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**A Research Report for the
Rockwell Hanford Operations**

**Darkling Beetle Populations
(*Tenebrionidae*) of the Hanford
Site in Southcentral Washington**

February 1978

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Battelle
Pacific Northwest Laboratories

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**Darkling Beetle Populations
(*Tenebrionidae*) of the Hanford
Site in Southcentral Washington**

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February 1978

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Summary

This 3-yr study documents the taxonomic composition, relative abundance, and seasonal distribution of darkling beetles occupying the Hanford Site in southcentral Washington. A taxonomic key and species diagnosis are provided to assist in identification by the nonspecialist. Analysis of food plant availability and selection serves to identify transfer pathways through beetle populations and permits construction of food web diagrams depicting the flow of materials through the darkling beetle component.

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Chapter I

INTRODUCTION

DARKLING BEETLE POPULATIONS (*TENEBRIONIDAE*) OF THE HANFORD SITE IN SOUTHCENTRAL WASHINGTON

CHAPTER I. INTRODUCTION

The Tenebrionidae are a large and diverse group of beetles, occurring in most zoogeographical regions of the world. There are nearly 15,000 described species world wide with over 1,300 of these inhabiting the United States (Arnett, 1960). They are often conspicuous dwellers in arid regions, but are not restricted to these areas. Most species are scavengers, occurring in a wide variety of situations where they feed upon decaying vegetation, animal excrement, fungi, and sometimes living parts of plants (Arnett, 1960). Several species are severe pests of stored products and have been the subject of much pest management research. Some species, including Tenebrio molitor, Tribolium castaneum, and Tribolium confusum, are easily reared, facilitating their use in research on insect hormones, insect irradiation studies, and a wide variety of other fundamental problems concerning insect biology.

Our species of Tenebrionids are conspicuous members of the local insect fauna. Some are locally referred to as "stinkbugs" due to their habit of elevating the posterior tip of the abdomen and emitting a foul-smelling defensive secretion when disturbed. During the spring and fall months, they are active during most of the day and are often observed walking quickly across the surface of the soil. They sometimes occur in large numbers.

The darkling beetles of the Hanford Site are typical of those which occupy semi-arid regions. Several species have long legs which serve to elevate their bodies above the hot soil surface. With one exception, our species have found flight unnecessary, resulting in the loss of their meta-thoracic flight wings and fusion of the elytra at the midline, a feature often found in desert-dwelling Tenebrionids.

Some important publications concerning the life histories and habits of darkling beetles can be found in Ahern, 1971; Arnett, 1962; Brown, 1973; Calkins and Kirk, 1975; Doyen and Tschinkel, 1974; Hewitt et al., 1974; Hinds and Rickard, 1973; Hyslop, 1912; Kram and Kram, 1972; Rickard, 1967; Rickard, 1970; Rickard and Haverfield, 1965; Rickard et al., 1974; Rogers and Rickard, 1975; Tanner and Packham, 1965; and Wakeland, 1926.

Chapter II

METHODS

Pitfall Trapping

Food Habit Study

Study Area

CHAPTER II. METHODS

PITFALL TRAPPING

A total of 25 pitfall traps was placed in each study location. The traps consisted of 3-1/2 x 3-1/2 in. metal cans placed at 5 m intervals in a straight line. The cans were buried flush with the surface of the soil. A 5% formalin solution was maintained in the traps. All captured darkling beetles were removed after 5 days and taken to the laboratory where they were identified and counted. Occasionally, a coyote or another animal would dig out one of the pitfall traps or a can would rust through, resulting in loss of the formalin. These traps were replaced immediately and results adjusted to represent a 25 trap, 5-day sampling effort.

FOOD HABIT STUDY

Food plant selection was determined using a microscopic technique where fragments of ingested food plants are used in species identification. A collection of all plant species known to occur within study areas was made and reference slides prepared.

The preparation of reference slides requires that collected plant samples be dried, partially ground (1 mm screen size) and mounted on a glass slide according to plant part (i.e., leaves, stems, flowers). This treatment results in mounted plant fragments approximating those found in beetle digestive tracts. Comparison of cellular characteristics can then be made between these reference slides and the unknown food plant material consumed by the beetles.

The digestive tracts of captured beetles were removed, cleared and permanently mounted on slides. Clearing consists of adding 3 or 4 drops of Hertwig's solution (Appendix A) to the slide containing a freshly removed beetle digestive tract. The Hertwig's solution is then carefully boiled off by holding the slide over the flame on a small alcohol burner.

After most of the Hertwig's has boiled away, enough Hoyer's solution is added to cover an area about 2/3 that of the cover slip. A teasing needle is then used to stir and evenly disperse the sample. A cover slip may then be placed on the slide. Air bubbles are drawn from slides by heating them over an alcohol burner and rapidly drawing them over a wet sponge.

Prepared slides were sent to the Composition Analysis Laboratories, Colorado State University, Fort Collins, Colorado, along with reference slides for analysis. A total of 20 fields was read for each slide and results posted to a keypunch advice form (Figure 2.1). These data were then keypunched and computer processed using the analytical program shown in Appendix B. A listing of key punched data is included in Appendix C. Abbreviations substituted for darkling beetle species names on the keypunch advice form are shown in Table 2.1. Published papers of particular value concerning materials and methodology of diet studies include Baumgartner and Martin, 1939; Brusven and Mulkern, 1960; Cavender and Hansen, 1970; Hansen and Flinders, 1969; Rogers and Uresk, 1974; and Sparks and Malechek, 1968.

STUDY AREA

The Hanford Site comprises about 570 square miles within Benton County, located in southcentral Washington. Federal acquisition of the lands occurred in 1943 and are now managed by the U.S. Department of Energy. Intensive study sites were selected for this research within most major plant communities existing on the Hanford Site (Table 2.2).

Upper and lower Snively old fields represent annual grass communities and occur at 533 m and 323 m elevation, respectively. Upper Snively was used as a wheat field prior to 1943 and lower Snively supported an alfalfa field. The dominant plant on both fields is now cheatgrass (Bromus tectorum). Cheatgrass accounts for about 90% of the total production on both fields (Rickard, 1972). Plant ecology studies have shown the old fields to be more productive than pristine vegetation stands. Figures 2.2 and 2.3 show the location of study sites at upper and lower Snively, respectively.

The IBP study plot was the site of intensive ecological studies as part of a contribution to the International Biological Program (IBP). This site is dominated by big sagebrush (Artemisia tridentata) and bluebunch wheatgrass (Agropyron spicatum). The sagebrush/bunchgrass association generally occurs at elevations above 300 m and is the dominant plant community on the ALE Reserve. The average annual rainfall for this area is about 9 in. (23 cm)

TABLE 2.2. Description of Study Areas

Study Area Number	Descriptive Name of Study Area	Dominant Plant Community		Elevation
		Common Name	Scientific Name	
1	Upper Snively old field	Cheatgrass	<u>Bromus tectorum</u>	533 m
2	Lower Snively old field	Cheatgrass	<u>Bromus tectorum</u>	323 m
3	IBP plot	Sagebrush/bunchgrass	<u>Artemisia tridentata</u> / <u>Agropyron spicatum</u>	330 m
4	Greasewood plot	Greasewood/cheatgrass	<u>Sarcobatus vermiculatus</u> / <u>Bromus tectorum</u>	210 m
5	Winterfat plot	Winterfat/cheatgrass	<u>Eurotia lanata</u> / <u>Bromus tectorum</u>	206 m
6	Hopsage plot	Hopsage/cheatgrass	<u>Atriplex spinosa</u> / <u>Bromus tectorum</u>	158 m
7	REDOX Pond area	Sagebrush/bluegrass	<u>Artemisia tridentata</u> / <u>Poa sandbergii</u>	192 m
8	B-C Cribs area	Sagebrush/bluegrass	<u>Artemisia tridentata</u> / <u>Poa sandbergii</u>	220 m
9	Manipulation (Control) area	Sagebrush/bluegrass	<u>Artemisia tridentata</u> / <u>Poa sandbergii</u>	198 m

FIGURE 2.2. Upper Snively Old Field Study Site

FIGURE 2.3. Lower Snively Old Field Study Site

(Stone et al., 1972). The study site is located at about 330 m elevation. Figure 2.4 shows the sagebrush/bunchgrass study site location.

The greasewood (*Sarcobatus vermiculatus*) site is located near Rattlesnake Springs in the northeast part of the ALE Reserve (Figure 2.5) at about 210 m elevation. An alkaline, saline soil combined with a water table near the soil surface is required for maintenance of greasewood communities. Greasewood plants are halophytes and readily absorb and translocate minerals. The annual precipitation is about 7 in. (18 cm) (Stone et al., 1972). Some past research efforts associated with this community include Rickard, 1965a, 1965b; Rickard 1967; Rickard and Cline, 1965; and Rickard and Keough, 1968.

The winterfat (*Eurotia lanata*) study site is located on the lower slopes of the Rattlesnake Hills at an elevation of about 200 m (Figure 2.6). This community is restricted to a narrow elevation gradient but does comprise several thousand acres. It is not known if this community is expanding or contracting in size or why sagebrush has not invaded the area. Winterfat is well known for its nutritional value and high palatability as forage for livestock and wild herbivores. Cheatgrass is the major understory plant. This community has received little study on the Hanford Site. Annual precipitation averages about 8 in. (20 cm) (Stone et al., 1972).

FIGURE 2.4. Sagebrush/Bunchgrass Study Site

FIGURE 2.5. Greasewood Study Site

FIGURE 2.6. Winterfat Study Site

Hopsage (*Atriplex spinosa*) plants are scattered over much of the Hanford Site but provide distinct communities at only a few locations, all at lower elevations. One of the most prosperous communities occurs near Goose-egg Hill on the site of an old lake bed (Figure 2.7). Hopsage is of special interest due to its ability to concentrate potassium from the soil. The hopsage study site is located at 158 m elevation and averages about 7 in. (18 cm) of precipitation each year (Stone et al., 1972).

Sagebrush-sandberg bluegrass (*Artemisia tridentata*/*Poa sandbergi*) communities dominate the lower elevation lands of Hanford. The climate is too dry to support bluebunch wheatgrass and has been successfully invaded by alien weeds. Past agricultural pursuits probably account for the mass invasion of alien plants. This community type exists over most of the waste management areas (Cline et al., 1975). Three beetle study plots--REDOX Pond, B-C Crib, and a control area located on the ALE Reserve are all of this community type. They are all located at about 200 m elevation (Figures 2.8, 2.9 and 2.10). Precipitation for these study areas averages about 6 in. (15 cm) (Stone et al., 1972).

FIGURE 2.7. Hopsage Study Site

FIGURE 2.8. REDOX Pond Study Site

FIGURE 2.9. B-C Crib Study Site

FIGURE 2.10. Control Area Study Site

Chapter III

BIONOMICS AND IDENTIFICATION

Family Recognition

Characterization of *Tenebrionidae*

**Other Families Which May Be Mistaken
for *Tenebrionidae***

**Illustrated Field Key to the Darkling Beetles
(*Tenebrionidae*) of the Hanford DOE Site
in Southeastern Washington**

Species Diagnosis and Bionomics

CHAPTER III. BIONOMICS AND IDENTIFICATION

FAMILY RECOGNITION

The Tenebrionidae are fairly diverse on the Hanford Site, with 18 species being present. They are quite variable in size, shape, and color, but the local species are all dark colored. Black is the most common coloration for local species but a few are brown. This family can nearly always be correctly identified by the eyes, legs, and antennae. The eyes are small, vertically elongated, and either notched (most species) or divided into dorsal and ventral sections (2 species). The tarsi of the front, middle, and hind legs have 5, 5, and 4 segments, respectively. The antennae are usually comprised of 11 segments and are enlarged distally. A more complete characterization is included below. Figure 3.1 illustrates the general features of Tenebrionid beetles. The relative size of local species is shown in Figure 3.2.

FIGURE 3.1. Dorsal View of a Representative Darkling Beetle

FIGURE 3.2. Relative Sizes of Darkling Beetle species. All approximately 0.8X life size. (A) Eleodes obscura, (B) Eleodes hispilabris, (C) Eleodes nigrina, (D) Eleodes humeralis, (E) Eleodes novoverrucula, (F) Eleodes granulata, (G) Coniontis lanei, (H) Coniontis setosa, (I) Coniontis ovalis, (J) Conisattus nelsoni, (K) Eusattus muricatus, (L) Stenomorpha puncticollis, (M) Philolithus densicollis, (N) Blapstinus substriatus, (O) Blapstinus discolor, (P) Anemia californica, (Q) Oxygonoder a hispidula, and (R) Lepidocnemeplatia sericea

CHARACTERIZATION OF TENEBRIONIDAE

Darkling beetles are variable in shape and size, ranging from 2 to 35 mm. They are generally black in color but may be brown, reddish, or yellowish with a vestiture of hair or scales. The head is directed forward and bears antennae with 11 (rarely 10) segments, which are filiform or gradually enlarged apically. The labrum is generally distinct, and the mandibles are short and robust. The labial palpi are 3 segmented, the maxillary palpi 4 segmented, and the apical segment is enlarged in both pairs. The eyes are small, transverse, and emarginate. The pronotum is broader than long, variably shaped but often oval. The procoxal cavities are closed behind. Legs are usually long, with the procoxae globose (rarely oval) not prominent, and always separated. The mesocoxae are round, usually widely separated, and the transverse metacoxae are separate. The femora and tibiae are usually slender, the latter with prominent apical spurs. The tarsi on the pro- and mesothoracic legs are 5-segmented while those of the metathoracic legs are 4-segmented. The scutellum is small and triangular. The elytra are more or less rounded apically, usually striate, with the intervals sometimes ridged.

Most of the local species are without metathoracic (flight) wings. The abdomen has 5 visible sternites, the first 3 appearing connate.

The larvae are elongate (like a wireworm) or C-shaped, subcylindrical, and somewhat stout, from 5 to 40 mm. They are usually yellowish, but may be darker. The head is exerted, subequal to thorax, with U- or Y-shaped epicranial suture. The antennae are 3-segmented and prominent. The clypeus and labrum are distinct; the mandibles are stout, with acute apices and a developed molar area. The thorax has 4-segmented legs, the prothoracic legs may be longer than the other pairs. The abdomen is 10-segmented, with the tenth segment greatly reduced. Urogomphi are present or absent (if absent the posterior dorsal segment may have spines or dense hairs).

The larval forms of many of the common species present at Hanford have not been described. Helpful works concerning the identification of larvae include Boving and Craighead (1931), Peterson (1960), and Brown (1973).

OTHER FAMILIES WHICH MAY BE MISTAKEN FOR TENEBRIONIDAE

Carabidae

The ground beetles (Carabidae) are dark-colored and occupy much of the same habitat as darkling beetles. The Carabidae can be distinguished by their large eyes; 11-segmented antennae, which are never enlarged distally; and 5-5-5 tarsal formula.

Anthicidae

The Anthicidae are very small beetles that may superficially resemble darkling beetles. They have a 5-5-4 tarsal formula and are usually dull brown or black in color, similar to tenebrionids. Our common anthicid (*Notoxus* sp.) has a horn-like process extending over the head. Anthicids also have a narrow neck immediately behind the head, and thread-like antennae.

Cerambycidae

Some Cerambycids may be mistaken for darkling beetles. Their eyes are notched, tarsi appear to be 4-4-4 (actually 5-5-5 with a small fourth segment), and the antennae are long, at least half the body length.

Scarabaeidae

One darkling beetle (*Anemia californica*) superficially resembles a Scarab beetle. However, scarabs have a tarsi formula of 5-5-5 and heavily clubbed antennae.

ILLUSTRATED FIELD KEY TO THE DARKLING BEETLES (TENEBRIONIDAE) OF THE HANFORD DOE SITE IN SOUTHEASTERN WASHINGTON

This field key was developed by the authors to permit ready identification of darkling beetle species known to inhabit Hanford. The general terminology

coupled with detailed illustrations should permit ready identification by the non-specialist. The general features of Tenebrionidae are shown in Figure 3.1.

1. a) Overall length greater than 8 mm (small specimens of Coniontis ovalis may approach 8 mm. This species occurs only at elevations above 1,000 ft and is black in color).7
- b) Overall length less than 8 mm (Conisattus nelsoni may approach 8 mm in length but is brown in color and occurs at elevations lower than 1,000 ft)2
2. a) Body covered with long, fine hair; apical angles of pronotum very acute; 4.5-5.5 mm Oxygonodera hispidula
- b) Body not covered with long fine hairs; Apical pronotal angles variable, may be acute but not produced forward.3
3. a) Body light colored, almost shining due to body covering of short, scale-like hairs; front tibiae triangular, expanded apically; body elongate, size very small, 2-3.3 mm Lepidocnemeplatia sericea
- b) Body dark colored, without scales; larger more robust species4
4. a) Front tibiae apically expanded, with two teeth; generally found in sandy areas at lower elevations; small, oval in form; ca. 3 mm Anemia californica
- b) Front tibiae not expanded and without teeth5
5. a) Eyes divided (from side view); elytra with striations; dorsal body color black6

2a

3a

4a

5a

- b) Eyes not divided; elytra without striations, body color brownish; body form similar to the genus Coniontis (see below); 6-7 mm . Conisattus nelsoni
6. a) Legs and antennae bright reddish-brown, markedly different from general body coloration; 5-6 mm . Blapstinus discolor
- b) Legs and antennae dark brown, not markedly different from general body coloration; 3.5-5.3 mm . Blapstinus substriatus
7. a) Body oval shaped (dorsal view); pronotum as wide as elytra and with lateral margin nearly continuous with that of elytra8
- b) Body not oval shaped, more elongate; pronotum usually narrower than elytra, with lateral margin obviously indented between pronotum and elytra11
8. a) Pronotum distinctly fringed with golden hairs, especially dense on anterior and posterior margins, appearing as a solid line of color; body nearly spherical; occupies sandy habitats; 9-12 mm Eusattus muricatus
- b) Pronotum without fringe of golden hairs9
9. a) Elytra, especially posteriorly, clothed with short golden hairs; 8-12 mm Coniontis setosa
- b) Elytra without golden hairs; generally occurs at higher elevations (greater than 1,000 ft)10

10. a) Posterior region of elytra roughly sculptured, appearing granular to the naked eye; larger species, 11-15 mm Coniontis lanei
- b) Posterior region of elytra smooth, smaller species, 8-10 mm . Coniontis ovalis
11. a) Elytra deeply, regularly grooved, appearing heavily striated without magnification; front femora may be toothed 12
- b) Elytra not deeply grooved, appearing smooth to the naked eye; lateral edges of elytra may be ridged; front femora never toothed 13
12. a) Anterior angles of pronotum obtuse; very large species, 23-35 mm . Eleodes obscura
- b) Anterior angles of pronotum acute; smaller than above species, 17-23 mm Eleodes hispilabris
13. a) Elytra laterally with two sharp ridges extending from the pronotum nearly to the posterior margin; pronotum very densely punctate, appearing very granular to the naked eye; active only in the fall and early winter, 11-20 mm . Philolithus densicollis
- b) Elytra without sharp ridges laterally; pronotum and activity periods variable 14
14. a) Side margin of pronotum sharp, produced laterally; elytra strongly convex; active only in the fall and early winter; 13-19 mm . . . Stenomorpha puncticollis

- b) Side margin of pronotum not produced laterally; elytra not strongly convex; active during spring and summer periods15
- 14b
15. a) Front tibiae with one spur much larger than the other; 14-17 mm Eleodes humeralis
- 15a
- b) Spurs of front tibiae nearly equal in size16
- 15b
16. a) Lateral margins of pronotum strongly rounded; entire elytra appearing strongly granular to the naked eye; 9-14 mm Eleodes novoverrucula
- 16a
- b) Lateral margins of pronotum not strongly rounded; elytra moderately granular along the sides only17
- 16b
17. a) Medium sized species, 12-14 mm; occasionally very abundant . . . Eleodes granulata
- b) Large species, 15-23 mm; elongate in form, never very abundant Eleodes nigrina

SPECIES DIAGNOSIS AND BIONOMICS

Oxygonodera hispidula (Figure 3.3)

This is a small (4.5-5.5 mm) dark brown beetle that is clothed with long, erect brownish-yellow hairs. These are rather uncommon beetles that occur in eastern Washington and southern Idaho.

