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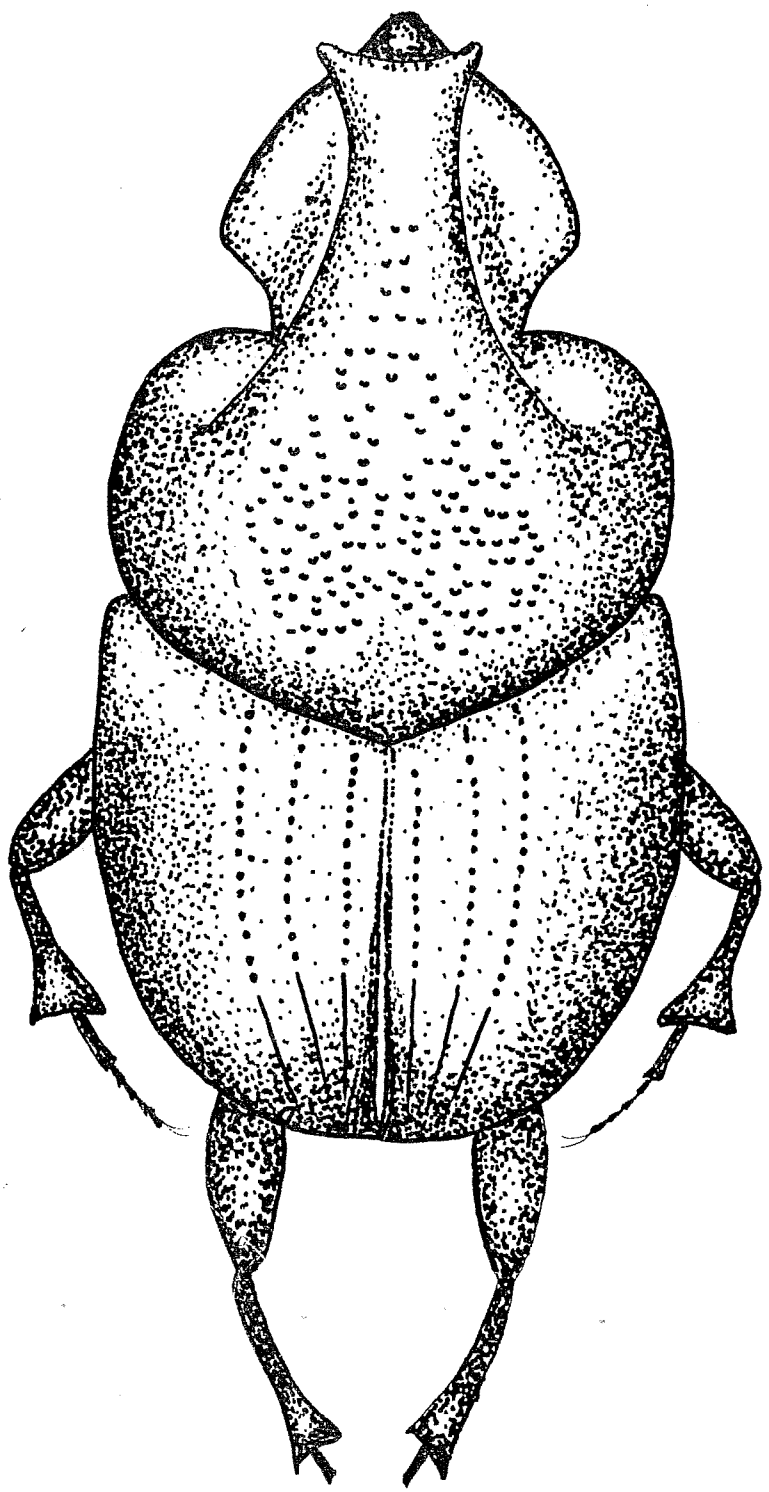
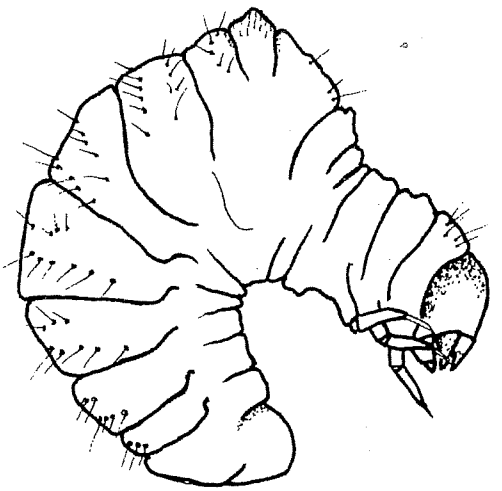
SAPROPHAGOUS SCARABAEIDAE (Coleoptera) OF NORTH DAKOTA





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Cover plate: Adult male and third instar larva of *Onthophagus hecate* (Panz.).

INTRODUCTION

The saprophagous Scarabaeidae attract attention, especially in a ranching state such as North Dakota, because of their peculiar habits, importance as decomposers of fecal and humus material and potential to transmit disease. Saprophagous Scarabaeidae are distinguished by their food preference, decomposed plant materials, as defined in the ecological section.

Adult Scarabaeidae are typified by an 8-11 segmented lamellate antenna (fig. 2) and a bi- or tridentate protibia (fig. 3).

Larvae are C-shaped grubs with a transverse anal slit, cribiform spiracles and a trilobed labrum. With the exception of the *Phyllophaga* and related economic species, few larvae of Scarabaeidae have yet been described. To better understand the phylogeny and the ecological requirements of scarab species, more intensified work is needed in larval taxonomy. The result of this work is a complete systematics, not just the taxonomy of adults.

This paper includes larval descriptions for sixteen species. Descriptions of *Aphodius ruricola* Melsh. and *Aphodius lentus* Horn are original. Specimens of nine other species were examined and re-described. The remaining descriptions were adapted as indicated in the text. Specimens of the two previously undescribed larvae are deposited in the North Dakota State University and United States National Museum insect collections.

The taxonomy and ecology of fifty species, included in five subfamilies and fourteen genera are described for the state. No comprehensive study of the North Dakota Scarabaeidae has been done prior to this paper. The published ranges of most scarab species, therefore, have not included North Dakota. The data presented extend the ranges of many species.

Since the validity of certain species and subspecies was questionable, new evidence is introduced to assess the validity of these taxa.

METHODS AND MATERIALS

Collecting Adults Several techniques were employed in collecting adult saprophagous Scarabaeidae because their habits were so diverse. Some species were diurnal, some nocturnal-photophilic and others nocturnal-photophobic.

Many species were abundantly collected directly from a confined microhabitat, such as dung. This was probably the most common method of collecting the majority of diurnal species. Although sometimes tedious, this method yielded more information on the ecology of the species than did light or pit traps.

Nocturnal-photophilic species were most effectively collected with light traps. Photophilic species were attracted to an 18", 15 watt

fluorescent U.V. bulb which was mounted on the shield of the light trap. Cyanide was placed in the receptacle as a killing agent.

Nocturnal-photophobic species were most effectively collected in pit traps. Two types of pit traps, permanent and temporary, were used.

For seasonal studies permanent pit traps were employed which caused minimum disturbance of the surrounding environment each time the trap was visited. A $5\frac{1}{2}$" deep by $5\frac{3}{4}$" in diameter galvanized receptacle was forced into the ground at the selected trap site. The ground inside the receptacle was carefully removed without disturbing the surrounding environment. A $1\frac{1}{2}$ quart stainless steel bowl was placed in the receptacle so that the tip of the bowl was flush with the soil surface. To preserve the specimens, enough ethylene glycol (1.5 inches/wk) was placed in the bowl to supply the intervals of study. A cover was placed over the trap to keep out leaf litter, rain and larger animals.

A rapid system for installing a set of temporary pit traps was devised by R. J. Sauer and D. L. Haynes. A sod-sampler the size of a one pint ice cream container was used to form a hole into which the container was placed. The sod-sampler retained the core of sod so that no debris disturbed the surrounding environment. The container was partially filled with ethylene glycol and covered. Specimens from pit traps were washed in alcohol and mounted for study.

Rearing Larvae All larvae were reared with the same technique. Adults were field collected and introduced into cages containing a four inch layer of soil or sand and a source of uncontaminated (i.e., not inhabited by insects) bovine fecal material. Precautions were taken so that no beetles escaped or entered the rearing cages, thus assuring proper identification of future larvae. As a double-check (in most cases) adults were reared from caged larvae.

Two problems were encountered in rearing larvae. Initial attempts at rearing *Aphodius* larvae were fruitless because dehydration of feces at high room temperatures (90°F) progressed faster than the development of the larvae. To correct this situation larvae were reared in plastic pails fitted with plastic tops containing small ventilation holes. The soil in the cages was dampened. This kept the humidity in the cage at a high level and prevented dehydration of the feces. The cages were then placed in a room where the day temperature remained at approximately 90°F and the night temperature at about 70°F. Larval development progressed rapidly and successfully in these conditions of high temperature and high humidity. Several species completed a generation in less than one month.

Obtaining oviposition was the second problem in attempting to rear some species. Mohr (1943) noted that *Aphodius distinctus* (Mull.) and *A. walshi* Horn frequent fecal deposits in large numbers, but never oviposit at these sites. The author found this true when trying to rear these two species. Apparently the adults are attracted to the feces, but oviposit in another site. Most likely feces are common attractants for large numbers of individuals stimulating them to congregate and copulate.

MORPHOLOGY

Although many modern techniques (e.g., serology, chromatography and cytogenetics) are presently employed for species identification, morphological distinction still is the most practical approach because identification is rapid and simplified.

