 1963). Its presence in the Bearpaws shows that its range is slightly farther east than previously known.

Thirteen colonies of *Formica neorufibarbis* Emery were sampled, primarily in the coniferous regions of the collecting area. They were found under rocks and in and under wood. This western ant is found from Alaska southward to central California to northern New Mexico. The eastern limit of the range appears to be in the Black Hills of South Dakota. From the previously published information, the Bearpaw Mountains could be an area

in intergradation between the typical *neorufibarbis* and the two subspecies, *gelida* Wheeler which is western but from higher elevation and the eastern subspecies *algida* Wheeler. The specimens are closer to the descriptions for *neorufibarbis* than that for either of the subspecies. The gaster hairs are numerous enough to mask the shining surface and to give a gray cast which separates these specimens from *algida*. The reddish thorax is slightly infuscated and distinctly lighter than the head which distinguishes them from *gelida*. The known range for *algida* does not extend west of Minnesota. The range for *gelida* does not extend east of the Rockies (Creighton, 1950). Only the known range of *neorufibarbis* includes the area of north central Montana.

A *Formica subpolita ficticia* Wheeler colony was found on a south slope of the Upper Big Sandy collecting area under a rock among the grass. The type locality of this species is Helena, Montana, with its range in the Rocky Mountains from Montana to Colorado and in the mountains of Utah. This ant species is not very numerous as Gregg (1963) published only two records from Colorado and there is only one from the Bearpaw Mountains.

The *rufa* group of the subgenus *Formica* is represented by three species in the Bearpaw Mountains. The most commonly collected species was *Formica obscuripes* Forel which is the "thatching ant" of the western prairies and mountains. Sixteen colonies were sampled with only two samples from under rocks and all of the remainder from typical thatched mounds. One mound was recorded in the mixed forest area on the north slope of the Lower Big Sandy area. The rest of the mounds sampled were from the grasslands although trees may have been near by. North central Montana is included in

the range for this species which extends from Illinois and Wisconsin northwestward to Washington and British Columbia. There are extensions of the range into the Rocky Mountain region to southern Colorado (Gregg, 1963).

A colony of *Formica criniventris* Wheeler was found on a southeast exposed slope of the Upper Big Sandy collecting area. This species has been found in widely separated areas. Dr. Gregg's collection contains only twenty-one records from Colorado and the Wheelers have eight records from North Dakota. The one collection from the Bearpaw Mountains includes a dealate female. The known range for the species, which includes the area of this study, extends from Colorado and Utah north to Montana and east to the Dakotas (Gregg, 1963).

Four records for *Formica dakotensis* Emery were made during this study. One was found in a rotten log in the bottom forest of the Lower Big Sandy site. Two other colonies were under rocks in the Big Sandy-Beaver Creek Divide area. A few "stray" members were taken from the upland grass area near the Eagle Rock School. Gregg (personal communication) confirmed the identification of the species with the statement: "In *dakotensis*, your specimens are not typical; they possess some of the traits characteristic of the true *dakotensis* and some of the subspecies *montigena*. It is likely that you have samples of a hybrid population, and they are in the right place geographically for this to happen. In the absence of breeding data, it is probably safest to call them *dakotensis* variation as I have done." The range for *dakotensis* extends from south central Ontario west to Montana and the Black Hills of South Dakota. The range for the subspecies *montigena* Wheeler is from New Mexico north to British Columbia. The

ranges of the two forms meet in western Montana (Creighton, 1950). The western subspecies, *montigena*, possess erect hairs on the gula and on the crest of the petiole. These characters are absent from the eastern *dakotensis*. The specimens collected in the Bearpaws have the hair on the petiole but lack hair on the gula. This combination of traits is also reported for the *dakotensis* found in North Dakota (Wheeler, 1963).

Two records of the *microgyna* group of the subgenus *Formica* were recorded during this study. *Formica microgyna* Wheeler was found in two places along Beaver Creek near an area covered by cottonwoods. Both nests were found under rocks in areas covered by grasses although the trees may have been near by. The range for this species is given as the mountains of Colorado, Wyoming and eastern Utah at elevations up to 8500 feet. The presence of *microgyna* in the Bearpaws gives a new record for its distribution towards the northeast of its previously known range which was from the mountains of Colorado, Wyoming and eastern Utah and northern New Mexico (Gregg, 1963).