(A) *Oxygonoderella hispidula*

(B) *Lepidocnemeplatia sericea*

(C) *Anemia californica*

(D) *Eusattus muricatus*

FIGURE 3.3. Darkling Beetle Species (A) *Oxygonoderella hispidula* 8X life size; (B) *Lepidocnemeplatia sericea* 8X life size; (C) *Anemia californica* 8X life size, and (D) *Eusattus muricatus* 4X life size.

Lepidocnemeplatia sericea (Figure 3.3)

This is a small species (2-3.3 mm) that is almost completely covered with light brown scales. This is a rare native species, but it appears to be increasing as a stored food pest. It has been recorded from eastern Washington and Oregon.

Anemia californica (Figure 3.3)

This is another small species (3 mm). The antennae appear 10-segmented since the eleventh segment is short and fused to the tenth segment. The general body form is oval with a shiny black coloration. The protibia is toothed. This is a rare species occurring in eastern Washington.

Eusattus muricatus (Figure 3.3)

These are common in sandy regions of eastern Washington, southern Idaho, and eastern Oregon. They possess a spherically-shaped body, 9-12 mm in length. The sides of the body possess long, light brown colored hairs. The

Conisattus nelsoni (Figure 3.4)

This is a small (6-7 mm) rare species that occupies sandy habitats in eastern Washington and northeastern Oregon. The color of the body is reddish-brown. The sides of the body have a fringe of long hairs.

Blapstinus spp. (Figure 3.5)

Two species of *Blapstinus* occur on the Hanford Reservation, *B. substriatus* and *B. discolor*. The body coloration on both species is dark brown. The legs and antennae of *B. discolor*, however, are bright reddish-brown while those of *B. substriatus* are dark brown like the body. *Blapstinus substriatus* is also slightly smaller (3.5-5.3 mm) than *B. discolor* (5-6 mm).

(A) *Blapstinus discolor*

(B) *Blapstinus substriatus*

FIGURE 3.5. Darkling Beetle Species (A) *Blapstinus discolor* and (B) *Blapstinus substriatus*, both 8X life size

Eleodes obscura (Figure 3.6)

This is the largest darkling beetle (23-35 mm) present on the Hanford Reservation and will usually present no difficulty in identification. The large size and deeply grooved elytra separate it from all but *E. hispilabris*. Their sizes may overlap slightly. However the apical angles of the pronotum are obtuse in *E. obscura* and acute in *E. hispilabris*. This species is common but never particularly abundant at Hanford. It occurs in eastern Washington, eastern Oregon, and Idaho. Adults probably live more than 1 yr, over-wintering in small mammal burrows.

Eleodes hispilabris (Figure 3.6)

This species is very common at all Hanford locations. It has deeply grooved elytra like *E. obscura*, but is smaller (see discussion for *E. obscura*).

pronotum is fringed with dense golden colored hairs, giving the appearance of a light colored line etching the anterior and posterior margins of the pronotum. Size ranges from 9-12 mm.

Coniontis setosa (Figure 3.4)

This species is common throughout the Hanford Site. It is dark-colored and averages 8-12 mm in size. The posterior portion of the elytra are covered with conspicuous pubescence (use hand lens or back-light to observe). Adults are often found beneath shrubs in litter. They may feign death when discovered. This species is common in eastern Washington, eastern Oregon, and Idaho.

Coniontis ovalis (Figure 3.4)

Coniontis ovalis is the smallest of the three *Coniontis* species at Hanford (8-10 mm). It lacks pubescence on the posterior portion of elytra, and the elytra are smooth. They are fairly common at higher elevations.

Coniontis lanei (Figure 3.4)

Coniontis lanei only occurs at elevations greater than 500 m at Hanford. It resembles *C. setosa* but is larger (11-15 mm) and lacks pubescence. Punctures on the elytra are coarse and dense, giving the posterior portion a rough granular appearance. Locally common in eastern Washington and eastern Oregon.

FIGURE 3.4. Darkling Beetle Species (A) *Coniontis setosa* 4X life size; (B) *Coniontis ovalis* 4X life size; (C) *Coniontis lanei* 4X life size; and (D) *Conisattus nelsoni* 6X life size

FIGURE 3.6. Darkling Beetle Species (A) Eleodes obscura 2X life size; (B) Eleodes hispilabris 3.6X life size; (C) Eleodes nigrina 3.6X life size; and (D) Eleodes humeralis 3.6X life size

The size ranges from 17-23 mm in length. Other species similar in size include E. nigrina and perhaps E. humeralis (at its upper size limit). Both nigrina and humeralis lack deeply grooved elytra. This species may become a pest in dryland wheat areas. It is very common in eastern Oregon, eastern Washington, and southern Idaho.

Eleodes nigrina (Figure 3.6)

This is a large species (15-23 mm). similar to E. hispilabris but lacks deeply grooved elytra. There is some overlap in size with E. humeralis but humeralis has one front tibial spur much larger than the other while they are about the same size in nigrina. This species is common at Hanford but never as abundant as E. hispilabris. General distribution is southern Idaho, eastern Oregon, and eastern Washington.

Eleodes humeralis (Figure 3.6)

Eleodes humeralis is a medium-sized (14-17 mm) species, locally very abundant during late summer months, especially in heavy shrub stands at lower elevations. The unequal size of front tibial spurs is a diagnostic character (use hand lens to observe). This species is common in eastern Washington, northeast Oregon, and northern Idaho.

Eleodes novoverrucula (Figure 3.7)

This is a medium-sized species (9-14 mm), with a strongly rounded pronotum (dorsal view) and granular elytra by which it may be readily recognized. It is common in eastern Washington, eastern Oregon, and Idaho.

Eleodes granulata (Figure 3.7)

This is a medium-sized species (12-14 mm). Superficially it is similar to *E. nigrina*, but *E. granulata* is smaller. This species is occasionally very abundant at Hanford but is less common at lower elevations. It is common in eastern Washington, eastern Oregon, and Idaho.

Philolithus densicollis (Figure 3.8)

This is a medium-sized species (11-20 mm), active in the fall. It always appears during the first week of September in moderate numbers and becomes abundant during late September and early October. There are often large concentrations within a small area. *Philolithus* only occurs at lower elevations (below 500 m). This species appears spindly and fragile. The elytra each have two sharp lateral ridges extending from near the pronotum to the posterior margin. Very common in eastern Washington and northeast Oregon.

Stenomorpha puncticollis (Figure 3.8)

This is a medium-sized species (13-19 mm), also active in the fall. It appears robust in contrast to the fragile appearance of *P. densicollis*. *Stenomorpha* first appears about 2 weeks after the first appearance of *Philolithus*. It is never as abundant as *Philolithus* and only occurs at higher elevations (above 1000 ft).

(A) *Eleodes novoverrucula*

(B) *Eleodes granulata*

FIGURE 3.7. Darkling Beetle Species (A) *Eleodes novoverrucula* and (B) *Eleodes granulata*, both about 4X life size

(A) *Stenomorpha puncticollis*

(B) *Philolithus densicollis*

FIGURE 3.8. Fall Occurring Darkling Beetles (A) *Stenomorpha puncticollis* and (B) *Philolithus densicollis*, both 4X life size

Chapter IV

ABUNDANCE AND DISTRIBUTION

**Abundance
Distribution**

CHAPTER IV. ABUNDANCE AND DISTRIBUTION

Darkling beetles are abundant throughout semi-arid regions of the western United States (Hewitt, 1974), but little is known concerning their seasonal patterns of abundance or distribution within the environment. Rickard (1970) studied the distribution of four ground-dwelling beetles in relation to season, topography, and vegetation on the Hanford Site. He found Eleodes hispilabris, Stenomorpha puncticollis, and Philolithus (=Pelecyporous) densicollis to be the most abundant species present. Philolithus and Stenomorpha occurred only during the fall months (September-November). Eleodes hispilabris was present throughout the year, except in winter, but was most abundant during May and June. Few Philolithus were captured at higher elevations and no Stenomorpha were taken at low elevation sites. The occurrence of wildfire was also found to have little effect on populations of darkling beetles.

The influence of climatic factors on the abundance of one species, Philolithus densicollis, was analyzed using a principal component analysis and a multiple regression model (Hinds and Rickard, 1973). This analysis showed that climatic data for the study area 2 years prior to capture accounted for about 90% of trapping variability.

ABUNDANCE

The relative abundance of darkling beetles inhabiting the Hanford Site was ascertained by pitfall trapping over a 3-yr period. A total of 3,048 specimens were collected representing 18 species and 10 genera. A comparison of beetle abundance in different plant communities on the ALE Reserve is shown in Table 4.1. A comparison of beetle abundance on the 200 Area plateau with a control area located near Rattlesnake Springs is shown in Table 4.2.

During 1973, there were over twice as many beetles collected in the upper old field cheatgrass community than in any other community. Eleodes novoverrucula and Blapstinus sp. were both abundant. Eleodes novoverrucula (as pimeloides) has been recorded as a serious pest to dryland agricultural crops (Hyslop, 1912). Coniontis setosa was also abundant in the upper old field in 1973. None of these species were abundant at this site in 1974 or 1975, nor were they abundant in other study areas, except for the hopsage community. Both Coniontis setosa and E. novoverrucula were common in the hopsage community with 77 and 138 captures in 1973, respectively.

Coniontis lanei was collected twice in pitfall traps located at the upper old field. This species commonly occurs at higher elevations and only incidentally occurs at low elevations. Eleodes granulata primarily occurred in association with the sagebrush/bunchgrass community. It was also common in the winterfat community, but only occurred infrequently at other locations.

TABLE 4.1. A Comparison of Beetle Abundance in Different Plant Communities on the ALE Reserve (a)

Species (a)	Cheatgrass Upper Old Field	Cheatgrass Lower Old Field	Sagebrush/ Bunchgrass	Greasewood	Hopsage	Winterfat
----- 1973 (6 trapping sessions) -----						
BLSP	178		0	0	7	0
COLA	2		0	0	0	0
COSE	83		7	4	77	4
ERGR	0		99	1	0	49
ELHI	5	Not	12	15	12	51
ELHU	0		0	1	3	5
ELNI	3	Sampled	1	16	0	20
ELNO	284		2	5	138	5
ELOB	11		6	0	1	0
EUMU	0		0	0	1	0
OXHI	0		22	4	3	13
PHDE	0		8	45	4	55
STPU	3		42	47	2	14
Total	569		199	138	248	216
----- 1974 (4 trapping sessions) -----						
BLSP	2	40	0	0	0	0
COLA	0	0	0	0	0	0
COSE	2	38	3	0	14	2
ELGR	0	1	63	3	0	18
ELHI	0	0	2	2	10	5
ELHU	0	0	0	0	0	0
ELNI	0	0	3	0	0	2
ELNO	3	0	0	0	0	0
ELOB	1	0	0	0	0	0
EUMU	0	0	0	0	0	0
OXHI	0	33	0	1	0	1
PHDE	0	0	0	8	55	13
STPU	5	50	9	41	10	9
Total	13	162	80	55	89	50
----- 1975 (6 trapping sessions) -----						
BLSP	17	33	0	0	1	0
COLA	0	0	0	0	0	0
COSE	24	4	0	1	12	2
ELGR	1	0	9	3	0	3
ELHI	1	3	8	7	4	6
ELHU	0	0	0	3	0	0
ELNI	1	1	0	3	2	0
ELNO	11	2	1	5	5	0
ELOB	0	0	0	0	0	0
EUMU	0	0	0	0	0	0
OXHI	0	11	205	1	0	0
PHDE	0	0	13	0	6	27
STPU	1	44	0	0	13	2
Total	56	98	236	23	43	40

(a) Species names given in Table 2.1.

TABLE 4.2. A Comparison of Beetle Abundance on the 200 Area Plateau with a Control Area on the ALE Reserve (a)

Species (a)	REDOX Pond Area	B-C Cribs Area	Control Area
	----- 1974 -----		
ANCA	1	2	7
CONE	29	0	318
COSE	3	0	1
ELHI	20	16	48
ELHU	1	1	5
ELNI	0	0	15
ELNO	1	0	2
ELOB	3	1	0
EUMU	8	89	0
PHDE	4	70	9
Total	70	179	405
	----- 1975 -----		
ANCA	0	0	1
CONE	1	2	2
COSE	5	0	1
ELHI	3	7	9
ELHU	0	1	0
ELNI	0	0	1
ELNO	0	0	0
ELOB	0	0	0
EUMU	19	4	1
PHDE	11	3	8
Total	39	17	23

(a) Species names are given in Table 2.1.

Eleodes hispilabris was widely distributed throughout the Hanford Site, occurring in all plant communities studied. Eleodes nigrina was also widely distributed but was never as abundant as E. hispilabris. Eleodes humeralis was never common at these study locations. Eusattus muricatus was common at lower elevations on the 200 Area plateau, in the sandy soil substrates that it prefers.

Oxygonodera hispidula was abundant only in the sagebrush/bunchgrass community and was totally absent from study locations on the 200 Area plateau. Anemia californica and Conisattus nelsoni only occurred at the 200 Area study sites. Both species are considered to be rare, but may be locally abundant on the Hanford Site.

Stenomorpha puncticollis was common at the ALE Reserve study sites but was absent from the 200 Area plateau while Philolithus densicollis was common on the 200 Area plateau and lower elevation sites on ALE but was absent from higher elevation ALE sites.

The distribution patterns of darkling beetle abundance are shown in Figure 4.1. There do not appear to be any consistent trends in abundance on a year-to-year basis. Several study areas do show an increase in darkling beetle abundance during fall sampling periods due to the emergence of the autumn beetles Philolithus densicollis and Stenomorpha puncticollis.

Several study areas are characterized by a dramatic increase in beetle abundance during certain periods. In July 1973, on the upper old field, about 150 Eleodes novoverrucula and over 50 Blapstinus sp. were collected. In 1974 there were only 3 E. novoverrucula and 2 Blapstinus collected for the whole season. In 1975, 11 E. novoverrucula and 17 Blapstinus were collected. These kinds of population fluctuations seem to be characteristic of darkling beetles but the causative factors remain unclear.

FIGURE 4.1. Seasonal Fluctuation in Darkling Beetle Abundance

DISTRIBUTION

Darkling beetles characteristically occur in species assemblages or groups of overlapping populations. There have been very few attempts to document how these assemblages are distributed throughout the environment. Doyen and Tschinkel (1974) studied six darkling beetle species in Arizona and found that they were separated spatially to some degree, being associated with different substrate types.

Calkins and Kirk (1973) studied the distribution of darkling beetles in relation to soil texture. Of the six species present, one was more prevalent in areas of loam and sand, two were common in sandy areas, and one was prevalent in clay and sandy soils.

The seasonal distribution of darkling beetles occupying the Hanford Site is shown in Table 4.3. Most species tend to be present through much of the season when weather conditions are favorable (March to October). Others, such as Philolithus densicollis and Stenomorpha puncticollis, are restricted to only a few months of the season, September to November (weather permitting). Eleodes obscura surely occurs earlier than May and later than August. This is a rather uncommon (although conspicuous) beetle and has probably just not been collected during these periods. Eleodes humeralis is shown occurring from June to October but is present in very limited numbers except during the August-September period, when it is fairly abundant.

TABLE 4.3. Seasonal Darkling Beetle Distribution

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
<u>Anemia californica</u>					X	X		X	X			
<u>Blapstinus</u> sp.			X			X	X	X				
<u>Coniontis setosa</u>			X						X	X		
<u>Contisattus nelsoni</u>					X		X	X		X		
<u>Eleodes granulata</u>			X		X		X		X	X		
<u>Eleodes hispilabris</u>			X			X		X		X		
<u>Eleodes humeralis</u>						X	X	X		X		
<u>Eleodes nigrina</u>			X			X	X			X		
<u>Eleodes novoverrucula</u>				X	X	X	X	X		X		
<u>Eleodes obscura</u>					X	X		X				
<u>Eusattus muricatus</u>				X	X		X			X		
<u>Oxygonodera hispidula</u>			X				X	X	X	X		
<u>Philolithus densicollis</u>									X	X		
<u>Stenomorpha puncticollis</u>									X	X		

The distribution of darkling beetles in relation to soil texture was analyzed by comparing beetle abundance in relation to the percent sand, silt and clay in the top 2 cm of soil. This depth was selected since it comprises the maximum depth of oviposition for most species.

Table 4.4 shows results of soil texture analysis for all study areas. The study locations at the B-C Crib, REDOX Pond, and Control area all have high sand contents. Study sites such as Upper Snively and Lower Snively old fields have relatively low percent sand content and more silt and clay. Other sites have intermediate sand content values except for the hopsage site. The hopsage site area is located at a low elevation, but it is situated in a deflated area where much of the sand substrate has been blown away. This site is also located in a former lake bed, which accounts for the high silt content. Table 4.5 shows the percentage distribution of darkling beetle captures among three soil texture classes: sand, sand-loam, and loam. The term loam as used here describes soil textures comprised of less than 50% sand; sandy-loam refers to soil containing 50-70% sand; and sandy soil consists of more than 70% sand.