The general external morphology of the saprophagous Scarabaeidae is outlined in figures 1 and 2 and only the more important and unique morphological variations among these scarabs are discussed in relation to their function. Terminology for other structures and vestitures of the exoskeleton follow the definitions in standard entomological glossaries.

ADULT MORPHOLOGY

The Head The labrum is vestigial in adult Scarabaeidae. Sutures in the dorsoventrally flattened head are lacking, making delineation of the clypeus, frons and genae difficult (fig. 1). Modifications of the clypeus are especially important in some species and range from a nearly entire margin (*Aphodius consentaneus* LeC.) to an emarginate, dentate clypeus (fig. 18). The specific variability in clypeal patterns (figs. 18-23) is probably related to the burrowing habits of these species. When burrowing in dung or soil the scarab uses the flattened head as a shovel, pushing the media forward with the anterior legs and upwards with the head.

The Legs The legs, as well as the head, are important in burrowing. Most variation occurs in the tibiae where the modifications of the teeth (for digging) and carinae, spurs and spinules (for bracing) are important in the different burrowing requirements of different species (fig. 3).

Vestitures Figure 4 is a composite elytron depicting some of the different vestitures (one on each interval) of the scarab exoskeleton. It is difficult to explain the specific variations of vestitures by function, but such variation is prominent throughout the Scarabaeidae.

LARVAL MORPHOLOGY

The epipharynx, maxillae and raster are all important variable characters in the larval Scarabaeidae.

The Epipharynx and Maxilla The epipharynx (fig. 5) is composed of a basal sclerite, the torma (which is divided into a dexiotorma (right), epitorma (center) and laeotorma (left)) and a fleshy phobal region. The dexio- and laeotorma normally extend cephalad and caudad. But in some species the laeotorma may not extend caudad. Microsensilla in the region of the protophoba vary in number intra- and interspecifically. Excepting the Geotrupinae, stridulatory teeth are present on the maxilla of the saprophagous Scarabaeidae. Variation in the numbers and location of these teeth are specific in many instances (especially in the Aphodiinae). Specific differences in the number of setae on the galea and lacinia are also apparent.

The Raster Setal patterns on the raster (fig. 6) or the venter of

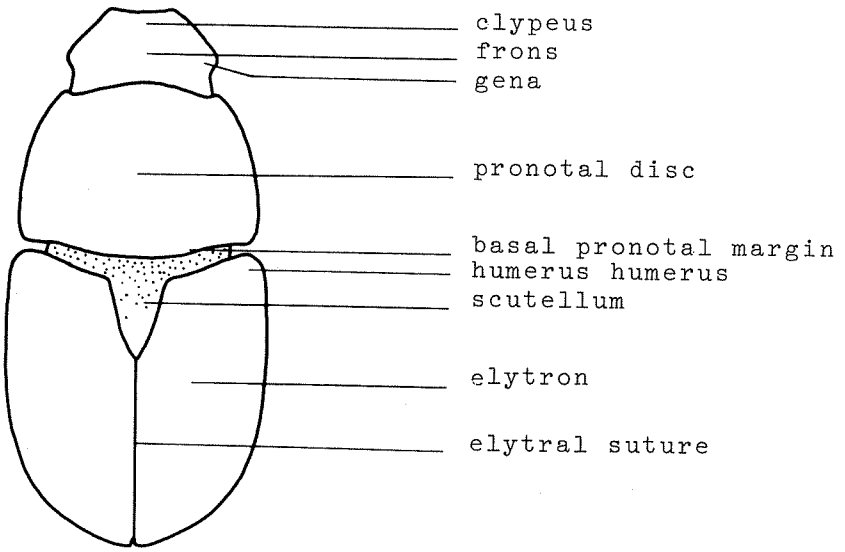

Figure 1. Dorsal aspect of *Aphodius fossor* (L.)

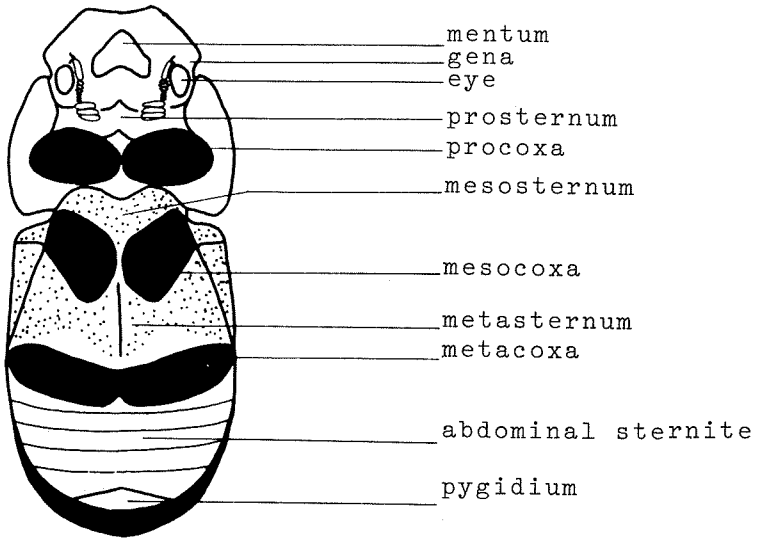

Figure 2. Ventral aspect of *Aphodius fossor* (L.) with legs removed.

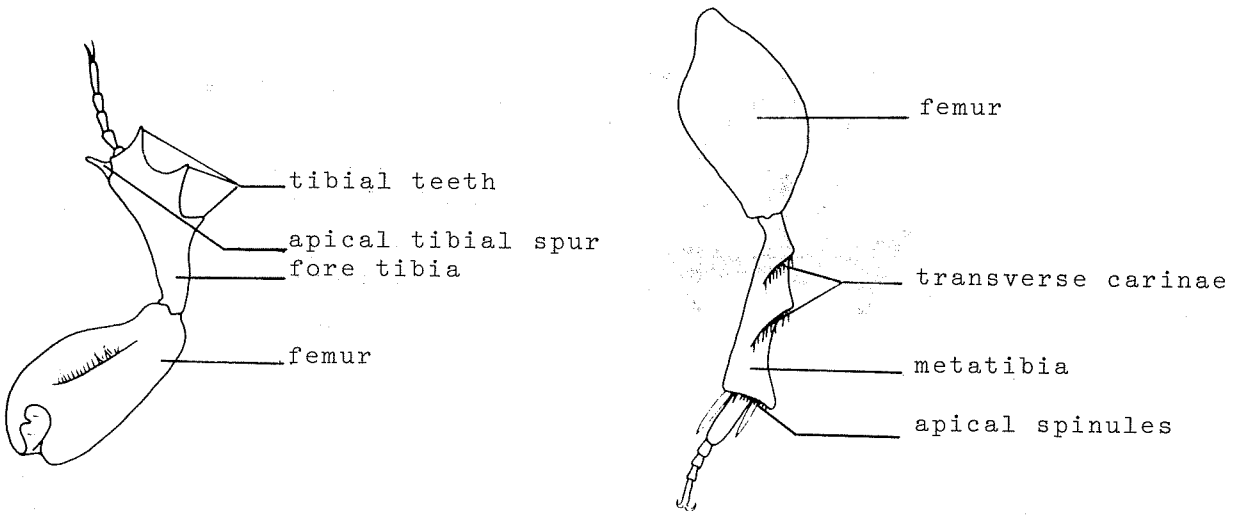

Figure 3. Proleg (left) and metaleg (right) of *Aphodius fossor* (L.) with coxae removed.

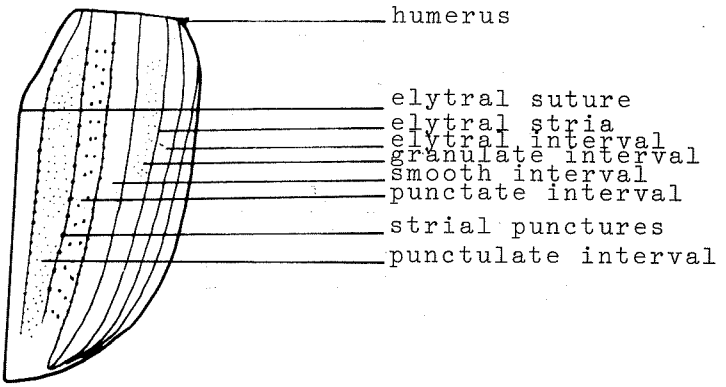

Figure 4. Composite elytron showing different vestitures of scarab exoskeleton.

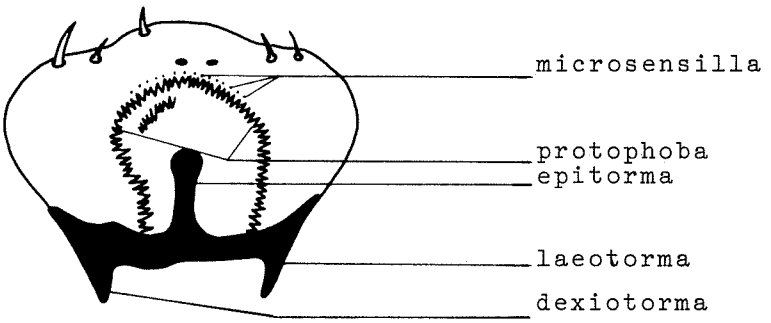

Figure 5. Epipharynx of an *Aphodius sp.* larva showing characters used to distinguish different species.