Formica spatulata Buren workers were found in three nests with two of the nests on the ridge separating the Beaver Creek and Big Sandy Creek drainage systems. One of the nests was on the high point overlooking the Divide collecting site from the north. The other nest was on the south-facing slope. All three nests were under rocks. Without having the females for this species there is some doubt as to the identification. Gregg (personal communication) in part wrote: "I have checked these pretty carefully; they might run to *rasilis densiventris*, but the heads do have mostly spatulate hairs, and do compare very well with specimens of

spatulata I have from Iowa. The species is known to extend from Iowa to Montana." The Wheelers (1963) recorded only two nests of *spatulata* along the Red River in North Dakota. In this study *spatulata* was found on a ridge at an elevation of 5600 feet.

SUMMARY AND CONCLUSIONS

Collections from four hundred fifty-two colonies of ants were made in the Bearpaw Mountains. Their distribution from the four major vegetation complexes is compiled in Table VIII.

Sixty-four collections of ants were made in the coniferous forests with a total of eleven species; however, all of the species were also represented in other vegetation types. The most frequently collected ants were of the species *Myrmica schenki emeryana* with twenty-one colonies sampled and *Formica sanguinea subnuda* with thirteen colonies represented. Other species that can be considered as being associated with the coniferous forests are *Formica neorufibarbis* and *Camponotus herculeanus*.

One hundred two collections of ants were made from the flood plain forests with twenty species represented. The most commonly collected species were also collected from the coniferous forest and/or the open meadow areas within the forests. *Formica sanguinea subnuda* was the most commonly collected species with twenty-one collections followed by *Myrmica schenki emeryana* with eighteen collections. *Lasius niger sitkaensis* with fifteen colonies was the third most commonly collected species from the bottom forest areas. Other species that were found more frequently in the deciduous forest areas than in other habitats were: *Myrmica lobicornis lobifrons*, *Leptothorax canadensis*, *Camponotus herculeanus*, *Formica hewitti*, *F. neorufibarbis*, and *F. integra haemorrhoidalis*.

The meadow grass areas along the stream valleys furnished forty-two collections with ten species; however, no species can be considered as

TABLE VIII. Ant Species in Relation to Vegetation Types

Species	Conifers	Bottom Forest	Meadow Grass	Grass- lands	Other	Total
<i>Myrmica</i>						
<i>brevinodis sulcinodoidis</i>		2	1		1	4
<i>lobicornis lobifrons</i>	4*	8	4	12	2	25
<i>schenki emeryana</i>	21	18	1	5	1	46
<i>Manica</i>						
<i>hunteri</i>				10		10
<i>Pogonomyrmex</i>						
<i>occidentalis</i>					3	3
<i>Aphaenogaster</i>						
<i>subterranea occidentalis</i>				1		1
<i>subterranea valida</i>				2	1	3
<i>Solenopsis</i>						
<i>molesta validiuscula</i>		2		15	1	18
<i>Leptothorax</i>						
<i>canadensis</i>	2	4			1	7
<i>rugatulus</i>		1			2	3
<i>Tapinoma</i>						
<i>sessile</i>				11	5	16
<i>Lasius</i>						
<i>alienus americanus</i>				2		2
<i>niger neoniger</i>	2			41	5	48
<i>niger sitkaensis</i>	7	15	18	10	9	59
<i>subumbratus</i>	3	1	2	1		7
<i>umbratus aphidicola</i>				5		5
<i>brevicornis microps</i>			1	1	1	3
<i>claviger coloradensis</i>				2	1	3
<i>latipes</i>				5		5

TABLE VIII. Ant Species in Relation to Vegetation Types (Continued)

Species	Conifers	Bottom Forest	Meadow Grass	Grass- lands	Other	Total
<i>Camponotus</i>						
<i>herculeanus</i>	3	5				8
<i>vicinus</i>	1			5	2	8
<i>Formica</i>						
<i>lasioides</i>		2		9		11
<i>obtusopilosa</i>					1	1
<i>puberula</i>				2		2
<i>rubicunda</i>				1		1
<i>sanguinea subnuda</i>	13	21	4	9	8	54
<i>altipetens</i>		1		2		3
<i>cinera lepida</i>		2	1			3
<i>fusca</i>	3	9	9	19	4	44
<i>fusca argentea</i>				1		1
<i>hewitti</i>		1				1
<i>neorufibarbis</i>	5	6		1	1	13
<i>subpolita ficticia</i>				1		1
<i>criniventris</i>				1		1
<i>dakotensis</i>		1		3		4
<i>integra haemorrhoidalis</i>		1		1		2
<i>obscuripes</i>		1	1	12	2	16
<i>microgyna</i>		1		1		2
<i>spatulata</i>				2	1	3
Total (39)	64	102	42	192	52	452

* The figure denotes the number of colonies sampled.

being characteristic of the meadows. The ants found in these areas were essentially the same species as found in the deciduous forests. Only *Lasius niger sitkaensis* colonies were found more often in association with the grasses than with the trees. Eighteen colonies were with the former and fifteen colonies with the latter.