Some species, such as Anemia californica, Conisattus nelsoni, and Eusattus muricatus, were only found in sandy soil and are probably limited to this soil type. Blapstinus was restricted to the loam soil type, but the situation is less clear than for the sand inhabiting species. Blapstinus greatest abundance occurred in Upper and Lower Snively old fields, so they may be more closely associated with community type than soil texture. A few (9% of total captures) occurred in the hopsage study location, possibly indicating an association with loam soils. This study site is dominated by hopsage with a sparse understory of cheatgrass and is located at lower elevations near sandy soil study locations where Blapstinus was absent.

TABLE 4.4. Soil Texture in Top 2 cm of Study Site Soils^(a)

Area	Sand	Silt	Clay
		%	
IBP	52.7 ± 3.7	42.3 ± 4.1	5.0 ± 1.2
Winterfat	54.3 ± 3.2	42.7 ± 3.8	3.0 ± 1.2
Hopsage	45.3 ± 2.7	45.7 ± 4.3	12.3 ± 1.9
Control	74.3 ± 2.0	22.7 ± 2.2	3.0 ± 1.0
Upper Snively	45.0 ± 1.2	46.3 ± 0.3	8.7 ± 0.9
Lower Snively	48.7 ± 0.9	42.7 ± 1.3	8.7 ± 0.9
Greasewood	53.3 ± 2.3	42.3 ± 2.4	4.3 ± 0.3
REDOX	84.3 ± 0.3	14.7 ± 0.3	1.0 ± 0.0
B-C Cribs	85.0 ± 2.6	12.3 ± 2.3	2.7 ± 0.3

(a) Average values ± S.E. from three replicates

TABLE 4.5. Distribution of Darkling Beetle Captures
Across Soil Texture Classes

Species	Sand	Sandy-Loam	Loam	Total Number Collected
<i>Anemia californica</i>	100	0	0	8
<i>Blapstinus</i> sp.	0	0	100	86
<i>Coniontis setosa</i>	7	7	86	108
<i>Conisattus nelsoni</i>	100	0	0	302
<i>Eleodes granulata</i>	0	92	8	25
<i>Eleodes hispilabris</i>	56	27	17	98
<i>Eleodes humeralis</i>	68	16	16	6
<i>Eleodes nigrina</i>	68	13	18	22
<i>Eleodes novoverrucula</i>	7	21	72	29
<i>Eleodes obscura</i>	50	0	50	2
<i>Eusattus muricatus</i>	100	0	0	57
<i>Oxygonodera hispidula</i>	0	7	93	46
<i>Philolithus densicollis</i>	25	60	15	419
<i>Stenomorpha puncticollis</i>	0	38	62	197

Oxygonodera hispidula occurs in several community types (Table 4.1), all of which have loamy soils. It is most abundant in the sagebrush/bunchgrass community where it commonly is found within tussocks of bluebunch wheatgrass. It will probably never occur extensively on the 200 Area plateau where this community type is largely absent.

Coniontis setosa occurred at nearly all study sites but was only abundant on loamy soils (Table 4.5). This species was particularly abundant in cheatgrass and hopsage communities (Table 4.2). Two congeneric species, *C. lanei* and *C. ovalis*, occur at higher elevations on Rattlesnake Mountain. None of the *Coniontis* species appear to be an important component of the 200 Area plateau darkling beetle fauna.

Philolithus densicollis was widely distributed across all soil textures. Rickard (1970) reported the restriction of this species to lower elevations and our present study confirmed these findings. *Philolithus* adults comprise an important segment of the ground-dwelling beetle population on the 200 Area plateau during fall months. Their soil dwelling larvae are undoubtedly an important component of the local soil fauna.

Stenomorpha puncticollis occurred primarily in areas with loam and sandy-loam soils (Table 4.5). These beetles are restricted to the higher elevations of the ALE Reserve and are probably not restricted to specific soil texture types.

It seems reasonable to assume that soil type is of critical importance in relation to larval development. Adults, being mostly wingless, are probably restricted to areas where the larvae develop. Habitat selection therefore is possibly influenced by two factors: 1) oviposition preferences by adult females, and 2) differential mortality of larvae in various soil textures.

Chapter V

FOOD HABITS

Food Plants Present

**Darkling Beetle Food Plant Selection on
the Hanford Site**

**Darkling Beetle Food Plant Selection
Within Specific Plant Communities**

**Comparisons of Food Plant Availability
and Selection**

**Food Plant Selection by Particular Beetle
Species**

CHAPTER V. FOOD HABITS

Food habit analysis is a useful tool in understanding how particular consumer populations divide up the available food supply. It also serves as a starting point for documenting how food stuffs and associated materials flow through the ecosystem.

There are two ecological processes that are fundamental to ecosystem functioning and to the many related processes inherent in ecosystem maintenance. These are energy flow and mineral cycling. Both processes are important when considering the 200 Area plateau ecosystem. Analysis of energy flow patterns documents how materials flow through the system and identifies components with high transfer rates. Mineral cycling is self descriptive, although little is known concerning transfer of particular elements or the role of biota in creating and maintaining nutrient pools within the system.

Diet characterization of major consumers is essential since consumption serves as a control point for all materials entering the transfer pathways. Basic questions to be answered include: 1) food materials present, 2) consumers present, 3) food preferences for specific consumers and dietary similarity of consumers occurring in the same community.

We know very little about what free-living consumers eat. This is true for the large animals such as deer, elk, cattle, and sheep, and we know even less about invertebrate consumers. Common knowledge assumes that they are opportunistic, eating whatever is available. Grasshoppers were considered to be omnivorous feeders until recent studies (Banfill and Brusven, 1973; Mulkern et al., 1969; Rogers and Uresk, 1974; Ueckert and Hanson, 1971; and Ueckert et al., 1972) showed that many species are highly selective.

Darkling beetles have also been assumed to be omnivorous feeders, but there are no published works documenting this assumption. These beetles are so abundant at times that their food habits become an important parameter for understanding their role in ecosystem functioning.

FOOD PLANTS PRESENT

The term food plant as used here refers to any plant material used as a food source. The plants may be living, dead, or ingested as litter material. A list of plant species known to occur on the Hanford Site and potentially available as a food source for darkling beetles is shown in Table 5.1.

DARKLING BEETLE FOOD PLANT SELECTION ON THE HANFORD SITE

Those plant species actually ingested by darkling beetles are shown in Table 5.2. There were 52 different food items recorded--8 grass species, 33 forb species, 6 shrub species, and 5 miscellaneous food types. The relative frequency of food item consumption is also shown in Table 5.2. A total of 959 slides, consisting of 19,180 observed fields were analyzed.

TABLE 5.1. Scientific and Common Names of Plant Taxa from the Hanford Site Discussed in the Document. Common Names are from Hitchcock and Cronquist (1973).

Scientific Name	Common Name
GRASSES	
<u>Agropyron dasytachyum</u> (Hook.) Scribn.	thick-spiked wheat grass
<u>Agropyron spicatum</u> (Pursh) Scribn. & Smith	bluebunch wheatgrass
<u>Bromus tectorum</u> L.	cheatgrass
<u>Festuca octoflora</u> Walt.	slender fescue
<u>Poa cusickii</u> Vasey	Cusick's bluegrass
<u>Poa sandbergii</u> Vasey	Sandberg's bluegrass
<u>Sitanion hystrix</u> (Nutt.) Smith	bottlebrush squirreltail
<u>Stipa comata</u> Trin. & Rupr.	needle and thread
<u>Stipa thurberiana</u> Piper	Thurber's needlegrass
FORBS	
<u>Ambrosia acanthicarpa</u> Hook.	bursage ragweed
<u>Amsinckia</u> sp.	fiddleneck
<u>Antennaria dimorpha</u> (Nutt.) T. & G.	low pussy-toes
<u>Astragalus</u> sp.	locoweed
<u>Balsamorhiza careyana</u> Gray	Carey's balsamroot
<u>Brodiaea douglasii</u> Wats.	Douglas' brodiaea
<u>Calochortus macrocarpus</u> Dougl.	sagebrush mariposa
<u>Castilleja</u> sp.	paintbrush
<u>Chenopodium leptophyllum</u> (Moq.) Wats.	slimleaf goosefoot
<u>Chenopodium</u> sp.	lamb's quarters
<u>Comandra umbellata</u> (L.) Nutt.	bastard toad-flax
<u>Crepis atrabarba</u> Heller	slender hawksbeard
<u>Cryptantha</u> sp.	cryptantha
<u>Cymopterus terebinthinus</u> (Hook.) T. & G.	turpentine cymopterus
<u>Descurainia pinnata</u> (Walt.) Britt.	western tansymustard
<u>Draba verna</u> L.	spring whitlow-grass
<u>Erigeron filifolius</u> Nutt.	thread-leaf fleabane
<u>Erodium cicutarium</u> (L.) L'Her.	alfilaria
<u>Erysimum asperum</u> (Nutt.) DC.	rough wallflower
<u>Euphorbia</u> sp.	spurge
<u>Helianthus</u> sp.	sunflower
<u>Holosteum umbellatum</u> L.	jagged chickweed
<u>Lappula radowskii</u> (Hornem.) Greene	western stickseed
<u>Lomatium macrocarpum</u> (Nutt.) Coult. & Rose	large-fruit lomatium
<u>Lupinus</u> sp.	lupine
<u>Mentzelia albicaulis</u> Dougl.	white-stemmed mentzelia
<u>Microsteris gracilis</u> (Hook.) Greene	pink microsteris
<u>Oenothera pallida</u> Lindl.	pale evening-primrose
<u>Phacelia linearis</u> (Pursh.) Holtz.	threadleaf phacelia
<u>Phlox longifolia</u> Nutt.	long-leaf phlox
<u>Plantago patagonica</u> Jacq.	indian-wheat
<u>Polemonium micranthum</u> Benth.	littlebells polemonium
<u>Psoralea lanceolata</u> Pursh.	lance-leaf scurf-pea
<u>Salsola kali</u> L.	russian thistle
<u>Sisymbrium altissimum</u> L.	Jim Hill mustard
<u>Sphaeralcea munroana</u> (Dougl.) Spach	Munro's globe-mallow
<u>Taraxacum officinale</u> Weber	common dandelion
<u>Townsendia florifer</u> (Hook.) Gray	showy townsendia
<u>Tragopogon dubius</u> Scop.	yellow salsify
Compositae	aster family
Liliaceae	lily family
SHRUBS	
<u>Artemisia tridentata</u> Nutt.	big sagebrush
<u>Atriplex spinosa</u> (Hook.) Collotzi	spiny hopsage
<u>Chrysothamnus nauseosus</u> (Pall.) Britt.	common rabbit-brush
<u>Chrysothamnus viscidiflorus</u> (Hook.) Nutt.	green rabbit-brush
<u>Eurotia lanata</u> (Pursh.) Moq.	winterfat
<u>Sarcobatus vermiculatus</u> (Hook.) Torr.	black greasewood

TABLE 5.2. Plant Taxa and Frequency of Ingestion by Darkling Beetles on the Hanford Site(a)

Taxon	Consumption Frequency, %
GRASSES	
<u>Agropyron spicatum</u>	<1
<u>Bromus tectorum</u>	9
<u>Festuca octoflora</u>	<1
<u>Poa cusickii</u>	<1
<u>Poa sandbergii</u>	1
<u>Stipa comata</u>	<1
<u>Stipa thurberiana</u>	1
Unknown grass	1
FORBS	
<u>Ambrosia acanthicarpa</u>	<1
<u>Amsinckia spp.</u>	1
<u>Antennaria dimorpha</u>	<1
<u>Astragalus spp.</u>	<1
<u>Balsamorhiza careyana</u>	<1
<u>Calochortus macrocarpus</u>	<1
<u>Castilleja sp.</u>	<1
<u>Chenopodium leptophyllum</u>	3
<u>Chenopodium sp.</u>	<1
<u>Crepis atrabarba</u>	1
<u>Cryptantha spp.</u>	1
<u>Cymopterus terebinthinus</u>	<1
<u>Descurainia pinnata</u>	15
<u>Draba verna</u>	<1
<u>Erigeron filifolius</u>	<1
<u>Erysimum asperum</u>	1
<u>Helianthus sp.</u>	1
<u>Lomatium macrocarpum</u>	<1
<u>Lupinus spp.</u>	<1
<u>Microsteris gracilis</u>	<1
<u>Phacelia linearis</u>	<1
<u>Plantago patagonica</u>	<1
<u>Polemonium micranthum</u>	<1
<u>Psoralea lanceolata</u>	<1
<u>Salsola kali</u>	2
<u>Sisymbrium altissimum</u>	5
<u>Sphaeralcea munroana</u>	3
<u>Taraxacum officinale</u>	<1
<u>Townsendia florifer</u>	<1
<u>Tragopogon dubius</u>	<1
Compositae	<1
Liliaceae	<1
Unknown forbs	2
SHRUBS	
<u>Artemisia tridentata</u>	13
<u>Atriplex spinosa</u>	1
<u>Chrysothamnus nauseosus</u>	2
<u>Chrysothamnus viscidiflorus</u>	<1
<u>Eurotia lanata</u>	8
<u>Sarcobatus vermiculatus</u>	4
MISCELLANEOUS	
Arthropod parts	5
Cryptogams	13
Hair	<1
Seeds	1
Pollen	2

(a) N = 959 slides, 19,180 observed fields.

Considering all darkling beetles together, the most frequently ingested food item was western tansymustard (*Descurainia pinnata*). This small plant with its yellow flowers is ubiquitous on the Hanford Site but even more common at lower elevations. It occurred in the diets with a frequency of 15%. Other common food plants included big sagebrush (13%), cryptogams, which are non-vascular plants--mosses, lichens and fungi (13%), cheatgrass (9%), winterfat (8%), Jim Hill mustard (*Sisymbrium altissimum*) 5%, and arthropod parts (5%). The remaining 45 food plants were consumed with a frequency less than 5%. The list of food plants utilized indicates that darkling beetles select a wide range of plant species. But this list represents the food source of an entire beetle family. Individual species may be more specific feeders.

DARKLING BEETLE FOOD PLANT SELECTION WITHIN SPECIFIC PLANT COMMUNITIES

Feeding preferences for grasshoppers have been shown to be influenced by the habitat in which they occur (Mulkern, 1967). This may also be true for darkling beetles. Table 5.3 shows a comparison of food items selected in different plant communities.

Cheatgrass (*B. tectorum*) was the only grass species consistently selected in all communities; however, the frequency of ingestion was low in all communities except the cheatgrass, greasewood/cheatgrass, and winterfat/cheatgrass communities. Surprisingly, little cheatgrass was consumed in the lower old field cheatgrass community. The abundant stands of Jim Hill mustard (*S. altissimum*) were apparently more attractive. Cheatgrass is an alien grass that has only been present in this area for the last 100 years. It is a very aggressive grass species and occurs in most areas to some degree. Darkling beetle populations are apparently able to utilize cheatgrass as a food resource when necessary. Bluebunch wheatgrass (*A. spicatum*) is a native bunchgrass that dominates most of the site above the 800 ft elevation level but it was not found to serve as a significant food base for darkling beetles. Grasses in general are not an important food item in darkling beetle diets except in the cheatgrass, greasewood/cheatgrass, and winterfat/cheatgrass communities where cheatgrass is consumed.

Several forbs were found to serve as important food items. Western tansymustard (*D. pinnata*) was abundant in diets of beetles from all communities except the upper and lower old field cheatgrass communities (Table 5.3). *Draba* (*Draba verna*) is a tiny flowering plant (generally < 5 cm) that is usually not consumed by darkling beetles in quantity. It comprised 11% of the diet of darkling beetles occupying the upper old field, but was an infrequent food item at other locations. Russian thistle (*Salsola kali*) was also not consumed to any great extent. It did comprise 5% of the diet in the hopsage community and 4% in the winterfat community, but was insignificant elsewhere (<1%). Jim Hill mustard (*S. altissimum*) was ingested infrequently in all study areas except the lower old field where the relative ingestion frequency reached 62%. This plant species was abundant at this location during these studies. Globe-mallow (*Sphaeralcea munroana*) comprised an inconspicuous part of the darkling beetle food base at all locations except the sagebrush/poa community. Globe-mallow is particularly abundant at this location and occurred in the diets with a 24% frequency.

TABLE 5.3. Plant Taxa and Frequency of Ingestion by Darkling Beetles in Different Plant Communities

Plant Taxa	Sagebrush/ Bunchgrass	Sagebrush/ Poa	Hopsage/ Cheatgrass	Winterfat/ Cheatgrass	Greasewood/ Cheatgrass	Cheatgrass Upper Old Field
GRASSES						
<i>Bromus tectorum</i>	7	5	2	11	19	7
<i>Festuca octoflora</i>	0	0	0	1	0	2
<i>Poa cusickii</i>	1	0	1	1	1	1
<i>Poa sandbergii</i>	3	0	0	3	1	0
<i>Stipa comata</i>	0	2	0	1	0	0
<i>Stipa thurberiana</i>	1	0	0	1	1	2
Unknown grasses	2	1	1	1	2	<1
FORBS						
<i>Ambrosia acanthicarpa</i>	0	0	0	1	0	0
<i>Amsinckia</i> sp.	0	0	0	1	0	0
<i>Antennaria dimorpha</i>	0	0	0	0	1	0
<i>Astragalus</i> sp.	0	0	0	1	0	0
<i>Castilleja</i> sp.	0	0	0	1	0	0
<i>Chenopodium leptophyllum</i>	23	4	15	1	1	0
<i>Chenopodium</i> sp.	0	1	0	0	1	0
<i>Crepis atrabarba</i>	0	0	0	2	0	0
<i>Cryptantha</i> sp.	0	1	1	1	0	0
<i>Descurainia pinnata</i>	13	25	14	7	16	1
<i>Draba verna</i>	0	1	0	0	1	0
<i>Erigeron filifolius</i>	0	0	0	1	0	0
<i>Erysimum asperum</i>	2	0	0	3	0	0
<i>Helianthus</i> sp.	0	0	0	4	1	1
<i>Microsteris gracilis</i>	0	0	1	0	1	0
<i>Phacelia linearis</i>	1	0	0	0	0	0
<i>Plantago patagonica</i>	0	0	0	1	0	0
<i>Polemonium micranthum</i>	0	0	1	0	0	0
<i>Salsola kali</i>	1	1	5	4	1	0
<i>Sisymbrium altissimum</i>	2	0	0	1	1	62
<i>Sphaeralcea munroana</i>	1	24	1	0	0	0
<i>Taraxacum officinale</i>	0	0	0	0	0	0
<i>Townsendia florifer</i>	0	0	0	1	0	2
<i>Tragopogon dubius</i>	0	0	0	0	0	2
Compositae	1	0	1	1	1	0
Liliaceae	0	1	1	1	1	1
Unknown forbs	2	4	2	1	1	2
SHRUBS						
<i>Artemisia tridentata</i>	7	18	5	5	5	7
<i>Atriplex spinosa</i>	1	2	10	1	0	0
<i>Chrysothamnus nauseosus</i>	1	0	1	1	8	0
<i>Chrysothamnus viscidiflorus</i>	0	0	0	1	0	0
<i>Eurotia lanata</i>	1	1	1	31	0	0
<i>Sarcobatus vermiculatus</i>	1	1	1	0	22	0
MISCELLANEOUS						
Arthropod parts	5	7	6	7	1	4
Hair	0	0	0	1	0	0
Cryptogams	24	4	28	15	20	0
Seeds	3	1	3	1	1	1
Pollen	0	1	4	2	1	5
Number of slides	49	152	109	219	153	88
Number of observed fields	980	3040	2180	4380	3060	1760

There were several shrubs that were important items in darkling beetle diets. Big sagebrush (A. tridentata) was consumed in all communities but most frequently in the sagebrush/poa community (18%). It was even consumed in the old field community where there is very little sagebrush present, although the beetles may have consumed the sagebrush in the nearby sagebrush/bunchgrass community and then wandered into the old fields where they were captured. Hopsage (Atriplex spinosa) had a 10% ingestion frequency for the hopsage community but was seldom consumed in other areas. This same trend occurred in the winterfat and greasewood communities. Winterfat (Eurotia lanata) had a frequency of ingestion of 31% and greasewood (Sarcobatus vermiculatus) had a frequency of ingestion of 22% within their respective communities. The cryptogams (mosses, lichens, and fungi) were the only miscellaneous food items with a high ingestion frequency. They frequently occurred in the diets of darkling beetles from all areas except the sagebrush/poa and lower old field communities.