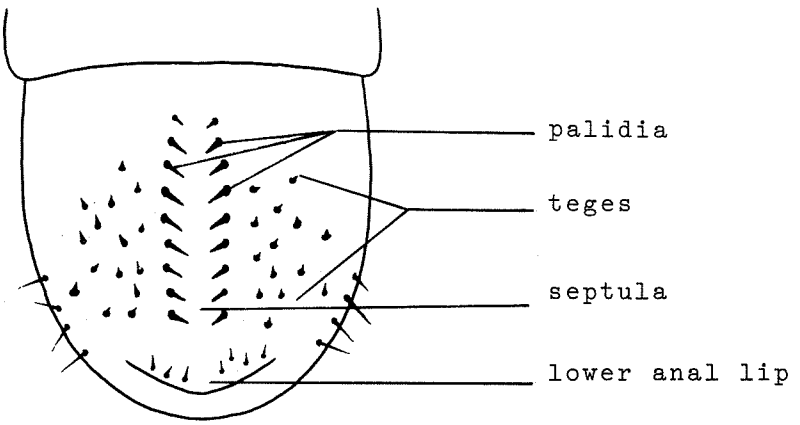

Figure 6. Venter of ninth and tenth abdominal segments showing setal pattern on raster (generalized).

the tenth abdominal segment vary from an unmodified teges (area of short setae) to a pair of tegillia divided by palidia (two rows of medially oriented, flattened setae divided by a septula).

ECOLOGY OF SAPROPHAGOUS SCARABAEIDAE

The species of Scarabaeidae discussed here are similar in general food preference. The diet for all species is some form of decomposed plant matter, such as humus or feces of herbivorous animals. Saprophagous species which feed on decomposed animal matter are found only in the Troginae and are not discussed.

Species of saprophagous Scarabaeidae are divided into two major groups based on food preference; 1) dung feeders, and 2) humus feeders. The division holds for most species, but is not absolute. Some species, such as *Geotrupes semiopacus* Jekel and *Onthophagus hecate* (Panzer) feed on humus when dung is not readily available. Others, such as *Aphodius distinctus* (Mull.) and *A. walshi* Horn, apparently feed on dung as adults and humus as larvae.

Both feces and humus represent energy which is not directly usable by higher plants and animals in a community. Saprophagous organisms are decomposers which utilize this potential energy source, help to recycle nutrients and contribute to a more efficient and integrated community.

DUNG AS A MICROHABITAT

The most abundant fecal material in North Dakota is that from cattle. Of the fifty species of saprophagous Scarabaeidae in North Dakota, twenty-three are associated with cattle dung. This large supply of fecal material provided by cattle, however, is not new to North Dakota. The large herds of buffalo that once roamed the grasslands of this state apparently offered the same habitat as the cattle do today. Some species which appear to be specific to cattle dung throughout the state are also collected in bison dung in Theordore Roosevelt Memorial Park (Table I).

Species Occurrence and Physical Change in Dung Although cattle dung forms the major type of fecal material in the state, many other types (e.g., sheep, deer and other herbivorous animals) are available and used by saprophagous Scarabaeidae. Table I summarizes fecal preference of dung-feeding species in North Dakota based primarily on my observations. Where fecal preference of a species was not determined by my observations published data were used, but the preferences of some remain unknown.

The dung of as many herbivorous mammals as possible were investigated, but the dung of some species was too scarce or too concealed to discover associations. Some mammals like the rabbit and the Pronghorn scatter their dung so no one large source is found. Others, such as pocket gophers, bury their dung so unless dug for, only accidental observations are made.

A fecal deposit is a microhabitat with discernable boundaries and

TABLE I

OCCURRENCE OF SPECIES IN VARIOUS FECAL SOURCES

Species	Fecal Source					
	cow	buffalo	sheep	deer	prairie dog	other burrowing mammals
Canthon praticola	*	*			*	
C. pilularius	*	*				
Onthophagus hecate	*	*	*	*		
O. pennsylvanicus	*		*			
Aphodius fossor	*	*				
A. hamatus	*					
A. erraticus	*					
A. haemorrhoidalis	*	*				
A. pseudabusus	*	*				
A. fimetarius	*	*	*	*		
A. tenellus	*		*			
A. ruricola	*	*	*	*		
A. granarius	*					
A. vittatus	*	*				
A. lentus	*		*			
A. explanatus					*	*
A. iowensis						*
A. criddlei						*
A. haldemani						*
A. concavus						*
A. dentigerulus					*	
A. coloradensis	*					
A. distinctus	*		*	*		
A. leopardus	*		*	*		
A. walshi	*		*			
Ataenius spretulus	*					
Dialytes criddlei				*		
Rhyssemus sonatus		*			*	
Geotrupes semiopacus	*		*	*		
Bothynus relictus	*	*				
B. gibbosus	*					

rapidly changing physical and biological properties. Mohr (1943) made a basic study of "cattle droppings as ecological units" in which he made the inaccurate conclusion that predictable physical and biological changes within this microhabitat are successional, with definitive microseres. The physical changes, however, are not the result of amelioration by dominant species. They occur with or without the presence of organisms. The successional concept, therefore, does not explain the rapid replacement of specific populations.

The major physical change in dung which affects the survival and replacement of a specific population is the rapid loss of water. Since most larvae which develop in dung, such as Diptera and Coleoptera, are not highly motile outside this microhabitat, the adult female must oviposit in the dung at a time which permits full development of the larvae before the drying process becomes a limiting factor to the growth of the larvae. Figure seven shows the water loss in dung and the oviposition (A & B) and pupation (C & D) times for many Diptera (A to C) and most *Aphodius* (B to D). Samples were taken in the field from June to August. Cores were removed from the center of one dropping to include the crusted surface and inner portion.

This dehydration is dependent upon environmental factors such as wind, humidity and temperature. In the sandhills of Richland County, some fecal deposits were observed to dry so fast during August that larval development of *Aphodius spp.* was halted at the third instar.

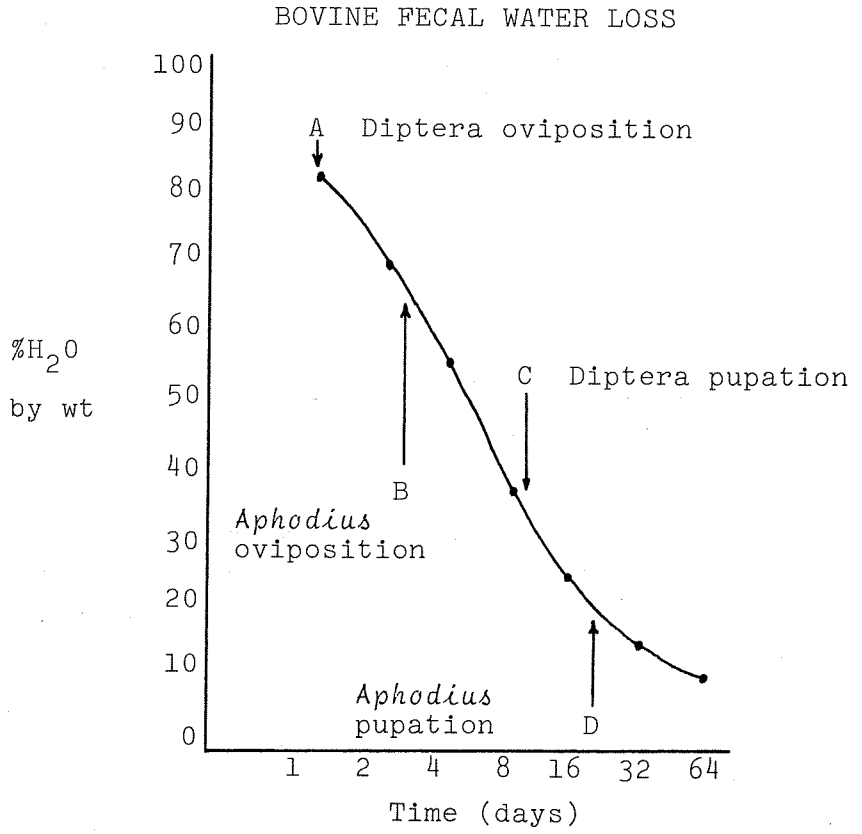

Figure 7. Water loss and insect development in a cattle dropping over a two month period from June 15 to August 15, 1966.

A rapid population change accompanies this progressive loss in water according to the tolerance of the species. As shown in figure seven the tolerance range of many Diptera is from 76% to 30% water, whereas the tolerance range of *Aphodius spp.* is from 60% to 10%. Table II reflects the taxon change with data taken from ten cattle droppings in Richland County and the North Dakota State University pastures at Fargo, from June through August 1965.

TABLE II.

TAXON CHANGE IN COW DUNG

taxa	days
	1 day 4 days 8 days 12 days 16 days 30 days
Diptera	**********
Aphodius	**********
Bothynus	**********
Canthon	**********
Geotrupes	**********
Onthophagus	**********

The species composition in the insect community of a fecal deposit is not only dependent on the stage of drying, but also the time of year. For example, populations of *Aphodius leopardus* Say are collected only in dung from late July to early September. Table III shows the periods of occurrence of adult *Aphodius spp.* in cow dung from March to November. It is based on observations of nearly two hundred cattle droppings, primarily from Cass and Richland Counties and light trap catches from Williston, Bowman, Trotters, Cavalier, Bismarck and Walcott, North Dakota.

TABLE III.