One hundred ninety-two collections were made in the upland grasslands with thirty-one species represented. The most commonly collected species was *Lasius niger neoniger* with forty-one out of forty-eight colonies taken in these areas. All ten of the collections of *Manica hunteri* were made from the grasslands of higher elevations and three of the four collections of the subspecies *Aphaenogaster subterranea* were from this xeric habitat. Eleven of the fifteen samples of *Tapinoma sessile* were taken in these areas. The other five samples were unrecorded as to habitat. Twelve of the sixteen records for the thatching ant, *Formica obscuripes*, were made from the upland grasslands. Other species that were found primarily in the xeric grasslands were: *Lasius alienus americanus*, *L. umbratus aphidicola*, *L. claviger coloradensis*, *L. latipes*, *Camponotus vicinus*, *Formica lasioides*, *F. rubicunda*, *F. wheeleri*, *F. fusca*, *F. subpolita ficticia*, *F. dakotensis* and *F. spatulata*.

Thirty-nine species or subspecies of ants were found inhabiting the Bearpaw Mountains. For 5.3%, two of these species, *Formica fusca* and *Camponotus herculeanus*, have Holarctic distribution. The remaining 94% or thirty-seven species or subspecies are confined to the Nearctic area. The distributions of these can be subdivided in various ways.

The Wheelers (1963) used the term "intraneous" for those species that range in all directions from the area under consideration. Gregg (1963) referred to these species as being "continental" in distribution in that they are found generally throughout the United States. Seven species, constituting 18.4% of the total population, found in the Bearpaw Mountains were in this group. The continental species found in the Bearpaws were: *Tapinoma sessile*, *Lasius alienus americanus*, *L. subumbratus*, *L. latipes*, *Formica lasioides*, *F. dakotensis* and *F. obscuripes*.

The distribution that centers north of Montana is represented by 5.3% of the population in the Bearpaws. *Leptothorax canadensis* and *Formica sanguinea subnuda* are the two species of ant that can be considered truly boreal.

Five species, which is 13% of the ant species found in the Bearpaws, have a distribution east of Montana. Although the ranges of *Myrmica schenki emeryana*, *Lasius niger neoniger*, *L. umbratus aphidicola* and *Formica rubicunda* extend westward to include the Rocky Mountains, the center of their distribution is primarily northeastern United States. *Formica spatulata* is found only in the northern prairie states from Minnesota and Iowa to Montana.

Fifteen species, which is 40% of the total found in the Bearpaw Mountains, have a range that is considered western. This includes the area from the western prairies and the Rocky Mountains westward to the Pacific Ocean. The species were: *Pogonomyrmex occidentalis*, *Solenopsis molesta validiuscula*, *Leptothorax rugatulus*, *Lasius niger sitkaensis*, *Lasius*

brevicornis microps, *Camponotus vicinus*, *Formica neorufibarbis*, *F. fusca argentea*, *F. altipetens*, *F. cinerea lepida*, *F. hewitti*, *F. integra haemorrhodalis*, *F. criniventris*, *F. obstusopilosa*, and *F. puberula*.

Six species of ants with a distribution that is considered to be confined to the Rocky Mountain area accounted for 16% of the population in the Bearpaw Mountains. These were: *Myrmica lobicornis lobifrons*, *Manica hunteri*, *Aphaenogaster subterranea valida*, *Lasius claviger coloradensis*, *Formica subpolita ficticia*, and *F. microgyna*.

The ants of western and Rocky Mountain distribution could have been carried into the Bearpaw Mountains by the prevailing westerly winds that attain hurricane velocity during some of the storms. The intraneous species could have spread into the area from their interglacial retreats as the habitats became available to them by the progressive zonations following the retreat of glaciers. The boreal ants could be some forms that were left behind in favorable habitats by the advancing vegetation belts following the melting of the glaciers. The present day distribution of the belt of subarctic forests extends into the Appalachian and Rocky Mountain chains. From the Rocky Mountain region, it would be very possible for the reproductives to be carried by the prevailing winds the two hundred miles to the Bearpaws. The eastern forms that are found in the Bearpaw Mountains have their ranges in the northeastern area of the country. These ants also have ranges that extend into the Rocky Mountain region so their presence in this island mountain range is explainable for they too could have been brought in by the prevailing westerly winds.