The data presented in Table 5.3 seems to indicate that the darkling beetle species in each community were primarily selecting those species of plants common to that community. Cheatgrass has a high ingestion occurrence in areas where it is a dominant plant and the same holds true for sagebrush, winterfat, hopsage, and greasewood. This does not necessarily mean, however, that the beetles feed on these items preferentially. This type of analysis requires a comparison between the food items present in the environment and their frequency of ingestion.

COMPARISONS OF FOOD PLANT AVAILABILITY AND SELECTION

A comparison of vascular plant frequency as it occurs in the various plant communities and in darkling beetle diets is shown in Tables 5.4-5.9. If a particular beetle is strictly omnivorous and distributed at random throughout the community, the frequency of ingestion for individual plant species should approximate its frequency of occurrence in the environment. The relationship between consumption and field frequencies for beetle species occupying the sagebrush/bunchgrass community is shown in Table 5.4.

The consumption frequencies of bluebunch wheatgrass (A. spicatum), Sandberg's bluegrass (P. sandbergii), and draba (D. verna) were much lower than their corresponding field frequencies. This indicates that these plant species are not being selected as food items. Others such as cheatgrass (B. tectorum) slim leaf goosefoot (Chenopodium leptophyllum), and big sagebrush (A. tridentata) occurred more frequently than would be expected from their environmental frequency. Both cheatgrass and slim leaf goosefoot occur in abundance along nearby roadsides and this may be serving as a food source for beetles who are later captured in the sagebrush/bunchgrass community so that cheatgrass and goosefoot may not be preferred food items. Both S. vermiculatus and E. lanata are indicated as occurring in the diets with a frequency of <1%. Actually, neither species occurs in this community. Their presence in the diets is undoubtedly due to slide reading error. It should be recognized that a value of 1% or less is merely an indication of a species' presence but should not be interpreted as absolute evidence of its occurrence.

TABLE 5.4. A Comparison of Vascular Plant Frequency in the Field and Diets of Darkling Beetles Inhabiting the Sagebrush/Bunchgrass Community on the Hanford Site, 1974

<u>Plant Taxon</u>	<u>Consumption Frequency</u>	<u>%</u>	<u>Field Frequency</u>
GRASSES			
<u>Agropyron spicatum</u>	0		22
<u>Bromus tectorum</u>	12		6
<u>Poa cusickii</u>	2		2
<u>Poa sandbergii</u>	4		17
<u>Stipa thurberiana</u>	2		2
FORBS			
<u>Antennaria dimorpha</u>	0		2
<u>Brodiaea douglasii</u>	0		1
<u>Calochortus macrocarpus</u>	0		5
<u>Chenopodium leptophyllum</u>	36		0
<u>Crepis atrabarba</u>	0		4
<u>Descurainia pinnata</u>	20		15
<u>Draba verna</u>	0		8
<u>Erigeron filifolius</u>	0		4
<u>Erysimum asperum</u>	4		0
<u>Lomatium macrocarpum</u>	0		1
<u>Phacelia linearis</u>	1		0
<u>Phlox longifolia</u>	0		6
<u>Salsola kali</u>	1		0
<u>Sisymbrium altissimum</u>	3		0
<u>Sphaeralcea munroana</u>	<1		0
SHRUBS			
<u>Artemisia tridentata</u>	11		4
<u>Atriplex spinosa</u>	1		0
<u>Chrysothamnus nauseosus</u>	1		0
<u>Eurotia lanata</u>	<1		0
<u>Sarcobatus vermiculatus</u>	<1		0

TABLE 5.5. A Comparison of Vascular Plant Frequency in the Field and Diets of Darkling Beetles Inhabiting the Lower Old Field Cheatgrass Community on the Hanford Site, 1974

<u>Plant Taxon</u>	<u>Consumption Frequency</u>	<u>Field Frequency</u>
	- - - - - % - - - - -	
GRASSES		
<u>Bromus tectorum</u>	8	33
<u>Festuca octoflora</u>	2	0
<u>Poa cusickii</u>	2	0
<u>Poa sandbergii</u>	0	6
<u>Stipa thurberiana</u>	2	0
FORBS		
<u>Amsinckia sp.</u>	0	7
<u>Descurainia pinnata</u>	1	4
<u>Draba verna</u>	0	1
<u>Helianthus sp.</u>	1	0
<u>Holosteum umbellatum</u>	0	7
<u>Lappula redowskii</u>	0	1
<u>Sisymbrium altissimum</u>	71	38
<u>Townsendia florifer</u>	2	0
<u>Tragopogon dubius</u>	3	1
SHRUBS		
<u>Artemisia tridentata</u>	8	0

Lower Old Field Community

This community is dominated by cheatgrass (B. tectorum). During the study period shown in Table 5.5, Jim Hill mustard (S. altissimum) was also abundant. Although cheatgrass is abundant in the field, it comprised only 8% of the food particles ingested by the beetles occupying this community (Table 5.5). This indicates that cheatgrass is not a preferred food item. Jim Hill mustard was nearly twice as frequent in the diets of beetles as in the field indicating that it was a preferred food plant. Most other plant species occurred in the diets and field samples with approximately the same frequency. Big sagebrush (A. tridentata) occurs in the diets of darkling beetles from this location but was probably consumed from nearby areas.

Upper Old Field Community

The vegetative structure of this community is very similar to the lower old field community, both being dominated by cheatgrass. Cheatgrass is consumed with a higher relative frequency on the upper old field as compared to

TABLE 5.6. A Comparison of Vascular Plant Frequency in the Field and Diets of Darkling Beetles Inhabiting the Upper Old Field Cheatgrass Community on the Hanford Site, 1974(a)

Plant Taxon	Consumption Frequency	%	Field Frequency
GRASSES			
<u>Bromus tectorum</u>	53		31
<u>Poa cusickii</u>	1		0
<u>Poa sandbergii</u>	0		5
FORBS			
<u>Descurainia pinnata</u>	1		9
<u>Draba verna</u>	15		0
<u>Sisymbrium altissimum</u>	0		16
<u>Taraxacum officinale</u>	8		0
<u>Compositae(a)</u>	10		39
SHRUBS			
<u>Artemisia tridentata</u>	9		0
<u>Chrysothamnus nauseosus</u>	2		0
<u>Sarcobatus vermiculatus</u>	<1		0

(a) Field frequency data for this taxa were calculated as the composite frequency of Tragopogon dubius and Microseris laevicaulia, the two Compositae other than T. officinale found at the site.

the lower old field and Jim Hill mustard was not found to occur in the diets at all (Table 5.6). These kinds of differences seem surprising since the old fields are so similar. This comparison is for the family as a whole. The species composition of beetles in the two areas is different (Table 5.6). The purpose of this comparison is to show what the beetles present in the particular plant community are eating. A comparison at the species level is included later in this analysis.

Sagebrush/Poa (Control)

The beetles occupying this study site selected cheatgrass (B. tectorum) much less frequently, though it was available (Table 5.7). Globe-mallow (S. munroana) and big sagebrush (A. tridentata) were both preferred food items of darkling beetles. Other plants occurred in diets at about the same level as their field occurrence (Table 5.7).

TABLE 5.7. A Comparison of Vascular Plant Frequency in the Field and Diets of Darkling Beetles Inhabiting the Sagebrush/Poa (Control) Site on the Hanford Site, 1974

<u>Plant Taxon</u>	<u>Consumption Frequency</u>	<u>Field Frequency</u>
	- - - - - % - - - - -	
GRASSES		
<u>Bromus tectorum</u>	6	44
<u>Festuca octoflora</u>	0	<1
<u>Poa sandbergii</u>	0	1
<u>Sitanion hystrix</u>	0	2
<u>Stipa comata</u>	2	0
FORBS		
<u>Chenopodium leptophyllum</u>	5	0
<u>Chenopodium sp.</u>	<1	0
<u>Cryptantha sp.</u>	1	2
<u>Descurainia pinnata</u>	30	31
<u>Draba verna</u>	<1	0
<u>Euphorbia sp.</u>	0	<1
<u>Phlox longifolia</u>	0	1
<u>Salsola kali</u>	<1	2
<u>Sphaeralcea munroana</u>	29	4
SHRUBS		
<u>Artemisia tridentata</u>	22	8
<u>Atriplex spinosa</u>	2	4
<u>Chrysothamnus viscidiflorus</u>	0	<1
<u>Eurotia lanata</u>	2	0
<u>Sarcobatus vermiculatus</u>	1	0

B-C Crib

The B-C Crib study area is very similar to the sagebrush/poa control area. Both cheatgrass and slender fescue (Festuca octoflora) were selected against (Table 5.8). Cheatgrass had a 20% field frequency and a 2% diet frequency while slender fescue had a 16% field frequency and 0% diet frequency. Both of these species are introduced annual grasses. Big sagebrush appears to be a preferred food item in the B-C Crib area. It has a 49% diet frequency and 8% field frequency. Western tansymustard (Descurainia pinnata) may also be a preferred food plant. It had a 36% diet frequency and occurred in the field with an 18% frequency. Rabbitbrush, an important shrub inhabiting disturbed areas, was eaten with about the same frequency as its occurrence in the environment.

TABLE 5.8. A Comparison of Vascular Plant Frequency in the Field and Diets of Darkling Beetles Inhabiting the B-C Crib, 200 Area Plateau Site on the Hanford Site, 1974

Plant Taxon	Consumption Frequency	%	Field Frequency
GRASSES			
<u>Agropyron spicatum</u>	0		<1
<u>Bromus tectorum</u>	2		20
<u>Festuca octoflora</u>	0		16
<u>Poa sandbergii</u>	0		5
<u>Stipa comata</u>	0		<1
FORBS			
<u>Ambrosia acanthicarpa</u>	2		0
<u>Amsinckia sp.</u>	5		<1
<u>Balsamorhiza careyana</u>	2		<1
<u>Brodiaea douglasii</u>	0		<1
<u>Calochortus macrocarpus</u>	0		<1
<u>Castilleja sp.</u>	2		0
<u>Comandra umbellata</u>	0		<1
<u>Cryptantha sp.</u>	1		13
<u>Cymopterus terebinthinus</u>	0		<1
<u>Descurainia pinnata</u>	36		18
<u>Erigeron filifolius</u>	0		<1
<u>Erodium cicutarium</u>	0		<1
<u>Lomatium macrocarpum</u>	1		0
<u>Lupinus sp.</u>	<1		0
<u>Mentzelia albicaulis</u>	0		<1
<u>Microsteris gracilis</u>	0		14
<u>Oenothera pallida</u>	0		<1
<u>Phacelia linearis</u>	0		<1
<u>Phlox longifolia</u>	0		<1
<u>Polemonium micranthum</u>	1		0
<u>Salsola kali</u>	0		<1
<u>Sisymbrium altissimum</u>	0		<1
<u>Sphaeralcea munroana</u>	<1		0
SHRUBS			
<u>Artemisia tridentata</u>	49		8
<u>Chrysothamnus nauseosus</u>	0		<1
<u>Chrysothamnus viscidiflorus</u>	<1		<1
<u>Eurotia lanata</u>	<1		0

REDOX Pond

Selection of food items by darkling beetles inhabiting the REDOX Pond area is nearly identical to that of the beetles in the B-C Cribs (Table 5.9). Cheatgrass and six-week fescue are selected against and big sagebrush is again a preferred food plant. Cryptantha and Cymopterus were both consumed at a higher level in the REDOX Pond area while Descurainia was consumed at a lower level.

TABLE 5.9. A Comparison of Vascular Plant Frequency in the Field and Diets of Darkling Beetles Inhabiting the Redox Pond Site on the Hanford Site, 1974

<u>Plant Taxon</u>	<u>Consumption Frequency</u>	<u>%</u>	<u>Field Frequency</u>
GRASSES			
<u>Agropyron dasytachyum</u>	0		3
<u>Bromus tectorum</u>	1		27
<u>Festuca octoflora</u>	0		11
<u>Poa sandbergii</u>	0		<1
<u>Sitanion hystrix</u>	0		<1
<u>Stipa thurberiana</u>	9		0
FORBS			
<u>Astragalus sp.</u>	0		1
<u>Calochortus macrocarpus</u>	0		<1
<u>Cryptantha sp.</u>	23		15
<u>Cymopterus terebinthinus</u>	12		<1
<u>Descurainia pinnata</u>	6		18
<u>Erigeron sp.</u>	0		1
<u>Lupinus sp.</u>	0		<1
<u>Microsteris gracilis</u>	0		1
<u>Oenothera pallida</u>	0		<1
<u>Salsola kali</u>	7		4
<u>Sisymbrium altissimum</u>	0		12
SHRUBS			
<u>Artemisia tridentata</u>	41		5
<u>Chrysothamnus viscidiflorus</u>	0		<1
<u>Sarcobatus vermiculatus</u>	1		0

FOOD PLANT SELECTION BY PARTICULAR BEETLE SPECIES

Food plant selection data presented in prior sections has dealt with feeding patterns and preferences for the family Tenebrionidae as a whole. This kind of analysis is valuable in showing transfer pathways on a family level, but food selection may vary for individual beetle species and, therefore, the actual pattern of material flow through the darkling beetle population would be dependent on the species composition of beetles inhabiting a particular community or habitat. Beetle abundance has been shown to vary in the different communities included in this study (Table 1.3). The relative frequency of plant taxa included in beetle diets on the Hanford Site is shown in Tables 5.10-5.22.

Diet of *Blapstinus* spp.

Diet information presented here includes samples from both *B. substriatus* and *B. discolor*. Ten food plants were identified (Table 5.10) in *Blapstinus* diets. Fragments of arthropod parts comprised 17% of the diet. These are small beetles and some of the arthropod fragments may be an artifact associated with the dissection and mounting of insect gut material. Plant pollen, big sagebrush (*A. tridentata*), slender fescue (*F. octoflora*), Thurber's needlegrass (*S. thurberiana*), *Townsendia* (*Townsendia florifer*), and unknown forbs each comprised 11% of the diet. *Blapstinus* was only abundant in the old field communities. Diet analyses were only performed for the lower old field community.

Diet of *Coniontis setosa*

A total of 24 different food items were selected by this beetle from the Hanford area (Table 5.11). The most frequently selected items were slim leaf goose foot (*C. leptophyllum*) 19%, Jim Hill mustard (*S. altissimum*) 18%, big sagebrush (*A. tridentata*) 12%, and Cryptogams 12%. Food selection changes for different communities. Big sagebrush was frequently consumed (60%) in the sagebrush/poa plot but accounted for less than 10% of the diet in other areas. Major food plants in other communities were Jim Hill mustard in the lower old field (65%), tansymustard (34%), and rabbitbrush (37%) in the greasewood community, slim leaf goosefoot (37%) and cryptogams (16%) in the hopsage community, and slim leaf goosefoot (42%) and cryptogams (33%) in the sagebrush/bunchgrass community. The large number of other grass, forb, and shrub species consumed indicates that *Coniontis* is a euryphagous feeder consuming a wide range of available food materials. Tables are included in Appendix D showing the food habits of *C. setosa* in the sagebrush/poa, lower old field, greasewood, hopsage, and sagebrush/bunchgrass study areas.

Diet of *Eleodes nigrina*

There were 22 food items consumed by this species on the Hanford Site (Table 5.12). Grasses comprised an insignificant part of the diet. Western tansymustard (*D. pinnata*) was the most important forb in the diet (15%). Big sagebrush (*A. tridentata*) and winterfat (*E. lanata*) were both frequently consumed with relative values of 12% and 16%, respectively.

TABLE 5.10. Plant Taxa and Frequency of Ingestion by Blapstinus spp. on the Hanford Site(a)

<u>Common Name</u>	<u>Consumption Frequency, %</u>
GRASSES	
<u>Bromus tectorum</u>	6
<u>Festuca octoflora</u>	11
<u>Stipa thurberiana</u>	11
FORBS	
<u>Descurainia pinnata</u>	6
<u>Sisymbrium altissimum</u>	6
<u>Townsendia florifer</u>	11
Unknown forb	11
SHRUBS	
<u>Artemisia tridentata</u>	11
MISCELLANEOUS	
Arthropod parts	17
Pollen	11

(a) $N = 26$ slides, 520 observed fields.

Populations inhabiting specific communities seemed to adjust their feeding to available plant species (Appendix D). In the winterfat community this beetle concentrated on winterfat (35%) and arthropod parts (14%) and took little sagebrush (7%) or western tansymustard (4%). In the greasewood community greasewood (S. vermiculatus) was the most frequently consumed shrub (19%) although sagebrush also had a high value (17%). Both western tansymustard (37%) and cryptogams (13%) were also frequently ingested. Beetles in the sagebrush/poa community selected a lot of sagebrush (15%), globe-mallow (S. munroana) 33%, goosefoot (Chenopodium sp.) 29%, and arthropod parts. This species is clearly an opportunistic feeder selecting those food plants that are present in abundance at any particular location.