PERIODS OF PROMINENT OCCURRENCE OF ADULT *APHODIUS SPP.* WHICH MAY OCCUR IN COW DUNG

species	date
	Mar Apr May June July Aug Sept Oct Nov
A. *fossor*	**********
A. *fimetarius*	**********
A. *haemorrhoidalis*	**********
A. *walshi*	**********
A. *distinctus*	**********
A. *vittatus*	**********
A. *leopardus*	**********
A. *ruricola*	**********

Table III can be used to predict the species composition of adult *Aphodius* in cow dung from early spring to mid-fall in North Dakota. For example, during late May a cattle dropping may have as many as six species of *Aphodius*.

Species Which Complete Larval Development in the Cattle Dropping Of the Scarabaeidae which occur in cow dung only species of *Aphodius* and *Bothynus* remain in the fecal deposit from egg through complete larval development. The average developmental period of four *Aphodius spp.* reared in the laboratory was 17 days from egg to pupa. Most adults emerged after four to five days as pupae. During this period the larvae are faced with competition from many larvae and predation by others. Table IV demonstrates the typical composition of a fecal deposit at four days (the time at which many *Aphodius* oviposit).

TABLE IV.

DENSITY OF INSECT POPULATIONS IN A TYPICAL BOVINE FECAL DEPOSIT

species	numbers
Diptera larvae	78
Staphylinidae*	82
*Sphaeridium scarabaeoides**	8
*Cercyon spp.**	21
Aphodius fimetarius[1]	16
Aphodius distinctus[1]	52

* = adults and larvae, [1]= adults only

My observations support Mohr's (1943) conclusion that much of the predation by adults and larvae of Staphylinidae, Hydrophilidae and Histeridae is on Diptera larvae in the fecal deposit. In several instances, however, histerid larvae were found feeding on *Aphodius* larvae as well as the more abundant Diptera larvae. Table V summarizes the predacious insects collected in North Dakota which are associated with dung.

The large numbers of fly larvae (Table IV) already present when eggs of *Aphodius* are deposited contribute to spatial competition which is somewhat alleviated by these predators.

Species Which Frequent the Cattle Dropping Only As Adults *Canthon*, *Onthophagus*, and *Geotrupes* are found only as adults in fecal deposits. But they remove amounts of dung from the deposit to a burrow where they oviposit in the stored fecal supply. Larval development in these genera (*Canthon*, *Onthophagus* and *Geotrupes*) is completely within a burrow, well away from the cattle dropping.

At times, as many as 30 *Onthophagus hecate* (Panz.) may be found beneath a fecal deposit digging burrows from two to eight inches deep into which they carry pieces of dung. Each burrow branches into pockets where the adult packs a pellet of dung (figure eight) into which one egg is

TABLE V.

PREDACIOUS COLEOPTERA ASSOCIATED WITH COW DUNG

Histeridae*

Atholus
americanus Payk.
falli Rickhardt

Euspilotus
assimilus Payk.

Hister
abbreviatus Fab.
depurator Say

Hypocaccus
fitchi Mars.
patruelis LeC.

Margarinotus
harrisi LeC.
immunis Er.

Saprinus
distinctus Mars.
pennsylvanicus Payk.

Hydrophilidae

Sphaeridium
scarabaeoides L.
bipustulatum Fab.

Cercyon
haemorrhoidalis Fab.
quisquillius L.
sp. 3
sp. 4
sp. 5

Staphylinidae

Philonthus
varians Payk.

and many other undetermined genera and species.

*determined by Dr. Rupert Wenzel, Field Museum of Natural History.

placed. A burrow may have from one to eight branches. *Geotrupes semiopacus* Jekel digs a burrow beneath dung in wooded pastures and lines the burrow with this dung (fig. 9). As many as ten of these large beetles have been counted beneath cow dung in Richland County. After they complete the burrows little is left of the fecal deposit for other inhabitants. *Canthon pilularius* L. and *praticola* Say roll a fecal ball from the deposit to a burrow where they bury the ball after ovipositing in it. I have collected as many as 25 *Canthon praticola* Say from one deposit of buffalo dung.

Only the adults are inhabitants of the cattle dropping where they can destroy or extensively reduce the fecal deposit as a microhabitat.

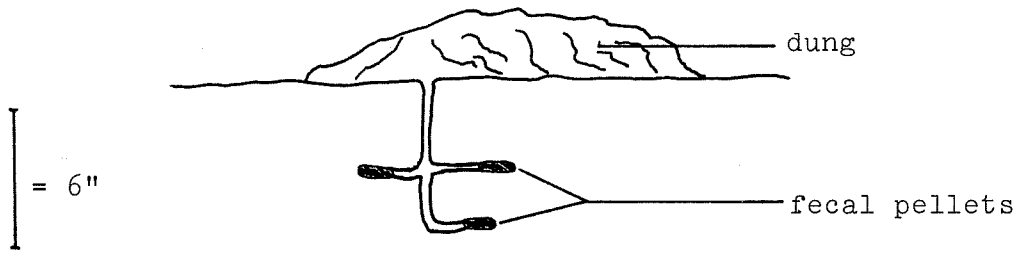

Figure 8. A burrow of *Onthophagus hecate* (Panzer) from the sandhills of Richland County.

HUMUS AS A HABITAT

Unlike the microhabitat of a cattle dropping, humus occurrence is widespread as the substrate in a floodplain, shelter belt or grassland community. It is more difficult, therefore, to quantify observations of individuals and ecological aspects of humus-feeding Scarabaeidae.

The most common method for collecting these Scarabaeidae is by light trap, but this only captures nocturnal-photophilic species and, except for locality, yields little ecological information. *Bolboceras filicornis* (Say), a humus-feeding scarab collected at light traps, was the only species of *Bolboceras* collected in North Dakota prior to 1965. The use of pit traps in areas of high humus yielded another species, *B. falli* (Wallis). This species is nocturnal but not photophilic. Other quantitative sampling techniques must be devised to successfully analyze the species composition of extensive habitats such as humus; Berlese funnels are adequate for only small sample areas and species of limited mobility.

Every major vegetative community contains a humus source available to some speices of Scarabaeidae. No attempt was made to evaluate physical changes or biological components of humus. Species occurrence or association with certain humus sources are listed in Table VI, with the habits of some species briefly discussed in the following pages. The table is based on light trap and pit trap collections from sites in Richland, Grand Forks, Pembina and Billings Counties from May through August 1966.

TABLE VI.

HUMUS PREFERENCE OF SOME SAPROPHAGOUS SPECIES

species	Humus source			
	floodplain forest	grassland	humus near standing water	shelter belts
Aphodius pinguis	*			*
A. pinguellis			*	
A. omissus			*	
Bolboceras falli	*			*
B. filicornis	*	*		*
Bolbocerosoma bruneri		*		
Eucanthus lazarus	*	*		
E. greeni	*	*		
Geotrupes semiopacus	*			*
Ochodaeus musculus	*	*		*

The ecology of *Aphodius spp.* which occur in the humus near standing water is little known. Data indicate a positive association with the high moisture and organic content of these areas, but the adults have not been observed feeding nor their larvae collected. The larvae are presumably free-living in the humus layer.

Geotrupes semiopacus Jekel is a diurnal, burrowing species of the Geotrupinae. When dung is not readily available, it will use humus as a food supply for future larvae. It constructs a burrow beneath a humus source and packs the end of this burrow with humus in which it oviposits (fig. 9).

Species of *Eucanthus*, *Bolboceras* and *Bolbocerosoma* are nocturnal, burrowing Geotrupinae. As Table VII suggests, adults of these species are collected at light traps most abundantly in July. The table is based on results of light traps run from May through August at six different sites across North Dakota in 1960, 1962, 1965 and 1966.

TABLE VII.

NUMBERS OF NOCTURNAL GEOTRUPINAE COLLECTED IN LIGHT TRAPS AT SIX SITES ACROSS NORTH DAKOTA

species	month			
	May	June	July	Aug
Bolboceras falli	0	2	15	4
B. filicornis	6	6	24	0
Bolbocerosoma bruneri	0	3	7	0
Eucanthus greeni	3	4	10	2
E. lazarus	2	13	23	2

These species construct burrows, as in figure 10, much the same as *Geotrupes* in which they store finely chewed humus for larval food. Howden (1955) suggests that differences in burrow types is species-specific in many cases.

Although it is apparent what the larvae of these species eat, it is much less apparent what the adults eat. Howden (1955) reports that some *Bolboceras spp.* feed on underground fungi, but *B. filicornis*, *B. falli*, *Bolobcerosoma bruneri*, *Eucanthus lazarus* and *greeni* have not been seen feeding as adults.

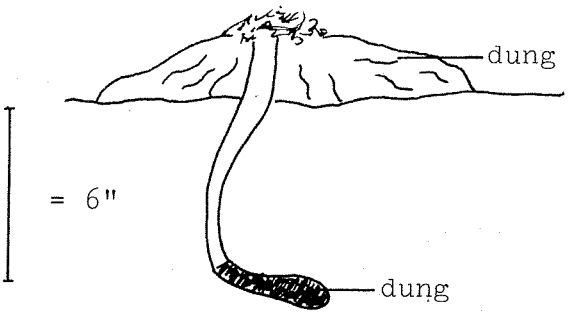

Figure 9.

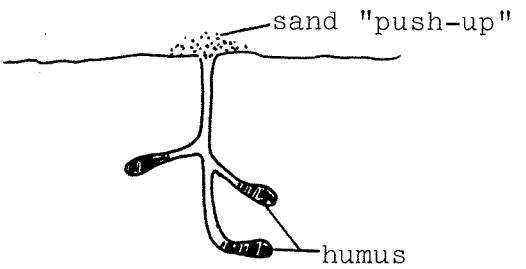

Figure 10.