New records concerning the distribution for eight species or sub-species were made. These were:

Myrmica lobicornis lobifrons
Manica hunteri
Aphaenogaster subterranea occidentalis
Aphaenogaster subterranea valida
Solenopsis molesta validiuscula
Lasius brevicornis microps
Formica hewitti
Formica microgyna

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Plate I.

The Eagle Rock collecting area showing the grass covered hills at the lower elevation of the Bearpaws in the foreground. The flood plain of the creek supports a willow-alder community. The draws have western serviceberry, hawthorne and snowberry.



Plate II.

A view looking south from the hill east of Dillons Bottoms. The quaking aspen are in protected areas as in the foreground. The creek valley is dominated by black cottonwood.



Plate III.

Upper Beaver Creek. The creek has been dammed to form a small lake. The collecting area included the lodgepole forest to the left, the hillside in the foreground and the area below the dam.



Plate IV.

Eagle Creek bottom forest. The trees in the area include: willow, black cottonwood, quaking aspen, ponderosa pine and Douglas fir. The stump contained an active colony of *F. sanguinea subnuda*.



Plate V.

A view of the Lower Big Sandy collecting area from the north slope. The north slope has areas of ponderosa pine, aspen, western serviceberry, hawthorne and snowberry and areas of grasses and forbs. Vegetation on the valley bottom is primarily willow. Across the creek there are drier grasslands and ponderosa pine along the ridges and aspen and lodgepole pine along the protected draws and east slopes.

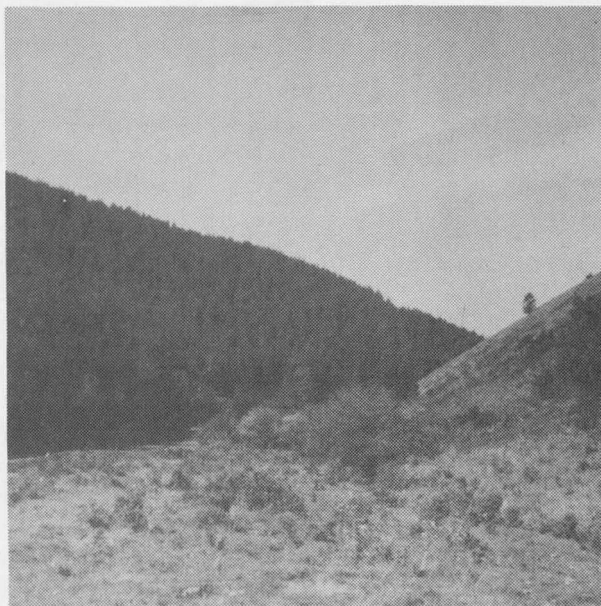


Plate VI.

The Upper Big Sandy collecting area. The stream valley is narrow with a lodgepole pine forest on the north slope and grasses on the south slope. The bottom of the valley is mesic with clumps of willow scattered among the grasses. The area is rather heavily grazed by cattle.



Plate VII.

The Big Sandy-Beaver Creek Divide collecting area. The north slope supports a cover primarily of lodgepole pine. The ridge and south slopes are grass covered.

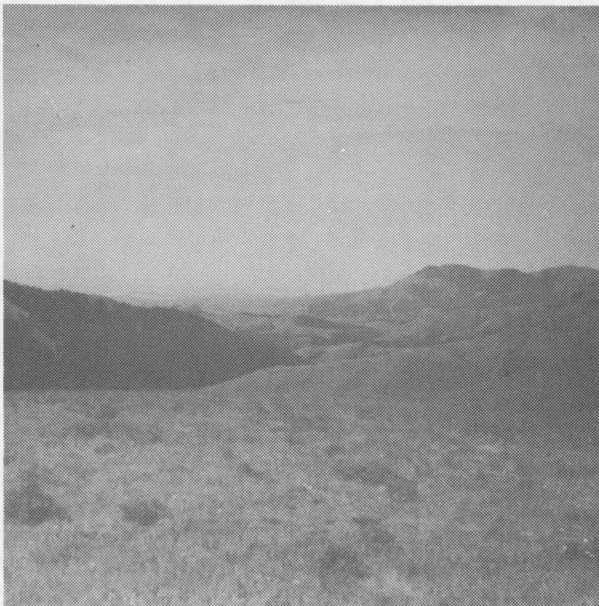


Plate VIII.

A view towards the west from the Big Sandy-Beaver Creek Divide. The peak at the right is Mount Centennial. The town of Big Sandy lies about 20 airline miles west.

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