Diet of *Eleodes novoverrucula*

This beetle species consumed 21 different food items from the Hanford Site (Table 5.13). Cryptogams (30%) and big sagebrush (A. tridentata)

TABLE 5.11. Plant Taxa and Frequency of Ingestion by Coniontis setosa on the Hanford Site (a)

<u>Common Name</u>	<u>Consumption Frequency, %</u>
GRASSES	
<u>Bromus tectorum</u>	8
<u>Poa cusickii</u>	<1
Unknown grass	1
FORBS	
<u>Castilleja sp.</u>	<1
<u>Chenopodium leptophyllum</u>	19
<u>Descurainia pinnata</u>	8
<u>Polemonium micranthum</u>	<1
<u>Salsola kali</u>	1
<u>Sisymbrium altissimum</u>	18
<u>Sphaeralcea munroana</u>	<1
<u>Tragopogon dubius</u>	1
Compositae	2
Liliaceae	<1
Unknown forb	2
SHRUBS	
<u>Artemisia tridentata</u>	12
<u>Atriplex spinosa</u>	2
<u>Chrysothamnus nauseosus</u>	3
<u>Chrysothamnus viscidiflorus</u>	<1
<u>Eurotia lanata</u>	2
<u>Sarcobatus vermiculatus</u>	2
MISCELLANEOUS	
Arthropod parts	3
Cryptogams	12
Seed	1
Pollen	3

(a) N = 97 slides, 1,940 observed fields.

TABLE 5.12. Plant Taxa and Frequency of Ingestion by Eleodes nigrina on the Hanford Site (a)

<u>Common Name</u>	<u>Consumption Frequency, %</u>
GRASSES	
<u>Bromus tectorum</u>	4
<u>Festuca octoflora</u>	1
<u>Poa sandbergii</u>	1
Unknown grass	1
FORBS	
<u>Antennaria dimorpha</u>	1
<u>Castilleja</u> sp.	1
<u>Chenopodium leptophyllum</u>	5
<u>Crepis atrabarba</u>	4
<u>Descurainia pinnata</u>	15
<u>Draba verna</u>	<1
<u>Erysimum asperum</u>	<1
<u>Helianthus</u> sp.	<1
<u>Salsola kali</u>	2
<u>Sphaeralcea munroana</u>	6
Unknown forb	1
SHRUBS	
<u>Artemisia tridentata</u>	12
<u>Chrysothamnus nauseosus</u>	2
<u>Eurotia lanata</u>	16
<u>Sarcobatus vermiculatus</u>	7
MISCELLANEOUS	
Arthropod parts	9
Cryptogams	9
Seed	3

(a) N = 49 slides, 980 observed fields.

TABLE 5.13. Plant Taxa and Frequency
of Ingestion by Eleodes
nonvoverrucla on the
Hanford Site(a)

<u>Common Name</u>	<u>Consumption Frequency, %</u>
GRASSES	
<u>Bromus tectorum</u>	5
<u>Poa sandbergii</u>	<1
<u>Stipa thurberiana</u>	2
Unknown grass	5
FORBS	
<u>Calochortus macrocarpus</u>	<1
<u>Chenopodium leptophyllum</u>	1
<u>Cryptantha</u> sp.	1
<u>Descurainia pinnata</u>	6
<u>Salsola kali</u>	4
<u>Sisymbrium altissimum</u>	<1
<u>Townsendia florifer</u>	<1
Compositae	<1
Unknown forb	1
SHRUBS	
<u>Artemisia tridentata</u>	16
<u>Atriplex spinosa</u>	5
<u>Chrysothamnus nauseosus</u>	4
<u>Eurotia lanata</u>	5
<u>Sarcobatus vermiculatus</u>	1
MISCELLANEOUS	
Arthropod parts	9
Cryptogams	30
Pollen	5

(a) $N = 38$ slides, 760 observed fields.

16%, were the most frequently consumed items. None of the other ingested food plants comprised more than 9% of the total diet at Hanford localities.

Analysis by community type showed similar results (Appendix D). Sagebrush (*A. tridentata*) had a high ingestion frequency in the greasewood (27%) and winterfat communities (20%), but was low in the hopsage community (2%). In the hopsage community, hopsage (*A. spinosa*) (11%), and cryptogams (63%) were the major food items. Western tansymustard (*D. pinnata*) (17%), and pollen (21%), were high on the list of preferred food items in the greasewood community. Arthropod parts (22%) were frequently consumed in the winterfat community, indicating scavenging by this species.

Diet of *Eleodes granulata*

Twenty-four food items were consumed by this species (Table 5.14). Preferred food items appear to be cheatgrass (*B. tectorum*) (18%), western tansymustard (*D. pinnata*) (15%), winterfat (*E. lanata*) (11%), and cryptogams (23%). All other food materials comprised 7% or less of the diet.

Analysis of food habits of *E. granulata* inhabiting the winterfat and sagebrush/bunchgrass communities revealed cheatgrass was consumed at the 17% level in both. Western tansymustard had a 14% ingestion frequency in the winterfat community and a 29% level in the sagebrush/bunchgrass community. Winterfat was only consumed in the winterfat community. Cryptogams had a high relative consumption frequency in both the winterfat and sagebrush/bunchgrass communities with 23% and 12%, respectively (Appendix D).

Diet of *Eleodes hispilabris*

A total of 34 food items were consumed by this species (Table 5.15), more than any other beetle included in this study. Grasses were relatively unimportant in the diet. Cheatgrass (*B. tectorum*) did comprise 10% of the diet in the winterfat community (Appendix B); but overall, cheatgrass accounted for only 4% of the total diet (Table 5.15). Forbs were the most important category. Western tansymustard (*D. pinnata*) (18%) and globe-mallow (*S. munroana*) (17%) were the important forbs in the diet. Western tansymustard was consumed most frequently in the greasewood (54%) and B-C Crib (46%) study sites, and infrequently at other locations (Appendix D). Globe-mallow was consumed only in the sagebrush/poa community, the lone study location where it was abundant. Winterfat (*E. lanata*) was a frequently ingested food item in the winterfat community. Cryptogams had an ingestion frequency ranging from 13-16% in the winterfat, hopsage, and greasewood communities. The large number of different food items consumed mostly at fairly low levels and the high levels for a few abundant plant species supports the earlier observations that this darkling beetle species is an omnivorous feeder, consuming whatever organic material is available.

TABLE 5.14. Plant Taxa and Frequency of Ingestion by Eleodes granulata on the Hanford Site (a)

<u>Common Name</u>	<u>Consumption Frequency, %</u>
GRASSES	
<u>Agropyron spicatum</u>	<1
<u>Bromus tectorum</u>	18
<u>Poa cusickii</u>	1
<u>Poa sandbergii</u>	1
<u>Stipa thurberiana</u>	1
Unknown grass	<1
FORBS	
<u>Astragalus sp.</u>	<1
<u>Crepis atrabarba</u>	<1
<u>Descurainia pinnata</u>	15
<u>Draba verna</u>	<1
<u>Erysimum asperum</u>	4
<u>Phacelia linearis</u>	<1
<u>Salsola kali</u>	4
<u>Sisymbrium altissimum</u>	1
Unknown forb	2
SHRUBS	
<u>Artemisia tridentata</u>	3
<u>Atriplex spinosa</u>	<1
<u>Chrysothamnus nauseosus</u>	1
<u>Eurotia lanata</u>	11
<u>Sarcobatus vermiculatus</u>	<1
MISCELLANEOUS	
Arthropod parts	7
Cryptogams	23
Seed	1
Pollen	3

(a) N = 73 slides, 1,460 observed fields.

TABLE 5.15. Plant Taxa and Frequency of Ingestion by Eleodes hispilabris on the Hanford Site (a)

<u>Common Name</u>	<u>Consumption Frequency (%)</u>
Grasses	
<u>Bromus tectorum</u>	4
<u>Poa cusickii</u>	<1
<u>Poa sandbergii</u>	1
<u>Stipa thurberiana</u>	<1
Unknown grass	1
Forbs	
<u>Ambrosia acanthicarpa</u>	<1
<u>Amsinckia</u> sp.	<1
<u>Castilleja</u> sp.	<1
<u>Chenopodium</u> sp.	<1
<u>Chenopodium leptophyllum</u>	3
<u>Cryptantha</u> sp.	<1
<u>Descurainia pinnata</u>	18
<u>Draba verna</u>	<1
<u>Erigeron filifolius</u>	<1
<u>Erysimum asperum</u>	1
<u>Helianthus</u> sp.	<1
<u>Lomatium macrocarpum</u>	1
<u>Lupinus</u> sp.	<1
<u>Plantago patagonica</u>	<1
<u>Salsola kali</u>	3
<u>Sisymbrium altissimum</u>	1
<u>Sphaeralcea munroana</u>	17
<u>Liliaceae</u>	<1
Unknown forb	1
Shrubs	
<u>Artemisia tridentata</u>	5
<u>Atriplex spinosa</u>	2
<u>Chrysothamnus nauseosus</u>	<1
<u>Chrysothamnus viscidiflorus</u>	<1
<u>Eurotia lanata</u>	9
<u>Sarcobatus vermiculatus</u>	<1
Miscellaneous	
Arthropod parts	14
Cryptogams	8
Seed	4
Pollen	3

(a) N = 124 slides, 2480 observed fields

Diet of *Eleodes humeralis*

There were 10 food items in the diet of *E. humeralis* (Table 5.16), all but two of which were of incidental nature. Big sagebrush (*A. tridentata*) (51%), and rabbitbrush (*C. viscidiflorus*) (36%), are the only important plant species in the diet. This supports our previous observations that *E. humeralis* occurs in abundance only in shrub-dominated areas where they have been observed feeding on the foliage. Bitterbrush (*Pursha tridentata*) is probably also an important food item, but this community type was not included in this study. *Eleodes humeralis* is a stenophagic feeder, concentrating on a few shrub species.

Diet of *Eleodes obscura*

Fourteen food items occurred in the diet of this beetle species (Table 5.17). Cheatgrass (*B. tectorum*) (24%), slender hawksbeard (*Crepis atrabarba*) (17%), and Russian thistle (*Salsola kali*) (26%), were the major plant species in the diet. This beetle has not been abundant on the Hanford Site in the past. Only 13 beetles are included in this diet analysis, so the diet preferences shown in Table 5.17 may not be representative of the population as a whole. The high selection values for cheatgrass and Russian thistle are of special interest since both plants are commonly associated with radioactive waste burial sites.

TABLE 5.16. Plant Taxa and Frequency of Ingestion by *Eleodes humeralis* on the Hanford Site^(a)

<u>Common Name</u>	<u>Consumption Frequency (%)</u>
Grasses	
<u>Bromus tectorum</u>	1
Unknown grass	<1
Forbs	
<u>Chenopodium leptophyllum</u>	1
<u>Salsola kali</u>	2
Shrubs	
<u>Artemisia tridentata</u>	51
<u>Atriplex spinosa</u>	2
<u>Chrysothamnus nauseosus</u>	36
<u>Sarcobatus vermiculatus</u>	4
Miscellaneous	
Arthropod parts	2
Cryptogams	1

(a) N = 18 slides, 360 observed fields

TABLE 5.17. Plant Taxa and Frequency of Ingestion by Eleodes obscura on the Hanford Site (a)

<u>Common Name</u>	<u>Consumption Frequency (%)</u>
Grasses	
<u>Bromus tectorum</u>	24
<u>Stipa thurberiana</u>	3
Forbs	
<u>Crepis atrabarba</u>	17
<u>Cymopterus terebinthinus</u>	7
<u>Descurainia pinnata</u>	<1
<u>Salsola kali</u>	26
<u>Taraxacum officinale</u>	6
<u>Townsendia florifer</u>	<1
Unknown forb	<1
Shrubs	
<u>Artemisia tridentata</u>	3
<u>Atriplex spinosa</u>	1
<u>Sarcobatus vermiculatus</u>	<1
Miscellaneous	
Arthropod parts	6
Cryptogams	7

(a) N = 13 slides, 260 observed fields

Diet of *Oxygonodera hispidula*

This tiny beetle species consumed 11 different food items (Table 5.18). Only three food items occurred with a high frequency. These were cryptogams (46%), arthropod parts (19%), and big sagebrush (11%). The high frequency for arthropod parts may be an artifact due to the dissection technique. A beetle this small (4-6 mm) is difficult to dissect without accidentally including some fragments of cuticle. This species probably relies heavily on cryptogams (lichens and fungi) for its food supply with many of the other food items being ingested incidentally.

Diet of *Conisattus nelsoni*

There were 17 food items taken by this beetle (Table 5.19). There were only three items with a high ingestion frequency: cheatgrass (B. tectorum) (14%), western tansymustard (D. pinnata) (37%), and big sagebrush (A. tri-
dentata) (14%). This relatively high selection of a grass, forb, and shrub

TABLE 5.18. Plant Taxa and Frequency of Ingestion by Oxygonodera hispidula on the Hanford Site(a)

<u>Common Name</u>	<u>Consumption Frequency (%)</u>
Grasses	
<u>Bromus tectorum</u>	2
Unknown grass	5
Forbs	
<u>Helianthus</u> sp.	2
<u>Salsola kali</u>	1
<u>Compositae</u>	<1
<u>Liliaceae</u>	2
Shrubs	
<u>Artemisia tridentata</u>	11
<u>Chrysothamnus nauseosus</u>	5
<u>Sarcobatus vermiculatus</u>	5
Miscellaneous	
Arthropod parts	19
Cryptogams	46

(a) N = 37 slides, 740 observed fields

species indicates that it is probably a general feeder. C. nelsoni was only abundant in the sagebrush/poa community during this study, thus, this analysis reflects only those food items readily available in that community.

Diet of *Eusattus muricatus*

Twenty-one food items occurred in the diet of E. muricatus (Table 5.20). Western tansymustard (D. pinnata) and big sagebrush (A. tridentata) were the only species consumed in large proportions with diet frequencies of 22% and 50%, respectively. All other food items occurred with less than 3% frequency. This species only inhabits sandy habitats. This analysis indicates that it consumes a variety of materials but concentrates on two common plant species abundant in these areas, big sagebrush and western tansymustard.

Diet of *Philolithus densicollis*

A total of 38 different food items was taken by this beetle (Table 5.21), indicating that this is an omnivorous species. Western tansymustard (D. pinnata) (17%), cryptogams (17%), winterfat (E. lanata) (9%), big sagebrush (A. tridentata) (9%), and greasewood (S. vermiculatus) (7%), were the most frequently consumed food items.

TABLE 5.19. Plant Taxa and Frequency of Ingestion by Conisattus nelsoni on the Hanford Site(a)

<u>Common Name</u>	<u>Consumption Frequency (%)</u>
Grasses	
<u>Bromus tectorum</u>	14
<u>Stipa comata</u>	3
<u>Stipa thurberiana</u>	5
Unknown grass	<1
Forbs	
<u>Chenopodium leptophyllum</u>	2
<u>Descurainia pinnata</u>	37
<u>Draba verna</u>	1
<u>Psoralea lanceolata</u>	1
<u>Sisymbrium altissimum</u>	<1
<u>Sphaeralcea munroana</u>	2
Unknown forb	6
Shrubs	
<u>Artemisia tridentata</u>	14
<u>Sarcobatus vermiculatus</u>	1
Miscellaneous	
Arthropod parts	7
Cryptogams	4
Seed	<1
Pollen	1

(a) N = 88 slides, 1760 observed fields

Beetles from the winterfat community tended to select winterfat (35%), cryptogams (15%), sunflower (Helianthus sp.) (11%), and Sandberg's bluegrass (Poa sandbergii) (8%). Those in the hopsage community took mostly western tansymustard (38%), hopsage (21%), and cryptogams (22%). Cheatgrass (B. tectorum) (16%), greasewood (29%), cryptogams (37%), and western tansymustard (9%), were major foods at the greasewood community. Sagebrush/poa community beetles ingested western tansymustard (39%), globe-mallow (S. munroana) (23%), big sagebrush (12%), cryptogams (13%), and western tansymustard (9%). B-C Crib beetles tended to select fiddleneck (Amsinckia sp.) (18%), western tansymustard (34%), big sagebrush (17%), and bursage ragweed (9%). Cryptogams comprised 7% of the P. densicollis diet from the B-C Crib area. This beetle is clearly an omnivorous feeder, but it does consistently select western tansymustard, big sagebrush, and cryptogams. Cryptogams are a consistently

TABLE 5.20. Plant Taxa and Frequency of Ingestion by Eusattus muricatus on the Hanford Site(a)

<u>Common Name</u>	<u>Consumption Frequency (%)</u>
Grasses	
<u>Bromus tectorum</u>	3
<u>Stipa thurberiana</u>	3
Unknown grass	2
Forbs	
<u>Amsinckia</u> sp.	2
<u>Balsamorhiza careyana</u>	2
<u>Cryptantha</u> sp.	<1
<u>Descurainia pinnata</u>	22
<u>Erigeron filifolius</u>	<1
<u>Polemonium micranthum</u>	1
<u>Sisymbrium altissimum</u>	1
<u>Sphaeralcea munroana</u>	<1
<u>Compositae</u>	<1
Unknown forb	2
Shrubs	
<u>Artemisia tridentata</u>	50
<u>Atriplex spinosa</u>	1
<u>Chrysothamnus nauseosus</u>	3
<u>Chrysothamnus viscidiflorus</u>	1
<u>Eurotia lanata</u>	<1
Miscellaneous	
Arthropod parts	2
Cryptogams	3
Seed	1

(a) N = 70 slides, 1400 observed fields

important part of the diet of P. densicollis at nearly all study sites (Appendix D). We have frequently noticed beetles of this species grazing on crustose lichens when released from pitfall traps where they had been imprisoned for a week.

Diet of Stenomorpha puncticollis

Twenty-three food items were selected by this beetle species (Table 5.22). Food items of importance include cheatgrass (B. tectorum) (23%), Jim Hill mustard (S. altissimum) (16%), winterfat (E. lanata) (14%), greasewood (S. vermiculatus) (11%), and cryptogams (13%).