Figures 9. A burrow of *Geotrupes semiopacus* Jek. in floodplain forest of Richland County.

10. A burrow of *Bolboceras filicornis* from sandhills of Richland County.

TAXONOMY OF SAPROPHAGOUS SCARABAEIDAE OF NORTH DAKOTA

Taxonomically, the saprophagous Scarabaeidae present several difficult problems.

Similar morphological adaptations present problems to the inexperienced worker and even genera are sometimes confused. For example, the distinction of *Psammodius* and *Rhyssemus*, in keys, is based only on the length of the apical metatibial spur and the shape of the first metatarsal segment. Detailed studies of the morphology, however, demonstrate that many of these similarities are superficial.

Geographical variation is pronounced in wide ranging species which complicates definition of many species. *Eucanthus lazarus* Fabricius, for example, has three distinct geographic populations in the United States; one in the gulf states, one in an area from the southwestern to north-central states and one in the southeastern states.

Many species are small and secretive in habit, so they are both difficult to collect and difficult to identify. Other species, such as those in the Geotrupinae, spend the majority of their life in burrows beneath the ground. Improved trapping techniques, especially the use of pit traps, alleviated some of the collecting difficulties.

Despite these difficulties, fifty species have been distinguished within the boundaries of North Dakota. More species undoubtedly will be added to this total as the biologies of some genera, such as *Rhyssemus*, *Psammodius* and *Aegialia* are studied in more detail.

SPECIES LIST OF NORTH DAKOTA SAPROPHAGOUS SCARABAEIDAE

Keys and descriptions of the North Dakota species of saprophagous Scarabaeidae are treated in the order of this species list. The total number of specimens collected and examined appears beside each species.*

SCARABAEINAE

Canthon Hoffmansegg	
praticola LeC.	33
pilularius (L.)	48
Onthophagus Latreille	
hecate (Panz.)	280
pennsylvanicus Harold	90
orpheus pseudorpheus How. & Cartw.	7

APHODIINAE

Aphodius Illiger	
fossor (L.)	102
erraticus (L.)	1
haemorrhoidalis (L.)	94
hamatus Say	15
omissus omissus LeC.	91
omissus torpidus Horn	103
pinguis Hald.	42
pinguellis Brown	179
fimetarius (L.)	160
tenellus Say	33
ruricola Melsh.	171
granarius (L.)	30
vittatus Say	58
alternatus Horn	45
pseudabusus Cartw.	5
lentus Horn	36
explanatus LeC.	19
iowensis Wickh.	4
criddlei Brown	40
haldemani Horn	1
concavus Say	8
fucosus Schmidt	16
consentaneus LeC.	2
dentigerulus Brown	75
coloradensis Horn	55
distinctus (Mull.)	181
leopardus Horn	53
walshi Horn	86
Ataenius Harold	
spretulus (Hald.)	79
texanus Harold	2
Dialytes Harold	
criddlei Brown	115
Rhyssemus Mulsant	
sonatus LeC.	33
Psammodius Fallen	
mimeticus (Fall)	1
Aegialia Latreille	
lacustris LeC.	1
conferta Horn	0
rufescens Horn	1

GEOTRUPINAE

Bolbocerosoma Shaeffer	
bruneri D. & McC.	21
Bolboceras Kirby	
falli (Wallis)	32
filicornis (Say)	72
Eucanthus Westwood	
lazarus (Fab.)	93
greeni Robinson	25
Geotrupes Latreille	
semiopacus Jekel	81

OCHODAEINAE

Ochodaeus Serville	
musculus (Say)	180

DYNASTINAE

Bothynus Hope	
relictus (Say)	125
gibbosus (DeGeer)	96

*Specimens are included from the collections of North Dakota State University, R. G. Helgesen and R. D. Gordon.

KEY TO SUBFAMILIES OF SAPROPHAGOUS SCARABAEIDAE

Adults

1. One apical metatibial spur; pygidium exposed.....*Scarabaeinae* (p. 18)
1'. Two apical metatibial spurs; pygidium rarely exposed.....2
2. Eleven segmented antennae.....*Geotrupinae* (p. 48)
2'. Eight to ten segmented antennae.....3
3. Mandibles bent, expanded and leaflike (fig. 11, pg. 24).....
.....*Dynastinae* (p. 55)
3'. Mandibles normally developed.....4
4. Nine segmented antennae.....*Aphodiinae* (p. 23)
4'. Ten segmented antennae.....*Ochodaeinae* (p. 55)

Larvae

1. No sensorial appendage on penultimate antennal segment; anal lobes not swollen.....*Dynastinae* (p. 55)
1'. Sensorial appendage on inner side of penultimate antennal segment; anal lobes swollen.....2
2. Antennae three-segmented; mandibles and maxillae without stridulatory teeth.....*Geotrupinae* (p. 48)
2'. Antennae four-segmented (secondary fold in first segment makes some appear five-segmented); mandibles and maxillae with stridulatory teeth.....3
3. Claws setiform or absent; dorsum of anterior abdominal segments distinctly enlarged; enclosed in fecal pellet beneath the soil.....*Scarabaeinae* (p. 18)
3'. Claws fully developed; dorsum of anterior abdominal segments not enlarged; not enclosed in fecal pellet.....*Aphodiinae* (p. 23)

SUBFAMILY SCARABAEINAE

Formerly recognized as the subfamily Coprinae, this subfamily includes the well known Sacred Scarab (*Scarabaeus sacer* L.) of Egypt. Species of this subfamily provide their larvae with a stored food supply consisting of a fecal or humus pellet in which the larvae spend their total immature life. A hidden scutellum, single apical metatibial spur and an exposed pygidium distinguished the Scarabaeinae from other saprophagous Scarabaeidae. Larvae have characteristic setiform or vestigal tarsal claws and four-segmented antennae. Two genera and five species occur in North Dakota.

KEY TO GENERA OF SCARABAEINAE

Adults

1. Meso- and metatibiae apically dilated.....*Onthophagus*
1'. Meso- and metatibiae slender and curved.....*Canthon*

Larvae

1. Dorsum of third abdominal segment with a distinct conical, setigerous wart; prothoracic shield with no lateral processes extending cephalad.....*Onthophagus*
1'. Dorsum of third abdominal segment with no distinct conical wart; prothoracic shield with lateral processes extending cephalad.....*Canthon*

Genus *CANTHON* Hoffmansegg, 1817

In North Dakota, only species of *Canthon* roll fecal pellets above the soil surface. The ball is rolled from a fecal source to an adequate burial site where oviposition takes place; thus the common name "tumble-bug". Adult color varies from dull black to dull metallic blue or green; clypeus bi- or quadridentate; meso- and metatibiae curved and slender. Larvae typically have a single terminal tarsal seta, with no claws; a single, broad caudal lobe; raster with pair of inconspicuous tegites. Robinson (1948) recently revised the genus *Canthon* for the United States.

KEY TO SPECIES OF *CANTHON*

1. Clypeus bidentate; metafemora margined anteriorly; pygidium densely granulate.....*pilularius*
1'. Clypeus quadridentate; metafemora entire anteriorly; pygidium sparcely granulate.....*praticola*

Canthon pilularius (Linneaus)

Scarabaeus pilularius Linneaus, C. 1758. Systema Naturae. ed. 10. p. 349.

Adult description: Length 10.3 mm. to 18.5 mm.; width 7.5 mm. to 11.0 mm. Dorsoventrally dull black, sometimes slightly metallic blue. Head granulate with clypeus broadly emarginate, bidentate; genae extended caudad to cover over half the eye dorsally. Pronotum distinctly convex with mixed coarse and fine granules; widest just anterior of middle; anterior angles acute. Elytra with mixed coarse and fine granules; ten pairs of striae, subhumeral striae carinate the length of elytra. Pygidium with dense coarse granules. Metafemora anteriorly margined. Meso- and metatibiae slender and curved.

Larval description: The following larval description is largely from Ritcher (1945). Width of head capsule 3.55 mm. (±.7 mm.). Setigerous frons. Pedium bare (one or two setae may exist). Chaetoparia each with seven to nine setae. Tormae symmetrical. Mesophoba monostichous. Four setae on haptolachus. Twelve to seventeen maxillary stridulatory teeth. Prothoracic shield with lateral projections extending cephalad. Dorsum of third abdominal segment smooth. Raster with pair of inconspicuous tegites. Tarsal claws absent; tarsi terminate in one long seta with eight to nine surrounding setae.

County records: BILLINGS CO. 28-V-66 (RGH), 15-VIII-66 (RGH); CASS CO. 18-VI-40 (SC); GOLDEN VALLEY CO. 4-VII-62 (SW & WB); McKENZIE CO. 1-VII-62 (SW & WB); RICHLAND CO. 2-VII-65 (RGH); STARK CO. 21-VIII-57 (DN); WILLIAMS CO. 5-VII-66 (DGA).

Remarks: During late June and July, the height of *Canthon* activity in North Dakota, *C. pilularius* (L.) bury fecal balls in separate chambers between three to six inches beneath the soil, several yards away from the fecal source. One egg is deposited in each ball. Lindquist (1935) states that the developing larva deposits excrement on the outside surface of the ball.

Canthon praticola LeConte

Canthon praticola LeConte, J. L. 1859. Smithsonian Contributions to Knowledge. 11:1-58.

Adult description: Length 8.6 mm. (±1.1 mm.); width 5.1 mm. (±.6 mm.). Dull black dorsoventrally. Head granulate to alutaceous with clypeus broadly emarginate, quadridentate; clypeofrontal suture distinct; genae extended caudad to cover over half the eye dorsally. Pronotum distinctly convex with mixed coarse and fine granules (sometimes alutaceous). Elytra similar to pronotum with seven obscurred striae; subhumeral striae carinate. Pygidium with sparse, coarse granules. Metafemora not anteriorly margined. Meso- and metatibiae slender and curved.

Larvae unknown.

County records: BILLINGS CO. 28-V-66 (RGH), 15-VIII-66 (RGH); BOTTINEAU CO. 20-VIII-66 (JK); EDDY CO. 26-IX-65 (WB); GRAND FORKS CO. 10-VII-66 (RGH); TOWNER CO. 10-VI-64 (DGA).

Remarks: The author has seen *praticola* bury fecal balls under and very near the fecal source, yet at other times roll a ball several yards away. Whereas the pellet formed by *C. pilularius* (L.) averages near 1.5 cm. in diameter, *C. praticola* (LeC.) builds one only one third this size. The biology of this species, however, is very similar to that of *C. pilularius* (L.).

Genus *ONTHOPHAGUS* Latreille, 1802

In their comprehensive study of the North American *Onthophagus*, Howden and Cartwright (1963) suggest that the genus *Onthophagus* "is perhaps the largest genus of beetles" with nearly 1500 species. There are only three recorded species in North Dakota. Unlike the *Canthon*, these species dig a burrow beneath a fecal supply. At the end of this burrow they construct, piece by piece, a fecal pellet into which one egg is placed. The larvae develop fully inside this pellet, seldom using more than half the supply of dung.

Males of this genus have two forms, a major male which is large and has prominent cephalic and/or pronotal protuberance and a minor male which is small and looks much like a female (this is particularly evi-

dent in *hecate* and *orpheus pseudorpheus*). Females have a cephalic carina and sometimes a slight pronotal evelation. Beetles of this genus are oval; colored dull black, dull to shining bronze, or metallic green; meso- and metatibiae apically dilated and truncate. Larvae possess a distinctive dorsal setigerous wart on the third abdominal segment.

KEY TO SPECIES OF *ONTHOPHAGUS*

Adults

1. Pronotal disc granulate; dorsal color dull black.....*hecate*
1'. Pronotal disc punctate; dorsal color piceous, bronze or metallic green.....2
2. Dorsal color metallic green; male with distinct anterior elevation; size 5.8 mm. to 9.0 mm.....*orpheus pseudorpheus*
2'. Dorsal color dull-shining piceous to bronze; neither sex with anterior pronotal protuberance; size 4.3 mm. to 5.0 mm..... .....*pennsylvanicus*

Larvae

1. Raster with pair of polystichous tegites, each of 25 to 40 setae.....*hecate*
1'. Raster with quadrate teges of 25 to 40 setae...*pennsylvanicus*

Onthophagus hecate (Panzer)

Scarabaeus hecate Panzer, G. 1794. Faunae insectorum americes borealis prodromus. p. 5.

Adult description: Length 7.3 mm. (±2.1 mm.); width 4.0 mm. (±1.0 mm.). Black, often with dorsal aeneous haze. Clypeus dorsoapically reflexed forming a distinct clypeal tooth; finely punctured; carina obsolete. Frontal carina slight. Pronotum convex; with bifurcate horn (in major males) not half as wide as head and extending to posterior of clypeus; coarsely tuberculate. Elytral striae margined and shining; intervals tuberculate with small, basal, setigerous punctures. Dorsal half of pygidium alutaceous, ventral half coarsely punctate. Meso- and metatibiae dilated apically.

Larval description: Larvae have head capsule width of 2.0 mm. (±.8 mm.). Frons setigerous. Pedium bare. Tormae symmetrical. Mesophoba monostichous. Six to eleven maxillary stridulatory teeth. Prothoracic shield laterally and anteriorly smooth. Dorsum of third abdominal segment with distinct setigerous wart. Pair of similar tegites on raster, each with twenty-five to forty setae. Tarsal claws absent; tarsi terminating in long seta surrounded by eight to nine small setae.

County records: BENSON CO. 10-VI-65 (RGH); BOTTINEAU CO. 30-V-66 (JK); CASS CO. 10-VI-59 (DN); DIVIDE CO. 12-VII-66 (RJS); DUNN CO. 20-VI-64 (DGA); EDDY CO. 10-VI-65 (RGH); LAMOURE CO. 12-VII-66 (RJS); McKENZIE CO. 24-VII-64 (RJS); RANSOM CO. 2-VI-62 (JO); RICHLAND CO. 17-VI-65 (RGH); SLOPE CO. 1-VII-65 (WK); STARK CO. 21-VII-57 (DN), 1-VIII-62 (DGA).

Remarks: This species is one of the most abundant and widespread of the saprophagous Scarabaeidae in North Dakota. It is often seen from May to September in and under fecal deposits. It oviposits only in a pellet formed in a chamber from two to eight inches beneath the soil surface. *O. hecate* (Panzer) is not specific to fecal types or habitat, sometimes using humus for larval pellets when a fecal supply is not available. See cover plate for adult male and third instar larva.

Onthophagus pennsylvanicus Harold

Onthophagus pennsylvanicus Harold, E. 1871. Coleopterologische Hefte. 8:115.

Adult description: Length 4.75 mm. (±.25 mm.); width 2.95 mm. (±.25 mm.). Dorsally dull black to piceous, often with aneous sheen; ventrally black, legs piceous. Clypeus dorsoapically reflexed and extended, smooth. Frons alutaceous to finely punctate. Both a clypeal and frontal carina present only in females and minor males. Pronotum convex with large, shallow, setigerous punctures; lacking any protuberance. Elytra with striae impressed and coarsely punctate. Pygidium coarsely, setigerously punctate. Meso- and metatibiae dilated apically. Venter alutaceous with setigerous punctures.

Larval description: This description is based largely on Ritcher's (1945) work. Head capsule width 1.31 mm. (±.08 mm.). Frons setigerous. Pedium bare. Tormae symmetrical. Mesphoba monstichous. Five to seven maxillary stridulatory teeth. Prothoracic shield smooth laterally and anteriorly. Dorsum of third abdominal segment with distinct setigerous wart. Raster with quadrate teges of twenty-five to forty-five setae. Tarsi similar to *O. hecate* (Panzer).

County records: RANSOM CO. 13-VII-62 (JO); RICHLAND CO. 26-VII-65 (RGH), 5-VIII-66 (RGH).

Remarks: *Onthophagus pennsylvanicus* Harold has been found only in southeastern North Dakota and is much less abundant than *O. hecate* (Panzer). They are more common in sandy soil of sheep pastures than in cow pastures.

Onthophagus orpheus pseudorpheus Howden and Cartwright

Onthophagus orpheus pseudorpheus Howden, H. F. and Cartwright, O. L. 1963. Proc. U.S.N.M. 114:53.

Adult description: Length 7.0 mm. (±1.0 mm.); width 4.0 mm. (±.4 mm.). Dorsoventrally metallic green with red-copper haze on anterior dorsum. Clypeus apically reflexed; coarsely and finely punctate; medially emarginate; distinct clypeal suture. Frontal carina laterally terminating in an acute horn caudad of eye. Convex pronotum of major males with broad anterior bifurcate horn extending to posterior of clypeus (females and minor males without such horn); coarsely setigerously punctate. Elytra distinctly striate, intervals punctate-tuberculate, with setae.

Larvae unknown.

County records: LAMOURE CO. 12-VII-66 (RGH); RICHLAND CO. 9-VII-66 (RGH), 25-V-66 (DGA & RDG).

Remarks: Howden and Cartwright (1963) suggest that *O. orpheus pseudorpheus* How. & Cartw. "appears to be a prairie form, unlike the other subspecies which are woodland forms." This species has been collected by pit traps in open range, floodplain forests and shelter belts in North Dakota.

SUBFAMILY APHODIINAE

Comprehensive works on this subfamily are Horn (1887) and Schmidt (1922). Much revisionary work is needed to bring the taxonomy of the Aphodiinae up-to-date. Jerath's (1960) work in larval Aphodiinae is outstanding.

Over half the North Dakota species of saprophagous Scarabaeidae are in the Aphodiinae. The species, included in six genera, are relatively small beetles. The biology of the less common species is poorly understood. The more common species, however, show a full spectrum from specific (*Dialytes*) to more general habitat and food preference (some *Aphodius*).

The distinctive elongate-oval shape and the nine segmented antennae are unique characters of the Aphodiinae. Larvae have four segmented antennae with a sensorial appendage on the penultimate segment and stridulatory teeth on the maxillae.

KEY TO THE GENERA OF NORTH DAKOTA APHODIINAE

Adults

1. Mandibles extended beyond clypeus.....*Aegialia* (p. 46)
1'. Mandibles concealed below clypeus.....2
2. Pronotum with alternate transverse furrows and swellings and with medial longitudinal furrow, these sometimes reduced to impressions (fig. 12, pg. 24).....3
2'. Pronotum without transverse furrows or swellings.....4
3. Longest apical metatibial spur as long or longer than first two tarsal segments; tarsi shorter than tibia, sometimes barely half as long and triangularly flattened.....*Psammodius* (p. 46)
3'. Longest apical metatibial spur shorter than first two tarsal segments; tarsus as long as tibia and never triangularly flattened.....*Rhyssemus* (p. 45)
4. Meso- and metatibia with transverse carinae (fig. 13, pg. 24); head usually with tubercles or traces of tubercles...*Aphodius* (p. 24)
4'. Meso- and metatibia without transverse carinae, mesotibia sometimes with traces (fig. 14, pg. 24); head never tuberculate.....5
5. Elytral intervals broadly carinate; outer apical angle of metatibia obtuse.....*Dialytes* (p. 45)
5'. Elytral intervals flat; outer apical angle of metatibia extended, spiniform.....*Ataenius* (p. 44)

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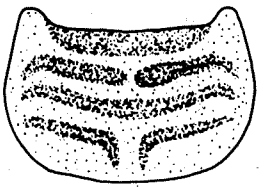

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Figures 11. Dorsal aspect of apical right mandible of *Bothynus relictus* (Say).
12. Pronotum of *Rhyssemus sonatus* LeC. showing transverse furrows.
13. Mesotibia of generalized *Aphodius* showing transverse carinae.
14. Metatibia with absence of transverse carinae and first metatarsal segment of *Ataenius*.