TABLE 5.21. Plant Taxa and Frequency of Ingestion by Philolithus densicollis on the Hanford Site^(a)

<u>Common Name</u>	<u>Consumption Frequency (%)</u>
Grasses	
<u>Agropyron spicatum</u>	<1
<u>Bromus tectorum</u>	6
<u>Festuca octoflora</u>	<1
<u>Poa cusickii</u>	<1
<u>Poa sandbergii</u>	3
<u>Stipa comata</u>	<1
<u>Stipa thurberiana</u>	<1
Unknown grass	<1
Forbs	
<u>Ambrosia acanthicarpa</u>	2
<u>Amsinckia sp.</u>	3
<u>Castilleja sp.</u>	1
<u>Chenopodium sp.</u>	<1
<u>Chenopodium leptophyllum</u>	<1
<u>Cryptantha sp.</u>	3
<u>Descurainia pinnata</u>	17
<u>Draba verna</u>	1
<u>Erigeron filifolius</u>	1
<u>Erysimum asperum</u>	2
<u>Helianthus sp.</u>	5
<u>Microsteris gracilis</u>	<1
<u>Polemonium micranthum</u>	1
<u>Psoralea lanceolata</u>	<1
<u>Salsola kali</u>	1
<u>Sisymbrium altissimum</u>	4
<u>Sphaeralcea munroana</u>	1
<u>Townsendia florifer</u>	1
<u>Compositae</u>	<1
<u>Liliaceae</u>	<1
Unknown forb	1
Shrubs	
<u>Artemisia tridentata</u>	9
<u>Atriplex spinosa</u>	2
<u>Eurotia lanata</u>	12
<u>Sarcobatus vermiculatus</u>	7
Miscellaneous	
Arthropod parts	1
Cryptogams	17
Hair	<1
Seed	<1

(a) N = 200 slides, 4000 observed fields

TABLE 5.22. Plant Taxa and Frequency of Ingestion by Stenomorpha puncticollis on the Hanford Site(a)

Plant Taxa	Consumption Frequency (%)
Grasses	
<u>Bromus tectorum</u>	23
<u>Poa cusickii</u>	1
Unknown grass	<1
Forbs	
<u>Amsinckia</u> sp.	<1
<u>Astragalus</u> sp.	1
<u>Chenopodium leptophyllum</u>	3
<u>Descurainia pinnata</u>	8
<u>Draba verna</u>	1
<u>Helianthus</u> sp.	1
<u>Microsteris gracilis</u>	1
<u>Polemonium micranthum</u>	<1
<u>Sisymbrium altissimum</u>	16
<u>Compositae</u>	<1
<u>Liliaceae</u>	<1
Unknown forb	1
Shrubs	
<u>Artemisia tridentata</u>	3
<u>Atriplex spinosa</u>	1
<u>Chrysothamnus nauseosus</u>	<1
<u>Eurotia lanata</u>	14
<u>Sarcobatus vermiculatus</u>	11
Miscellaneous	
Arthropod parts	<1
Cryptogams	13
Seed	<1

(a) N = 127 slides, 2540 observed fields

Cheatgrass was consumed at all study sites (Appendix D): upper old field (38%), lower old field (4%), greasewood community (38%), hopsage community (8%), and winterfat community (13%). The low relative frequency of cheatgrass consumption in the lower old field is associated with a high frequency of ingestion for Jim Hill mustard, the latter probably being a preferred species. Goosefoot (Chenopodium sp.) (27%) and cryptogams (32%) were also readily consumed in the hopsage community. Winterfat (64%) and western tansymustard (14%) were favored in the winterfat community. Greasewood (28%), cryptogams (16%), and cheatgrass (38%), were consumed in quantity in the greasewood community.

Diet Similarity

The diet composition of individual beetles coupled with abundance and length of activity periods determines in large part the impact darkling beetles have within natural communities. Measurement of diet similarities permits grouping beetle cohorts having the same feeding patterns, thereby simplifying management of controlled areas or aiding in our understanding of ecosystem functioning.

A similarity matrix is shown in Table 5.23. High indices of diet similarity indicate a high degree of dietary overlap. Similarity analysis for E. nigrina and E. hispilabris resulted in a calculated value of 68.0, which is interpreted as meaning these two beetles select basically the same food items. The low similarity values for E. humeralis and all other species means that humeralis is a very unique beetle in terms of its food selection.

The means of the similarity indices are shown in the last column ($\bar{X}$) of Table 5.23. This permits a ranking of those species with a high degree of overlap (high means) and those with low means, indicating little dietary overlap with other darkling beetle species. Application of an analysis of variance test revealed the mean values to be significantly different ($\alpha=0.05$). A Student-Neuman-Kuels multiple range test was then used to identify the values responsible for the statistical significance in mean values. Similar letters indicate those mean values that are not significantly different from each other. We interpret this to mean that E. nigrina, E. novoverrucula, E. granulata, P. densicollis, and E. hispilabris select the same food plant species, but as a group are different from all other beetles. The only species that have completely unique diets are E. humeralis, E. obscura, and Blapstinus sp.

TABLE 5.23. Similarity Indices for Diets of Darkling Beetles

Species	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	$\bar{X}^{(a)}$
<u>Eleodes nigrina</u> (1)		52.4	57.0	63.0	68.0	51.7	48.8	51.4	39.7	40.8	31.3	27.6	24.2	46.3 A
<u>Eleodes novoverrucula</u> (2)			60.1	49.9	50.4	54.9	42.7	37.0	39.9	64.0	38.7	28.8	29.4	45.7 A
<u>Eleodes granulata</u> (3)				61.0	59.6	39.9	49.3	60.0	32.5	38.5	28.7	41.4	10.2	44.9 AB
<u>Philolithus densicollis</u> (4)					55.8	48.3	42.8	57.9	39.9	38.2	26.6	19.7	18.6	43.5 AB
<u>Eleodes hispilabris</u> (5)						44.7	45.4	40.3	38.0	33.2	33.9	24.9	14.2	42.4 ABC
<u>Coniontis setosa</u> (6)							41.6	56.4	38.2	35.2	35.1	23.7	25.3	41.3 BCD
<u>Conisattus nelsoni</u> (7)								35.8	51.2	26.1	41.6	31.7	20.2	39.8 CD
<u>Stenomorpha puncticollis</u> (8)									21.6	25.9	30.0	35.5	10.3	38.5 D
<u>Eusattus muricatus</u> (9)										23.4	28.2	16.1	58.2	35.6 E
<u>Oxygonodera hispidula</u> (10)											29.9	20.1	25.5	33.4 E
<u>Blapstinus spp.</u> (11)												18.3	14.4	29.7 F
<u>Eleodes obscura</u> (12)													9.8	24.8 G
<u>Eleodes humeralis</u> (13)														21.7 H

(a) Means followed by similar letters are not significantly different.

Chapter VI

FOOD WEBS

**Transfer Pathways through Darkling
Beetle Populations**

Literature Cited

CHAPTER VI. FOOD WEBS

Darkling beetles inhabiting the Hanford Reservation consume 52 different food items, most of which are plant species. They, in turn, are consumed by a variety of predators. Johnson (1975) reported that both deer mice and pocket mice consumed substantial quantities of insects during March, April, and May. It is highly probable that darkling beetles were major contributors to these diets. They are available to the mice during these months, are flightless, and therefore can be easily captured by deer and pocket mice. Ground squirrels are more herbivorous and probably consume few Tenebrionids. Coyotes also include darkling beetles in their diets. Stoel (1976) reported significant coyote predation on darkling beetles during the months of June and November. The results for November probably reflect consumption of Philolithus densicollis since they are concentrated in areas of abundance, are slow moving, and lack defensive secretions. In addition, they become nearly immobile during periods of cold weather and would be an easy prey item with the onset of winter conditions. One of us (Uresk) has observed coyote scats containing as many as 3 dozen darkling beetle elytra in one grouping.

TRANSFER PATHWAYS THROUGH DARKLING BEETLE POPULATIONS

Very little is currently known about the details of native consumer diets despite recent research interest in this area. It is currently impossible to accurately estimate the number of darkling beetles consumed by any of their known predators or the importance of darkling beetle biomass as a food base for native carnivores. Figure 6.1 shows transfer pathways for energy and nutrients from the primary producers to the top carnivores. The only food chain leading to man occurs through the beetle-upland game bird-man pathway. All other food chains terminate with coyotes or raptorial birds as the top consumers. Coyotes are wide ranging scavengers that forage both on and off the reservation. Raptorial birds are mostly migratory, nesting on the Hanford Site, traveling southward with the completion of the breeding season. The Swainson's Hawk is known to over-winter as far away as Argentina. These far-ranging top consumers possess the ability to transport materials off the Hanford Site.

FIGURE 6.1. Food Web Showing Relationship of Darkling Beetles to Transfer Pathways

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Appendix A

Microscope Slide Mounting Media Preparations

Hertwigs Solution:

270 g chloralhydrate crystals
19 cc IN HCl
20 cc glycerin

Combine glycerin and HCl, add chloral hydrate crystals, and stir until dissolved.

Hoyers Solution:

200 g chloralhydrals crystals
50 cc water
200 cc glycerin
30 g acacia flakes

Combine glycerin and water, add chloralhydrate crystals, stir until dissolved. Warm the solution and stir in acacia flakes. Let stand until clear.

Appendix B

**Computer Program to Calculate Frequency
Percentages for Each Beetle Species and Food Item**


```

DDIET,110,CM50000,10100.          R SAUER 26828      331/300 AREA
ACCOUNT(CUN=BCC363,PW=BCC363)
MAP(0FF)
FTN,A,R=3,GO.
REWIND(INPUT)
COPYSF(INPUT,OUTPUT,LR,S30)
EXIT(S)
REWIND(INPUT)
COPYSF(INPUT,OUTPUT,LR,S30)
X
      PROGRAM DIET(INPUT,OUTPUT,TAPE5=INPUT,TAPE6=OUTPUT)
      DIMENSION FREQ(100),DENS(100),NAME(100),ISPS(26),IDATA(26)
      DIMENSION DATA(26)
C... PLACE A BLANK CARD AT THE END OF EACH GROUP (CONSUMER SPECIES,
C... DATE OR WHATEVER) TO RE ANALYZED.
C... INITIALIZE COUNTERS AND VARIABLES
85  TOTFQ=TOTDENS=0.
      NSLIDS=NNAME=0
      TFLDS=0.
      DO 10 J=1,100
      FREQ(J)=0.
      DENS(J)=1000000000.
C... DENS IS INITIALIZED TO A VALUE THAT WILL BLOW THE OUTPUT FORMAT TO
C... INDICATE WHEN FREQUENCY WAS 100 PERCENT AND DENSITY WAS INDETERMINATE.
      NAME(J)=10H
10  CONTINUE
30  CONTINUE
      DO 32 JJ=1,26
      ISPS(JJ)=10H
      IDATA(JJ)=0
32  CONTINUE
      READ(5,100)MDATE,MCONS,IFLDS,(ISPS(J),IDATA(J),J=1,7),IFOLLOW
100  FORMAT(3X,A6,6X,A4,13,8X,7(A4,13),11)
      IF(EOF(5).NE.0) GO TO 90
      IF(IFOLLOW.GT.0)READ(5,105)(ISPS(J),IDATA(J),J= 8,14),IFOLLOW
      IF(EOF(5).NE.0) STOP "ERROR 1"
      IF(IFOLLOW.GT.0)READ(5,105)(ISPS(J),IDATA(J),J=15,21),IFOLLOW
      IF(EOF(5).NE.0) STOP "ERROR 2"
      IF(IFOLLOW.GT.0)READ(5,105)(ISPS(J),IDATA(J),J=22,28),IFOLLOW
      IF(EOF(5).NE.0) STOP "ERROR 3"
105  FORMAT(30X,7(A4,13),11)
      IF(MCONS.EQ.4H) GO TO 35
      MCONS=MCONS
      MDATE=MDATE
      DO 15 K=1,28
15  DATA(K)=IDATA(K)
      TFLDS=TFLDS+IFLDS
C... COUNT SLIDES
      NSLIDS=NSLIDS+1
C... NNAME IS THE NUMBER OF OBSERVED FOOD SPECIES, WHICH ARE STORED IN NAME
C... LOG IN THE FOOD SPECIES NAMES IF NECESSARY, AND ACCUMULATE OBSERVATIONS.
      DO 20 J=1,28
      IF(ISPS(J).EQ.4H) GO TO 25
      DO 40 JK=1,NNAME
      KEEP=JK
      IF(ISPS(J).EQ.NAME(JK)) GO TO 50
40  CONTINUE
      NNAME=NNAME+1
      NAME(NNAME)=ISPS(J)
      FREQ(NNAME)=DATA(J)
      GO TO 20
50  FREQ(KEEP)=FREQ(KEEP)+DATA(J)
20  CONTINUE
25  CONTINUE
      GO TO 30
C... SUMMARIZE THE DATA FOR THE CONSUMER SPECIES
35  CONTINUE
      DO 70 J=1,NNAME
      FREQ(J)=FREQ(J)/TFLDS*100.
      TOTFQ=TOTFQ+FREQ(J)
      IF(FREQ(J).GE.100.) GO TO 70
      DENS(J)=ALOG(-1./((FREQ(J)/100.-1.))
      TOTDENS=TOTDENS*DENS(J)
70  CONTINUE
      WRITE(6,220)MCONS,MDATE,TFLDS,NSLIDS,NNAME
220  FORMAT(1H1,0 DIET ANALYSIS FOR CONSUMER *,A4,0 ON DATE *,A6,1X,
1=WITH*,F6,0,0 OBSERVED FIELDS,*,14,0 SLIDES AND*,13,0 FOOD SPECIES
2=)
      WRITE(6,200)
200  FORMAT(///,0 FOOD SPECIES      FREQUENCY      DENSITY*)
      DO 80 K=1,NNAME
80  WRITE(6,210)NAME(K),FREQ(K),DENS(K)
210  FORMAT(1H,3X,A4,9X,F10.4,2X,F7.4)
      DO 75 K=1,NNAME
      FREQ(K)=FREQ(K)/TOTFQ*100.
      DENS(K)=DENS(K)/TOTDENS*100.
75  CONTINUE
      WRITE(6,230)
230  FORMAT(///,0 FOOD SPECIES      REL FREQ      REL DENS*)
      DO 76 J=1,NNAME
76  WRITE(6,210) NAME(J),FREQ(J),DENS(J)
      CONTINUE
      GO TO 85
90  CONTINUE
      END

```

Appendix C

Data Listing of Food Items Contained in Gut Contents of Dissected Beetles

Date	Month	Year	Site	Slide No.				Consumer	No. Fields	No. Read	Slide No.				Consumer	No. Fields	No. Read	Date	Month	Year	Site
				1	2	3	4				1	2	3	4							
06137410	06137410	06137410	06137410	A 1ARTR	20			CONE	20		A 1ARTR	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 2DEPI	15UNK	3		CONE	20		A 2DEPI	15UNK	3		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 3UNKF	5SAVE	10DEPI	5	CONE	20		A 3UNKF	5SAVE	10DEPI	5	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 4DEPI	3UNKF	18		CONE	20		A 4DEPI	3UNKF	18		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 5STCO	20			CONE	20		A 5STCO	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 6NULL	0			CONE	20		A 6NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 7RTE	20			CONE	20		A 7RTE	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 8NULL	0			CONE	20		A 8NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 9DEPI	20			CONE	20		A 9DEPI	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 10ARTR	14DRVE	7		CONE	20		A 10ARTR	14DRVE	7		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 11NULL	0			CONE	20		A 11NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 12NULL	0			CONE	20		A 12NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 13NULL	0			CONE	20		A 13NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 14NULL	0			CONE	20		A 14NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 15NULL	0			CONE	20		A 15NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 16ARTR	8SPHA	10DEPI	5	CONE	20		A 16ARTR	8SPHA	10DEPI	5	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 17ARTR	18DEPI	10		CONE	20		A 17ARTR	18DEPI	10		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 18UNKF	2DEPI	14ARTH	2	CONE	20		A 18UNKF	2DEPI	14ARTH	2	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 19NULL	0			CONE	20		A 19NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 20DEPI	10ARTH	10		CONE	20		A 20DEPI	10ARTH	10		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 21MOSS	2DEPI	19ARTH	4	CONE	20		A 21MOSS	2DEPI	19ARTH	4	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 22DEPI	20			CONE	20		A 22DEPI	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 23DEPI	14ARTH	7		CONE	20		A 23DEPI	14ARTH	7		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 24UNKF	10UNKP	10		CONE	20		A 24UNKF	10UNKP	10		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 25UNKG	2DEPI	16MOSS	6	CONE	20		A 25UNKG	2DEPI	16MOSS	6	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 26ARTR	10DEPI	2		CONE	20		A 26ARTR	10DEPI	2		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 27DEPI	20			CONE	20		A 27DEPI	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 28DEPI	20			CONE	20		A 28DEPI	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 29NULL	0			CONE	20		A 29NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 30UNKF	10SPHA	10		CONE	20		A 30UNKF	10SPHA	10		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 31DEPI	6UNKF	9ARTH	2	CONE	20		A 31DEPI	6UNKF	9ARTH	2	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 32NULL	0			CONE	20		A 32NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 33PRTE	20			CONE	20		A 33PRTE	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 34NULL	0			CONE	20		A 34NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 35NULL	0			CONE	20		A 35NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 36NULL	0			CONE	20		A 36NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 37STCO	18ARTH	4DEPI	5	CONE	20		A 37STCO	18ARTH	4DEPI	5	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 38NULL	0			CONE	20		A 38NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 39NULL	0			CONE	20		A 39NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 40ARTR	2ARTH	8DEPI	2MOSS	2	CONE	20	A 40ARTR	2ARTH	8DEPI	2MOSS	2	CONE	20	06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 41ARTH	15ARTH	6UNKF	5	CONE	20		A 41ARTH	15ARTH	6UNKF	5	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 42ARTH	20			CONE	20		A 42ARTH	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 43ARTH	1UNKF	17MOSS	1	CONE	20		A 43ARTH	1UNKF	17MOSS	1	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 44ARTH	4DEPI	18UNKF	2	CONE	20		A 44ARTH	4DEPI	18UNKF	2	CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 47NULL	0			CONE	20		A 47NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 48NULL	0			CONE	20		A 48NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 49NULL	0			CONE	20		A 49NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 50NULL	0			CONE	20		A 50NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 78UNKF	20			CONE	20		A 78UNKF	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 79ARTH	10DEPI	10		CONE	20		A 79ARTH	10DEPI	10		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 80RTE	10SIAL	10		CONE	20		A 80RTE	10SIAL	10		CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 81NULL	0			CONE	20		A 81NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 82FECC	20			CONE	20		A 82FECC	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 83NULL	0			CONE	20		A 83NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 84ARTH	20			CONE	20		A 84ARTH	20			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 85NULL	0			CONE	20		A 85NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 86NULL	0			CONE	20		A 86NULL	0			CONE	20		06137408	06137408	06137408	06137408
06137410	06137410	06137410	06137410	A 89NULL	0			CONE	20		A 89NULL	0			CONE	20		06137408	06137408	06137408	06137408