Known Larvae

1. Lower anal lobe divided into two distinct lobes.....2
1'. Lower anal lobe emarginate or entire.....3
2. Maxilla with stridulatory teeth on stipes.....*Ataenius*
2'. Maxilla without stridulatory teeth on stipes.....*Psammodius*
3. Lower anal lip entire.....*Aegialia*
3'. Lower anal lip emarginate (fig. 15, pg. 25).....*Aphodius*

Genus *APHODIUS* Illiger, 1798

Brown (1928, 1929) and Cartwright (1939, 1957) are among the most comprehensive and recent works of this genus.

By number of individuals and speices, the most common Aphodiinae belong to the *Aphodius*. The habitats of these speices vary from humus and a rather wide range of fecal deposits to specific animal burrows.

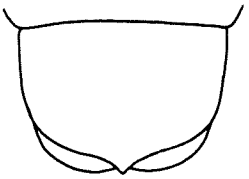
Within the Aphodiinae, the *Aphodius* are characterized by an expanded clypeus which conceals the mandibles and two or more transverse carinae on the meso- and metatibiae. Larvae have swollen anal lobes, the lower lobe being emarginate. The tarsungulus is fully developed.

KEY TO SPECIES OF *APHODIUS*

Adults

1. Scutellum one-fifth the length of elytra or more.....2
1'. Scutellum one-eighth the length of elytra or less.....9
2. Apical metatibial spinules equal in length; margin of fore tibiae entire above teeth (pg. 49) .....*Fosser*
2'. Apical metatibial spinules varying in length; margin of fore tibiae serrulate above teeth 3

3. Scutellum flat and smooth throughout; margin of fore tibiae above teeth feebly serrulate 4
3'. Scutellum longitudinally impressed, distinct anteriorly; protibial serrulation distinct 5
4. Elytral intervals alutaceous; elytra lack pigmentation (yellow-brown color) ..... *erraticus* (p. 51)
4'. Elytral intervals smooth, shining; elytra black, red at apical one-third ..... *haemorrhoidalis* (p. 52)
5. Elytral surface alutaceous, never shining.....*hamatus* (p. 30)
5'. Elytral surface smooth, shining.....6
6. Basal pronotal margin strong, entire.....*pinguis* (p. 32)
6'. Basal pronotal margin obsolete or very short and indistinct, never entire.....7
7. Apex of clypeus uniform in thickness, or nearly so.....*pinguellis* (p. 33)
7'. Apex of clypeus distinctly thickened, nearly twice as thick as rest of clypeal margin.....8
8. Elytra uniformly pigmented, black.....*omissus omissus* (p. 31)
8'. Elytra lacks pigment along suture (two longitudinal stripes apparent).....*omissus torpidus* (p. 32)
9. Apical metatibial spinules equal in length.....10
9'. Apical metatibial spinules varying in length, not equal....16
10. Mesosternum distinctly carinate between coxae (fig. 17, pg. 25).....11
10'. Mesosternum smooth and flat between coxae.....12



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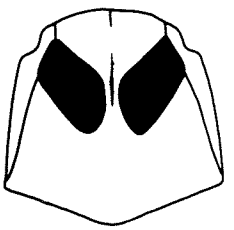

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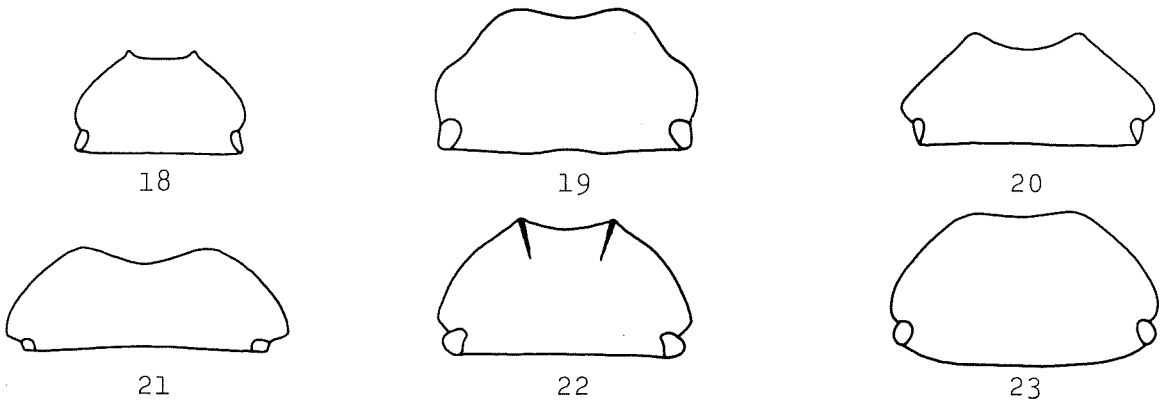
Figures 15. Emarginate lower anal lip of *Aphodius spp.* (ventral aspect).
16. Metatibia and first metatarsal segment of *Aphodius fossor* (L.) showing apical metatibial spinules equal in length.
17. Carinate mesosternum of *Aphodius vittatus* Say (ventral aspect).

11. First segment of metatarsus as long as next three segments .....*vittatus* (p. 36)
11'. First segment of metatarsus as long as next two, no longer .....*granarius* (p. 35)
12. Clypeus with two distinct clypeal teeth (fig. 18, pg. 26)... .....*pseudabusus* (p. 37)
12'. Clypeus emarginate, broad and rounded (fig. 19, pg. 26)....13
13. Frons with at least traces of three tubercles, usually well developed in males and weak in females.....14
13'. Frons smooth, convex, with no traces of tubercles..*alternatus* (p. 37)

14. First metatarsal segment no longer than next two segments.. ..... *ruricola* (p. 34)
14'. First metatarsal segment as long as next three segments....15
15. Coarse pronotal punctures sparse, elytra, red-orange..... ..... *fimetarius* (p. 33)
15'. Coarse pronotal punctures dense, elytra dark red-brown..... ..... *tenellus* (p. 34)
16. Pronotal sides explanate.....17
16'. Pronotal sides convex and entire, never explanate.....20
17. Clypeus angulate at sides of emargination (fig. 20)..... ..... *explanatus* (p. 38)
17'. Clypeus round at sides of emargination (fig. 21).....18
18. Anterior of clypeus granulate or rugose.....19
18'. Clypeus entirely smooth, without granules or punctures; elytral intervals polished, shining..... *haldemani* (p. 40)
19. Elytral intervals finely alutaceous, dull; pronotum and head light red..... *criddlei* (p. 39)
19'. Elytral intervals smooth, shining; pronotum and head black ..... *iowensis* (p. 34)
20. Mesosternum carinate between coxae; anterior face of fore tibiae punctate..... *lentus* (p. 38)
20'. Mesosternum flat between coxae; anterior face of fore tibiae impunctate, smooth.....21
21. Elytra distinctly pubescent..... *walshi* (p. 43)
21'. Elytra devoid of hairs, smooth.....22
22. Sides of clypeal emarginations angulate (fig. 22).....23
22'. Sides of clypeal emarginations rounded (fig. 23).....24
23. Clypeus dentate with subacute teeth inside emargination.... ..... *dentigerulus* (p. 41)
23'. Clypeus dentiform (fig. 22); never dentate..... *coloradensis* (p. 42)



Figures 18. Head of *Aphodius pseudabusus* Cartw. showing emarginate clypeus with two teeth (dorsal view).
19. Head of *Aphodius fimetarius* (L.) showing broad and rounded emarginate clypeus (dorsal view).
20. Head of *Aphodius explanatus* LeC. showing clypeus angulate at sides of emargination (dorsal view).
21. Head of *Aphodius criddlei* Brown showing clypeus rounded at sides of emargination (dorsal view).
22. Head of *Aphodius coloradensis* Horn showing dentiform clypeus.
23. Head of *Aphodius leopardus* Horn showing very broadly emarginate clypeus, rounded at sides (dorsal view).

24. Pronotum rufopiceous, red or brown; never black.....25
24'. Pronotum black.....26
25. Pronotal disc smooth, or nearly so.....*concavus-fucosus* (p. 40)
25'. Pronotal disc evenly punctate throughout.....*consentaneus* (p. 41)
26. Pronotum with coarse punctures.....*leopardus* (p. 43)
26'. Pronotum with fine punctures.....*distinctus* (p. 42)

Larvae

1. Raster with teges divided by palidia.....*granarius* (p. 35)
1'. Raster with teges; no palidia.....2
2. Teges bilobed (fig. 24 and 26, pg. 28).....3
2'. Teges subquadrate to subtriangular (fig. 25, pg. 28).....4
3. Laeotorma produced cephalad and caudad (fig. 32, pg. 28).....*vittatus* (p. 36)
3'. Laeotorma produced cephalad only (fig. 30, pg. 28)...*ruricola* (p. 34)
4. Maxilla with stridulatory teeth on stipes and palpifer (fig. 33 and 35, pg. 28).....5
4'. Maxilla with stridulatory teeth on stipes only (fig. 34, pg. 28).....7
5. Lacinia dorsally with mesal row of 5-6 setae (fig. 33, pg. 28).....*fimetarius* (p. 33)
5'. Lacinia dorsally with mesal row of 8-9 setae (fig. 35, pg. 28).....6
6. Palpifer with 4-6 stridulatory teeth (fig. 35, pg.28)..*fossor* (p. 27)
6'. Palpifer with 1-2 stridulatory teeth.....*hamatus* (p. 32)
7. Raster with teges of less than 40 setae (25-30).....*lentus* (p. 38)
7'. Raster with teges of more than 40 setae (50-90).....8
8. Lacinia dorsally with mesal row of 5 setae....*haemorrhoidalis* (p. 30)
8'. Lacinia dorsally with mesal row of 7-8 setae.....*erraticus* (p. 29)

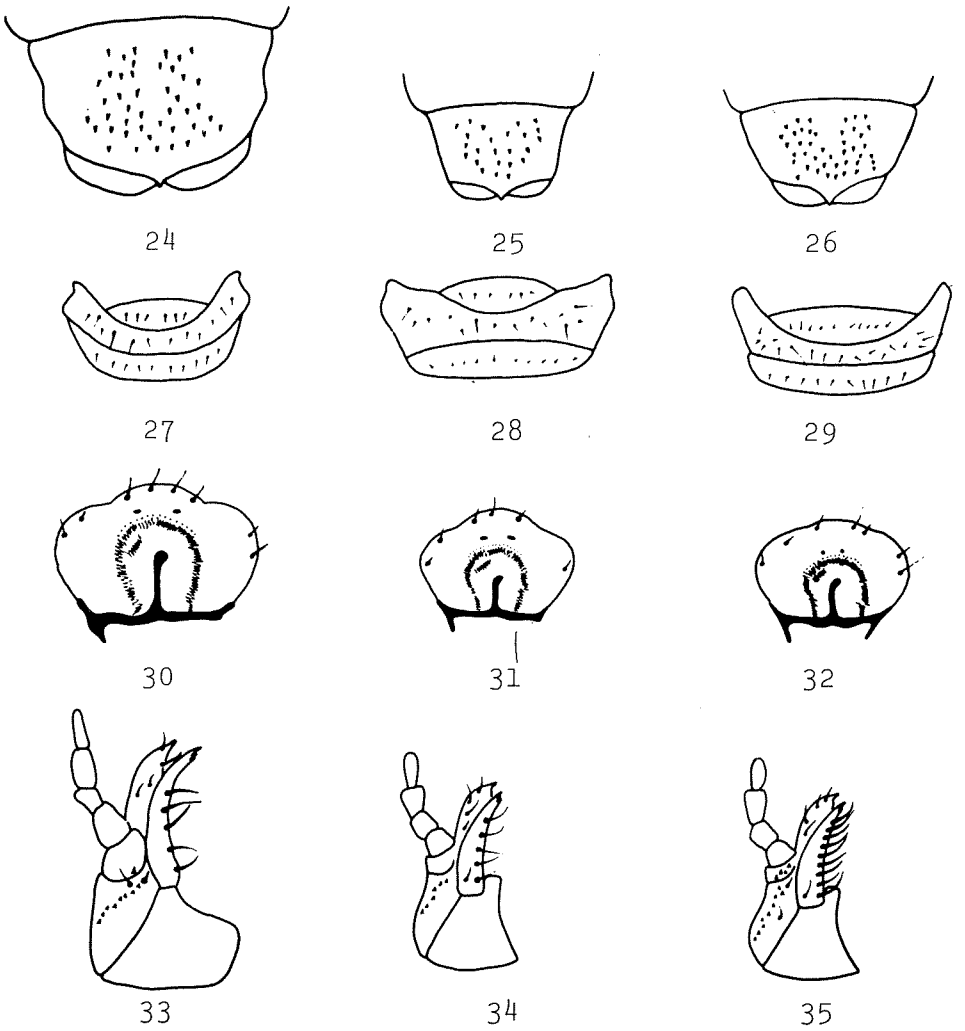
Aphodius fossor (Linneaus)

Scarabaeus fossor Linneaus, C. 1758. Systema Naturae, ed. 10. p. 348.

Adult description: Length 10.5 mm. (±2.0 mm.); width 5.1 mm. (±.6 mm.). Dorsoventrally black. Head convex, punctate. Clypeus very broadly emarginate, apices of emargination reflexed. Three tubercles transverse the clypeofrontal area, well developed in males, weakly so in females. Pronotum shining, with sparse punctures, an anterior fovea present in males. Scutellum slightly longer than one fourth elytral lingth; slightly convex and anteriorly punctate, never with longitudinal depression. Elytral striae with very indistinct punctures; intervals with very fine punctures, otherwise very smooth, shining. Metasternal groove cariniform anteriorly. Apical metatibial spinules equal in length.

Larval description: Head capsule width 3.5 mm. (±.2 mm.); alutaceous, red-brown. Two posterior setae, one exterior seta, one anterior seta and one seta in anterior angle, on each side of frons. Four to five pairs of dorsoepicranial setae.

Epipharynx with 15-23 proptphobal microsensillae; bistichous on left, monostichous on right. Dexiotorma sinuate, produced caudad and cephalad; laeotorma straight, produced cephalad. Epitorma asymmetrical, apex pro-



Figures 24. Raster of *Aphodius ruricola* Melsh. showing bilobed teges.
25. Raster of *Aphodius lentus* Horn.
26. Raster of *Aphodius vittatus* Say showing bilobed teges.
27. Third abdominal segment of *Aphodius ruricola* Melsh. Dorsal view.
28. Third abdominal segment of *Aphodius lentus* Horn. Dorsal view.
29. Third abdominal segment of *Aphodius fossor* (L.). Dorsal view.
30. Epipharynx of *Aphodius ruricola* Melsh. with only the dexiotorma produced caudad.
31. Epipharynx of *Aphodius lentus* Horn with only the dexiotorma produced caudad.
32. Epipharynx of *Aphodius vittatus* Say with the laeo- and dexiotorma produced caudad.
33. Maxilla of *Aphodius ruricola* Melsh. showing one stridulatory tooth on the palpifer and five setae on the mesal edge of the lacinia.
34. Maxilla of *Aphodius lentus* Horn showing lack of stridulatory teeth on palpifer and mesal row of five setae on the lacinia.
35. Maxilla of *Aphodius fossor* (L.) showing palpifer with four stridulatory teeth and lacinia with mesal row of nine setae.

duced toward laeotorma.

Maxilla with a row of 16-20 stridulatory teeth on the stipes and 4-6 such teeth on palpifer. Galea dorsally with eight setae; ventrally with a mesal row of 18-20 short setae. Lacinia dorsally with nine setae on mesal edge.

Two plicae on abdominal segments 1-5. Prescutum with 12 setae, scutum with 2-5 long and 5-8 short setae and scutellum with 16 setae (see fig. 29). Raster with subquadrate teges of 130-170 small, stout setae.

County records: BOTTINEAU CO. 27-V-65 (JK); DUNN CO. 22-VI-65 (RJS); McKENZIE CO. 2-VIII-61 (CDM), 16-VII-65 (RGH); PEMBINA CO. 28-VII-65 (RGH); RANSOM CO. 14-V-59 (SC); RICHLAND CO. 17-VI-65 (RGH); SLOPE CO. 1-VIII-61 (CDM); TRAILL CO. 17-VIII-61 (RLP).

Remarks: *Aphodius fossor* is widely distributed throughout North Dakota and found consistently in cow dung from late June to early September.

Aphodius erraticus (Linneaus)

Scarabaeus erraticus Linneaus, C. 1758. Systema Naturae. ed. 10. p. 348.

Adult description: Length 7.0 mm. (±.3 mm.); width 3.4 mm. (±.1 mm.). Head, pronotum, scutellum, legs, venter piceous to black; elytra yellow-brown entirely dull. Head punctate throughout. Clypeus nearly entire, middle deflexed. One distinct clypeofrontal tubercle. Pronotum densely punctate. Scutellum one-fifth length of elytra, coarsely punctate. Elytral surface alutaceous; intervals moderately punctate; striae shallow, punctures coarse, elytral suture raised posteriorly. Apical metatibial spinules unequal in length.

Larval description: Head capsule width 2.33 mm. (±.6 mm.); smooth, yellowish-brown. Clypeus with transverse protuberance, anterior angles of which raise into a tubercle.

Epipharynx with 19-21 protophobal microsensillae; protophoba tristichous on left; monostichous on right. Both dexio- and laeotorma produced cephalad and caudad; somewhat symmetrical. Epitorma asymmetrical.

Maxilla with row of 9-13 stridulatory teeth on stipes; no such teeth on palpifer. Galea dorsally with 6-7 setae, ventrally with mesal row of 8-9 short setae. Lacinia dorsally with mesal row of 7-8 setae, 2-3 short posterior setae.

Two plicae on each abdominal segment 1-5. Prescutum with ten setae; scutum with 4-6 long setae and 11-15 short setae on each side; scutellum with 16 setae. Raster with teges of 52-75 setae.

County records: GRAND FORKS CO. 7-VII-66 (RDG).

Remarks: Only one specimen of *Aphodius erraticus* (L.) has been