06137410	CONE 20	B81DEPI 6MOSS 14	10197302	PHDE 20	C39MOSS 10BRTE 10
06137410	CONE 20	B82NULL 0	10197302	PHDE 20	C40HAIK 5EULA 10ARTR 5
06137410	CONE 20	B83NULL 0	10197402	PHDE 20	C41NULL 0
06137410	CONE 20	B84ARTH 10ARTR 5DEPI 5	10257402	PHDE 20	C42ARTR 14DEPI 6
06137410	CONE 20	B85DEPI 16MOSS 4	10257402	PHDE 20	C43AMSP 6POSE 2EULA 3ERAS 4
06137410	CONE 20	B86NULL 0	10257402	PHDE 20	C44EULA 20
06137410	CONE 20	B87NULL 0	10257402	PHDE 20	C45NULL 0
06137410	CONE 20	B88DEPI 20	10197302	PHDE 20	C46EULA 7ERAS 11MOSS 2
06137410	CONE 20	B89NULL 0	10197302	PHDE 20	C47ERAS 4EULA 8FRAC 5
06137410	CONE 20	B90DEPI 20	10197302	PHDE 20	C48EULA 18FRAC 2
06137410	CONE 20	B91DEPI 20	10197302	PHDE 20	C49MOSS 20
06137410	CONE 20	B92NULL 0	10197302	PHDE 20	C50EULA 8FRAC 8ARTR 2POSE 2
06137410	CONE 20	B93DEPI 10MOSS 10	10197302	PHDE 20	C51AMSP 4POSE 12EULA 21OFL 2
06137410	CONE 20	B94DEPI 48RTE 16	10197302	PHDE 20	C52MOSS 3EULA 15AMSP 1ERAS 1
06137410	CONE 20	B95DEPI 20	10197302	PHDE 20	C53ARTR 10EULA 10
06137410	CONE 20	B96NULL 0	10197302	PHDE 20	C54TOFL 10AMSP 10
06137410	CONE 20	B97NULL 0	10197302	PHDE 20	C55ARTR 48RTE 16
06137410	CONE 20	B98NULL 0	10197302	PHDE 20	C56EULA 28RTE 18
06137410	CONE 20	B99DEPI 20	10197302	PHDE 20	C57EULA 15BRTE 5
06257402	ELGR 20	C1ERAS 20	10197302	PHDE 20	C58AMSP 10BRTE 10
06257402	ELGR 20	C2ERAS 18EULA 2	10197302	PHDE 20	C59TOFL 20
06257401	ELGR 20	C3ERAS 20	10197302	PHDE 20	C60NULL 0
06257401	ELGR 20	C4MOSS 2EULA 2ARTR 1POSE 15	10197302	PHDE 20	C61NULL 0
06257401	ELGR 20	C5NULL 0	10197302	PHDE 20	C62EULA 20
06257401	ELGR 20	C6NULL 0	10197304	PHDE 20	C63MOSS 19DEPI 1
10257407	PHDE 20	C7PGMI 1DEPI 15AMSP 3UNKF 1	10197304	PHDE 20	C64PRTE 15MOSS 4
10257407	PHDE 20	C8CASP 20	10197304	PHDE 20	C65MOSS 3DEPI 15AVE 2RTE 9
10257407	PHDE 20	C9DEPI 20	10197304	PHDE 20	C67DEPI 1BRTE 9SAVE 5MOSS 6
10257407	PHDE 20	C10NULL 0	10197304	PHDE 20	C68SAVE 20
10257407	PHDE 20	C11MOSS 20	10197304	PHDE 20	C69MOSS 6BRTE 14
10257407	PHDE 20	C12DEPI 12AMSP 5ARTH 2	10197304	PHDE 20	C70MOSS 12ARTH 5DEPI 2
10257407	PHDE 20	C13ARTR 3AMSP 12	10197304	PHDE 20	C71SAVE 20
10257407	PHDE 20	C14FRAC 15ARTH 5	10197304	PHDE 20	C72MOSS 10DEPI 2SAVE 5
10257407	PHDE 20	C15FRAC 1DEPI 19	10197304	PHDE 20	C73SAVE 18MOSS 2
10257407	PHDE 20	C16AMSP 10ARTR 10	10197304	PHDE 20	C74NULL 0
10257407	PHDE 20	C17AMSP 8ARTH 12	10197304	PHDE 20	C75MOSS 10DEPI 11
10257407	PHDE 20	C18FRAC 10DEPI 10	10197304	PHDE 20	C76MOSS 16SAVE 4
10257407	PHDE 20	C19ARTR 19ARTH 1	10197304	PHDE 20	C77MOSS 2SAVE 13
10257407	PHDE 20	C20ARTR 10DEPI 10	08027406	ELOR 20	C78ARTR 9STTH 8ARTH 1SAVE 1
10257407	PHDE 20	C21AMSP 10DEPI 10	08137408	BLSP 20	C83ARTR 20
10197302	PHDE 20	C22ARTR 20	08137408	BLSP 20	C84NULL 0
10197302	PHDE 20	C23MOSS 20	08137408	BLSP 20	C85NULL 0
10197302	PHDE 20	C24EULA 20	08137408	BLSP 20	C86NULL 0
10197302	PHDE 20	C25ARTR 2POSE 12EULA 6	08137408	BLSP 20	C87UNKF 20
10197302	PHDE 20	C26POSE 18EULA 2	08137408	BLSP 20	C88NULL 0
10197302	PHDE 20	C27MOSS 8EULA 10POSE 2	08137408	BLSP 20	C89NULL 0
10197302	PHDE 20	C28POSE 14EULA 6	08137408	BLSP 20	C90TOFL 20
10197302	PHDE 20	C29STAL 2POSE 4ELOC 4EULA 10	08137408	BLSP 20	C91NULL 0
10197302	PHDE 20	C30POSE 7MOSS 4EULA 9	08137408	BLSP 20	C92NULL 0
10197302	PHDE 20	C31EULA 2DEPI 3POSE 14RTE 1	08137408	BLSP 20	C93NULL 0
10197302	PHDE 20	C32DEPI 1EULA 8POSE 1AMSP 4	08137408	BLSP 20	C94NULL 0
10197302	PHDE 20	C33EULA 20	08137408	BLSP 20	C95NULL 0
10197302	PHDE 20	C34MOSS 8EULA 4STCO 8DEPI 2	08137408	BLSP 20	C96STTH 20
10197302	PHDE 20	C35NULL 0	08137408	BLSP 20	C97NULL 0
10197302	PHDE 20	C36EULA 14POSE 5MOSS 1	10257409	ELNO 20	C99NULL 0
10197302	PHDE 20	C37NULL 0	08027406	ELOR 20	C100DEPI 10YTE 19
10197302	PHDE 20	C38AMSP 20	08057407	EUMU 20	C1DEPI 10ARTR 13UNKF 1

08057407	EUMU	20	D2DEPI	2ARTR	19UNKF	1AMSP	2	06137410	ELHI	20	D85ARTP	20	
08057407	EUMU	20	D3DEPI	13ARTR	11AMSP	1		06137410	ELHI	20	D86CHLE	20DEPI	
08057407	EUMU	20	D4DEPI	10ARTR	7UNKF	4ARTH	1	06137410	ELHI	20	D87DEPI	6ARTH	
08057407	EUMU	20	D5DEPI	14ARTR	6EULA	1		06137410	ELHI	20	D88SPHA	20	
08057407	EUMU	20	D6BACA	20ARTR	1			06137410	ELHI	20	D89SPHA	20	
08057407	EUMU	20	D7BACA	12UNKF	8			06137410	ELNI	20	D91CHLE	20ARTH	
08057407	EUMU	20	D8ARTH	20				06137410	ELNI	20	D92SPHA	20	
08057407	EUMU	20	D9BACA	1ARTH	10DEPI	9		06137410	ELNI	20	D93ARTH	20	
08057407	EUMU	20	D10ARTR	20DEPI	2AMSP	2SEED	2	06137410	ELNI	20	D94SPHA	20	
08057407	EUMU	20	D11BRT	14ARTR	7			06137410	ELNI	20	D95NULL	0	
08057407	EUMU	20	D12UNKG	2ARTR	19DEPI	10AMSP	2BACA	1	06137410	ELNI	20	D96ARTR	20DEPI
08057407	EUMU	20	D13ARTR	15DEPI	8AMSP	2		06137410	ELNI	20	D97SPHA	20	
08057407	EUMU	20	D14ARTR	1DEPI	20AMSP	1BRT	4	06137410	ELNI	20	D98CHLE	15SAVE	
08057407	EUMU	20	D15ARTR	20DEPI	1			08137401	ELNI	20	D99SEED	20	
08057407	EUMU	20	D16DEPI	19ARTR	9AMSP	1POMI	1	07167404	COSE	20	E1ARTR	2DEPI	
08057407	EUMU	20	D17ARTR	20				07167404	COSE	20	E2DEPI	20BRT	
08057407	EUMU	20	D18DEPI	20				07307304	COSE	20	E3SAVE	15BRT	
08057407	EUMU	20	D19DEPI	8ARTH	12ARTH	2		07307304	COSE	20	E4SAVE	10BRT	
08057407	EUMU	20	D20DEPI	12ARTH	4POMI	11		07067304	ELNO	20	E5ARTH	12MOSS	
08057407	EUMU	20	D21UNKF	7ARTH	7DEPI	7		07067304	ELNO	20	E6ARTR	20SAVE	
08057407	EUMU	20	D22ARTR	20DEPI	11AMSP	1		06217304	OXHI	20	E7MOSS	20	
08057407	EUMU	20	D23ARTR	8AMSP	12			07167304	OXHI	20	E8SAVE	20	
08057407	EUMU	20	D24ARTR	20				06187304	OXHI	20	E9UNKG	20	
06137407	EUMU	20	D25ARTH	7UNKF	14			07167304	ELGR	20	E12MOSS	20	
06137407	EUMU	20	D26DEPI	10ARTR	14COMP	1AMSP	1	06197304	ELNI	20	E35ARTR	19SAVE	
06137407	EUMU	20	D27DEPI	9ARTH	20POMI	2		06187304	ELNI	20	E36DEPI	20SAVE	
06137407	EUMU	20	D28ARTR	20AMSP	23BRT	3		06187304	ELNI	20	E37DEPI	11SAVE	
06137407	EUMU	20	D29DEPI	4ARTH	20BRT	3		06187304	ELNI	20	E38DEPI	20	
06137407	EUMU	20	D30NULL	0				06187304	ELNI	20	E39DEPI	5SAVE	
06137407	EUMU	20	D31ARTR	18DEPI	13ARTH	1		06197304	ELNI	20	E40CHNA	18UNKG	
06137407	EUMU	20	D32ARTR	16SFHA	1MOSS	7		07067304	ELNI	20	E43UNKG	4ARTH	
06137407	EUMU	20	D33ARTR	18BRT	2UNKF	1		07067304	ELNI	20	E44ARTH	28BRT	
06137407	EUMU	20	D34ARTR	10DEPI	9ARTH	1		07067304	ELNI	20	E45UNKG	1DEPI	
07087407	EUMU	20	D58ARTR	10DEPI	9BRT	5		07067304	ELNI	20	E46DEPI	14ARTH	
07087407	EUMU	20	D59ARTR	15DEPI	7ENDO	1MOSS	1	07167304	ELNI	20	E47DEPI	14UNKG	
07087407	EUMU	20	D60ARTR	7DEPI	18			07167304	ELNI	20	E48SAVE	20	
07087407	EUMU	20	D61ARTR	9DEPI	12			07167304	ELNI	20	E49ARTR	20	
07087407	EUMU	20	D62ARTR	10DEPI	14MOSS	1POMI	1	07167304	ELNI	20	E50MOSS	9SAVE	
07087407	EUMU	20	D63ARTH	04DEPI	13BRT	3ORYP	1	06217304	ELNI	20	E51NULL	0	
07087407	EUMU	20	D64ARTR	20				06217304	ELNI	20	E52DEPI	20SAVE	
07087407	EUMU	20	D65ARTH	1DEPI	20			07167304	ELHI	20	E53DEPI	17BRT	
06137407	EUMU	20	D66ARTR	20ARTH	1			07067304	ELHI	20	E54DEPI	20BRT	
06137407	EUMU	20	D67ARTR	20MOSS	9			07067304	ELHI	20	E55DEPI	20	
06137407	EUMU	20	D68ARTR	20DEPI	1			07067304	ELHI	20	E56DEPI	16ARTH	
06137407	EUMU	20	D69ARTR	3MOSS	6DEPI	18UNKG	2	07067304	ELHI	20	E57DEPI	3MOSS	
06137407	EUMU	20	D70ARTR	20				07307304	ELHI	20	E58MOSS	12DEPI	
06137407	EUMU	20	D71ARTR	20AMSP	2DEPI	1UNKG	1	06187304	ELHI	20	E71DEPI	14CPVE	
06137407	EUMU	20	D72ARTR	20DEPI	6ARTH	2MOSS	2	06187304	ELHI	20	E72DEPI	17CHNA	
06137407	EUMU	20	D73ARTR	20DEPI	3			06187304	ELHI	20	E73DEPI	17ARTH	
06137407	EUMU	20	D74ARTR	18DEPI	1MOSS	2ENDO	1	06127304	ELNO	20	E74UNKF	4ARTH	
06137407	EUMU	20	D75ARTR	20DEPI	1			06187504	ELHU	20	E75	DEPI	
06137407	EUMU	20	D76ARTR	20MOSS	6DEPI	3		06187304	ELNO	20	E76DEPI	14MOSS	
06137407	EUMU	20	D77ARTR	16DEPI	5BACA	1		06187304	ELNO	20	E77DEPI	20MOSS	
06137407	EUMU	20	D78ARTR	19MOSS	3			10257402	PHDE	20	F1FULA	13ERAS	
06137407	EUMU	20	D79ARTR	18MOSS	2DEPI	1		10257402	PHDE	20	F2FULA	8ERAS	
06137407	EUMU	20	D80ARTR	13MOSS	8DEPI	13		10257402	PHDE	20	F3NULL	0	
06137410	ELHI	20	D84NULL	0				10257402	PHDE	20	F4DEPI	6FRAC	
											12ERAS	3	

10197304	PHDE 20	J49BRTE	8SAVE	9MOSS	3	10297401	COSE 20	K18ARTR	19BRTE	1			
10197304	PHDE 20	J50BRTE	9SAVE	6MOSS	5DEPI 2	10197304	STPU 20	K19MOSS	10DEPI	1SAVE	70COMP	20UNK	1
10197304	PHDE 20	J51SAVE	4MOSS	20BRTE	1	10197304	STPU 20	K20SAVE	20BRTE	1			
10197304	PHDE 20	J52DEPI	4SAVE	10MOSS	9BRTE 2	10197304	STPU 20	K21ARTE	16MOSS	4			
10197304	PHDE 20	J53SAVE	15BRTE	5ARTH	1	10197304	STPU 20	K22ARTR	65AVE	4BRTE 10			
10197304	PHDE 20	J54BRTE	2SAVE	18		10197304	STPU 20	K23SAVE	10BRTE	10LEPI	4BRTE	1	
10197304	PHDE 20	J55SAVE	9MOSS	10BRTE	3	10197304	STPU 20	K24ARTR	3BRTE	18BRTE	1		
10267309	STPU 20	J56SAVE	1BRTE	20		10197304	STPU 20	K25ARTR	25AVE	65BRTE	10DEPI	6BRTE	2
10267309	STPU 20	J57BRTE	20			10197304	STPU 20	K26BRTE	20				
10267309	STPU 20	J58BRTE	20			10197304	STPU 20	K27SAVE	16BRTE	3MOSS	15BRTE	2	
10197302	STPU 20	J59EULA	20AMSP	1BRTE	5	10197304	STPU 20	K28BRTE	16SEEL	4			
10197302	STPU 20	J60EULA	20BRTE	3		10197304	STPU 20	K29SAVE	23BRTE	15ARTH	2		
10197302	STPU 20	J61EULA	20			10197304	STPU 20	K30SAVE	10BRTE	10			
10197302	STPU 20	J62EULA	17BRTE	11HESP	1	10197304	STPU 20	K31MOSS	13SAVE	1ARTP	1LEPI	DENDU	5
10197302	STPU 20	J63BRTE	8HESP	12EULA	4	10197304	STPU 20	K32SAVE	15DEPI	2BRTE	1ARTE	2	
10197302	STPU 20	J64EULA	12DEPI	10BRTE	6HESP 1	10197304	STPU 20	K33SAVE	20				
10197302	STPU 20	J65EULA	19HESP	1BRTE	7	10197304	STPU 20	K34SEED	26BRTE	20			
10197302	STPU 20	J66EULA	19BRTE	6		10197304	STPU 20	K35SAVE	14BRTE	6			
10197302	STPU 20	J67EULA	12BRTE	7SEED	4HESP 2	10197304	STPU 20	K36BRTE	20				
10197302	STPU 20	J68EULA	20BRTE	3		10197304	STPU 20	K37ARTE	8SAVE	9ARTH	1LEPI	3MOSS	1
10197302	STPU 20	J69EULA	19BRTE	3		10197304	STPU 20	K38AKG	15AVE	20MOSS	1		
10197302	STPU 20	J70EULA	17BRTE	8HESP	5	10197304	STPU 20	K39ARTE	16SAVE	1			
10197302	STPU 20	J71EULA	20			10197304	STPU 20	K40BRTE	12SAVE	4SIAL	4		
10197303	STPU 20	J72UNKF	3BRTE	19		10197304	STPU 20	K41BRTE	20				
10197303	STPU 20	J73MOSS	2BRTE	2EULA	19	10197304	STPU 20	K42SEED	4BRTE	13SAVE	6		
10197303	STPU 20	J76GPSP	14MOSS	6BRTE		10197304	STPU 20	K43BRTE	4SAVE	7MOSS	9		
07067302	ELNI 20	J80MOSS	25AKA	16EULA	2BRTE 4	10197304	STPU 20	K44SAVE	20MOSS	1			
07067302	ELNI 20	J81ARTH	20			10197304	STPU 20	K45BRTE	10MOSS	4			
07067302	ELGR 20	J82EULA	1BRTE	19MOSS		10197304	STPU 20	K46BRTE	3SAVE	4SIAL	17DEPI	1	
07067302	ELGR 20	J83POCU	8EULA	18MOSS	4ARTH 1	10197304	STPU 20	K47BRTE	3SAVE	15DEPI	1		
07067302	ELGR 20	J84MOSS	20			10257409	STPU 20	K48BRTE	6MOSS	14			
07067302	ELGR 20	J85MOSS	20EULA	1		10257409	STPU 20	K49ARTR	20				
06117302	ELGR 20	J86EULA	15MOSS	5ERAS	1POCU 3DEPI 1	10257409	STPU 20	K50NULL	0				
06227302	ELGR 20	J87MOSS	19EULA	1		10257409	STPU 20	K51ARTE	2BRTE	1MOSS	1LEPI	3	
06227302	ELGR 20	J88DEPI	2EULA	2MOSS	18SEED 4	10257409	STPU 20	K52MOSS	20				
06227302	ELGR 20	J89EULA	9MOSS	7BRTE	6ARTH 4	10257409	STPU 20	K53MOSS	15POCU	20UNA	4		
06227302	ELNI 20	J90EULA	19MOSS	7		10257409	STPU 20	K54ARTE	60AVE	9MOSS	9		
07067302	ELNI 20	J91EULA	16MOSS	2ARTH	2UNKF 6	10257409	STPU 20	K55BRTE	8BRTE	4MOSS	6		
07067302	ELNI 20	J92EULA	12FEED	6ERAS	2	10257409	STPU 20	K56POVE	20				
06227302	ELNI 20	J93MOSS	16EULA	9ARTH	12	10257408	STPU 20	K57NULL	0				
06227302	ELNI 20	J94ARTE	20EULA	12MOSS	2	10257408	STPU 20	K58SIAL	20				
06227302	ELNI 20	J95MOSS	6ARTH	15EULA	10CASE 2	10257408	STPU 20	K59NULL	0				
06227302	OXHI 20	J96MOSS	20			10257408	STPU 20	K60SIAL	20				
06227302	OXHI 20	J97MOSS	20			10257408	STPU 20	K61ARTE	20				
06227302	OXHI 20	J98MOSS	20			10257408	STPU 20	K62NULL	0				
06227302	OXHI 20	J99MOSS	20			10257408	STPU 20	K63BRTE	3SIAL	18			
06227302	OXHI 20	J100MOSS	20			10257408	STPU 20	K64NULL	0				
06137410	ELNI 20	K1NULL	0			10257408	STPU 20	K65SIAL	19ARTH	1			
06137410	ELNI 20	K2SPHA	3ENIG	3MOSS	4DEPI 3ARTH 9UNKF 2	10257408	STPU 20	K66SIAL	20				
06137410	ELNI 20	K3NULL	0			10257408	STPU 20	K67SIAL	20				
06137404	OXHI 20	K10NULL	0			10287408	STPU 20	K68ARTR	20				
06257408	COSE 20	K12SIAL	8SEED	5BRTE	9LILY 2ARTH 2	10287408	STPU 20	K69SIAL	14BRTE	7			
06257408	COSE 20	K13UNKP	20BRTE	4SEED	1	10267408	STPU 20	K70SIAL	20				
06257408	COSE 20	K14SIAL	20UNKS	1		10267408	STPU 20	K71SIAL	20				
03297403	COSE 20	K15NULL	0			10287408	STPU 20	K72SIAL	20				
08137409	COSE 20	K16BRTE	20COMP	2		10287408	STPU 20	K73SIAL	20				
08137409	COSE 20	K17BRTE	40COMP	20		10287408	STPU 20	K74SIAL	20				

07317301	COSE 20	G66ARTR	3CHLE	15MOSS	6	10GRSP	2SAVE	2	06227302	ELHI 20	H33ERFI	3BRTE	8ARTH	7EULA	4MOSS	1	
07317301	COSE 20	G67ARTR	4CHLE	4MOSS	15	3	28RTE	5	06227302	ELHI 20	H34BRTE	6EULA	6SEED	6MOSS	6		
07317301	COSE 20	G68CHLE	1MOSS	15	3	28RTE	2	2	06227302	ELHI 20	H35ARTH	2UNKG	1EULA	19SAKA	4MOSS	1	
07317301	COSE 20	G69CHLE	3MOSS	15BRTE	3	28RTE	2	2	07167302	ELGR 20	H36ARTR	20					
07317301	COSE 20	G70ARTR	2CHLE	14MOSS	2GRSP	2COMP	2	2	07167302	ELGR 20	H37ARTR	1EULA	12DEPI	3GRSF	3ARTH	1	
07317301	COSE 20	G71CHLE	15MOSS	4GRSP	2COMP	1			06227302	ELGR 20	H38ARTR	2EULA	7MOSS	6ARTH	5		
07317301	COSE 20	G72CHLE	2MOSS	16GRSP	1				06227302	ELGR 20	H39ARTR	2BRTE	4DEPI	6EULA	1MOSS	7	
07317301	COSE 20	G73CHLE	18MOSS	2					06227302	OXHI 20	H40BRTE	2MOSS	20				
07317301	COSE 20	G74CHLE	2MOSS	17COMP	1				07067302	ELGR 20	H41BRTE	6MOSS	16				
07317301	COSE 20	G75SEED	2MOSS	12CHLE	6				07067302	ELGR 20	H42BRTE	3MOSS	1EULA	15ARTH	3		
07317301	COSE 20	G76CHLE	14MOSS	3SAKA	3				07067302	ELGR 20	H43MOSS	20					
07317301	COSE 20	G77CHLE	10MOSS	10	5				07067302	ELGR 20	H44SEED	5MOSS	15				
07317301	COSE 20	G78CHLE	13MOSS	5BRTE	1GRSP	1			07067302	ELGR 20	H45MOSS	18EULA	1ARTH	1			
07317301	COSE 20	G79CHLE	14MOSS	5DEPI	1LICK	1SPHA	1		06207302	ELGR 20	H46BRTE	12EULA	9MOSS	3			
07317301	COSE 20	G80CHLE	14MOSS	5ARTR	1LICK	1			06207302	ELGR 20	H47BRTE	7EULA	2MOSS	3LICH	4		
07317301	COSE 20	G81MOSS	6CHLE	14BRTE	1SAKA	1			06207302	ELGR 20	H48BRTE	3EULA	15LICH	1UNKF	4ARTH	1	
07317301	COSE 20	G82MOSS	3CHLE	17					06207302	ELGR 20	H49BRTE	2MOSS	7				
07317301	COSE 20	G83MOSS	2CHLE	12					06147302	ELGR 20	H50EULA	3UNKP	20SAKA	20ARTP	1UNKG	1	
07317301	COSE 20	G84MOSS	3CHLE	17					06147302	ELGR 20	H51ARTH	6SEED	1SAKA	3BRTE	13CRAT	1	
07317301	COSE 20	G85MOSS	11CHLE	12					06147302	ELGR 20	H52ARTH	15SAKA	20CRAT				
07317301	COSE 20	G86MOSS	2CHLE	16SAKA	2BRTE	1			06147302	ELGR 20	H53SEED	15SAKA	20CRAT				
07317301	COSE 20	G87CHLE	20						06147302	ELGR 20	H54ARTH	13BRTE	12CRAT				
07317301	COSE 20	G88MOSS	6CHLE	15GRSP	7				06147302	ELGR 20	H55LAKP	20SAKA	14ARTH	18RTE	5CPH	1	
07317301	COSE 20	G89CHLE	15GRSP	7					06147302	ELNI 20	H56CRAT	20MOSS	1				
07317301	COSE 20	G90UNKP	2CHLE	6SAKA	7				06147302	ELNI 20	H57MOSS	18RTE	1DEPI	20UNKF	1ARTH	35SAKA	2
07317301	COSE 20	G91BRTE	10CHLE	6GRSP	2SAKA	1MOSS	1		06147302	ELNI 20	H58CRAT	20					
07317301	COSE 20	G92CHLE	10CHLE	6GRSP	2SAKA	1MOSS	3		06147302	ELNI 20	H59SEED	1ARTH	20				
07317301	COSE 20	G93CHLE	10CHLE	6GRSP	2SAKA	1MOSS	3		06147302	ELNI 20	H60CRAT	1ARTH	20				
07317301	COSE 20	H20ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H61ARTH	5SAKA	3UNKG	20SEED	5MOSS	3SEED	3
07317301	COSE 20	H21ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H62ARTH	5SAKA	8BRTE	20SEED	5MOSS	9SEED	1
07317301	COSE 20	H22ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H63ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H23ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H64ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H24ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H65ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H25ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H66ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H26ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H67ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H27ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H68ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H28ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H69ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H29ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H70ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H30ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H71ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H31ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H72ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H32ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H73ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H33ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H74ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H34ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H75ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H35ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H76ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H36ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H77ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H37ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H78ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H38ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H79ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H39ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H80ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H40ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H81ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H41ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H82ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H42ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H83ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H43ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H84ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H44ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H85ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H45ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H86ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H46ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H87ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H47ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H88ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H48ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H89ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H49ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H90ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H50ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H91ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H51ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H92ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H52ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H93ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H53ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H94ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H54ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H95ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H55ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H96ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H56ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H97ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H57ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H98ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H58ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H99ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H59ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H00ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H60ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H01ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H61ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H02ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H62ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H03ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H63ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H04ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H64ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H05ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H65ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H06ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H66ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H07ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H67ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H08ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H68ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H09ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H69ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H10ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H70ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H11ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H71ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H12ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H72ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H13ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H73ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H14ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H74ARTR	11MOSS	3ARTH	20RTE	4CHHP	1EULA		06147302	ELHI 20	H15ARTH	5SAKA	10CRAT	10MOSS			
07317301	COSE 20	H75ARTR															

06207302	GXHI 20	H100NULL 0
10257403	COSE 20	110CHLE 4ARTH 1DEPI 4UNKF 8
10257403	COSE 20	12ARTH 20
10257403	COSE 20	13MOSS 3ARTH 20CHLE 9ARTH 3
10257403	COSE 20	14UNKF 20
08137408	COSE 20	15SIAL 20
08137408	COSE 20	16SIAL 20
08137408	COSE 20	17SIAL 20
08137408	COSE 20	18SIAL 20BRTE 1
08137408	COSE 20	19SIAL 19ARTH 1
08137408	COSE 20	110SIAL 20
08137408	COSE 20	111ARTH 20
08137408	COSE 20	112SIAL 16BRTE 4
08137408	COSE 20	113SIAL 20
08137408	COSE 20	114SIAL 20
08137408	COSE 20	115ARTH 20
08137408	COSE 20	116SIAL 20
08137408	COSE 20	117TRDU 15UNKF 20UNKG 1
08137408	COSE 20	118TRDU 10BRTE 10
08137408	COSE 20	119SIAL 15BRTE 5
08137408	COSE 20	120SIAL 20
08137408	COSE 20	121SIAL 15BRTE 5
08137408	COSE 20	122NULL 0
08137408	COSE 20	123SIAL 20
08137408	COSE 20	124SIAL 20BRTE 2
08137408	COSE 20	125NULL 0
08137408	COSE 20	126PRTE 8SIAL 16
08137408	COSE 20	127SIAL 20
09107410	COSE 20	128ARTH 20
09107410	COSE 20	131ARTH 16ARTH 2
09107410	COSE 20	132ARTH 12DEPI 8
09107410	COSE 20	133ARTH 20
09107410	COSE 20	134ARTH 1GRSP 18DEPI 3
08137303	COSE 20	135ARTH 5CHLE 15
08137303	COSE 20	136NULL 0
08137303	COSE 20	137NULL 0
08137303	COSE 20	138ARTH 1ENCO 14ARTH 3GRSP 1MOSS 2SPHA 1
08137303	COSE 20	139CHLE 16
08137303	COSE 20	140PMI 2ENCO 4DEPI 19
08137303	COSE 20	141ENCO 10CHLE 10ARTH 2
08137303	COSE 20	142DEPI 12CHLE 8
08027410	COSE 20	143NULL 0
10257410	COSE 20	145BRTE 16ARTH 4
07087410	COSE 20	146NULL 0
07087410	COSE 20	149ARTH 20
07087410	COSE 20	150SAVE 4SEED 2ARTH 7UNKF 10BRTE 1
07087410	COSE 20	151ARTH 20
07087410	COSE 20	152NULL 0
07087410	COSE 20	153ARTH 20
07087410	COSE 20	154NULL 0
07087410	COSE 20	155ARTH 20
07087410	COSE 20	156DEPI 20
07087410	COSE 20	157NULL 0
08027407	EUMU 20	158ARTH 20
08027410	ELNI 20	159NULL 0
08027410	ELNI 20	160CHLE 20
09107407	ELHI 20	183DEPI 6ARTH 8BRTE 4ARTH 4

09107410	ELHI 20	184EULA 18ARTH 1GRSP 1
08027410	ELHI 20	185EULA 13ARTH 7GRSP 1
08027410	ELHI 20	186SPHA 20
08027410	ELHI 20	187SPHA 3GRSP 14DEPI 2ARTH 2
10257410	ELHU 20	188ARTH 20
10257410	ELHU 20	189GRSP 7ARTH 14
09107410	ELHU 20	190ARTH 20
09107410	ELHU 20	191ARTH 20
09107407	ELHU 20	192ARTH 20ARTH 5
10257406	ELHU 20	193ARTH 20
10197302	ELNI 20	194EULA 7POSE 4SEED 7ARTH 2BRTE 1
10197302	ELNI 20	195EULA 18HESP 2POSE 2
10197302	ELNI 20	196EULA 19HESP 3
10197302	ELNI 20	197EULA 15BRTE 5
10197302	ELNI 20	198EULA 13EULA 8BRTE 5
10197302	ELNI 20	199EULA 20
07307304	ELHI 20	200UNKF 6MOSS 6SEED 2SAVE 4POSE 2
10197404	COSE 20	201DEPI 20FOU 1
10197403	COSE 20	202NULL 0
10197302	ELHI 20	203EULA 20
10197302	ELHI 20	204MOSS 7EULA 11HESP 5
10197302	ELHI 20	205EULA 10ARTH 10
10197403	PHDE 20	206GRSP 20
10197403	PHDE 20	207GRSP 13MOSS 2
10197403	PHDE 20	208GRSP 13MOSS 2
10197403	PHDE 20	209GRSP 20
10197302	PHDE 20	210HESP 6BRTE 4EULA 8MOSS 2
10197302	PHDE 20	211MOSS 8HESP 6EULA 6DEPI 6
10197302	PHDE 20	212HESP 16EULA 4
10197302	PHDE 20	213MOSS 17HESP 1EULA 2
10197302	PHDE 20	214UNKF 6HESP 12EULA 2
10197302	PHDE 20	215MOSS 17HESP 6EULA 1
10197302	PHDE 20	216HESP 13UNKF 7EULA 2MOSS 1
10197302	PHDE 20	217HESP 16EULA 2DEPI 1MOSS 2
10197302	PHDE 20	218MOSS 6HESP 1EULA 10DEPI 4BRTE 5
10197302	PHDE 20	219UNKF 6EULA 19HESP 1MOSS 1
10197302	PHDE 20	220MOSS 14HESP 9DEPI 1EULA 2
10197302	PHDE 20	221MOSS 10HESP 10
10197302	PHDE 20	222MOSS 7HESP 10EULA 4
10197302	PHDE 20	223DEPI 4MOSS 6EULA 9ARTH 1HESP 6
10197302	PHDE 20	224EULA 8HESP 6SEED 1MOSS 7UNKF 1
10197302	PHDE 20	225MOSS 7HESP 11EULA 1ARTH 2DEPI 1
10197302	PHDE 20	226HESP 11MOSS 8EULA 3
10197302	PHDE 20	227EULA 18SEED 1MOSS 2BRTE 1HESP 1ARTH 1
10197304	PHDE 20	228 6BRTE 6MOSS 9SAVE 3DEPI 2
10197304	PHDE 20	229MOSS 13DEPI 5BRTE 9
10197304	PHDE 20	230DEPI 19MOSS 4BRTE 3
10197304	PHDE 20	231MOSS 11DEPI 1BRTE 3SAVE 5SEED 1
10197304	PHDE 20	232MOSS 8BRTE 7DEPI 2SAVE 4ARTH 1
10197304	PHDE 20	233MOSS 6BRTE 5SAVE 7DEPI 4SIAL 3
10197304	PHDE 20	234BRTE 11MOSS 4SAVE 9
10197304	PHDE 20	235MOSS 14SAVE 9DEPI 5BRTE 1
10197304	PHDE 20	236DEPI 3SAVE 11MOSS 14BRTE 4
10197304	PHDE 20	237MOSS 11BRTE 5SAVE 5
10197304	PHDE 20	238MOSS 10BRTE 3DEPI 4SAVE 5
10197304	PHDE 20	239MOSS 9SAVE 14DEPI 12BRTE 3
10197304	PHDE 20	240MOSS 6SAVE 16BRTE 6DEPI 1

011074A8	PHDE	20	M18ARTR	20															
011074A8	PHDE	20	M19DEPI	6ARTR	4FRAC	12AGSP	1												
011074A8	PHDE	20	M20DEPI	20SAKA	1														
011074A8	PHDE	20	M21ARTR	18BRTE	2														
011074A8	PHDE	20	M22DEPI	20															
053075A3	CONE	20	M23STTH	20ARTH	2														
053075A3	CONE	20	M24STTH	20															
053075A3	CONE	20	M25BRTE	20															
053075A3	CONE	20	M26PSLA	14ARTH	2SIAL	2UNKF	2												
053075A3	CONE	20	M27BRTE	16ARTH	4														
052875A6	ELGR	20	M28BRTE	7ARTH	7AGSP	3MOSS	7												
052875A6	ELGR	20	M29MOSS	4BRTE	8ARTH	4ASTR	2SIAL	2SAVE	2										
052875A6	ELGR	20	M30MOSS	8UNKG	2SAKA	2DRVE	3SEED	8											
052875A6	ELGR	20	M31DEPI	4UNKF	4MOSS	10STTH	2ARTR	2											
041075A2	PHDE	20	M32SIAL	19COMP	2														
041075A2	PHDE	20	M33SIAL	20															
041075A2	PHDE	20	M34SIAL	18DEPI	2														
062474A6	ELGR	20	M35MOSS	20ARTR	1														
062474A6	ELGR	20	M37UNKF	20															
062474A6	ELGR	20	M38BRTE	2LICH	17MOSS	7													
103074A9	ELHI	20	M39ARTR	19UNKP	1														
103074A9	ELHI	20	M40DEPI	20SIAL	7STTH	2													
052975A4	ELNO	20	M41ARTR	5STTH	15														
052975A4	ELNO	20	M42SIAL	4UNKG	3CHNA	6ARTH	1UNKF	3BRTE	5										
041074A9	PHDE	20	M43HESP	16DEPI	6SEED	2													
052975A4	ELNO	20	M45CAMA	4DEPI	16														
052975A4	ELNO	20	M47UNKG	15ARTR	5														
062474A7	ELHI	20	M48RTE	8ARTH	12SEED	2													
062474A7	ELHI	20	M50ARTH	16ARTR	8														
062775A5	EUMU	20	M51ARTR	6CHNA	15DEPI	1STTH	1												
062775A5	EUMU	20	M52ARTR	18SIAL	5ERFI	8STTH	1												
062775A5	EUMU	20	M53ARTR	18SIAL	5BRTE	4STTH	3												
052975A5	EUMU	20	M54ARTR	14MOSS	2BRTE	8													
052975A5	EUMU	20	M55ARTR	7BRTE	6SEED	7													
052975A5	EUMU	20	M57CHNA	12ARTR	12UNKG	4													
052975A5	EUMU	20	M58ARTR	5BRTE	5UNKG	15CHNA	5												
093074A9	PHDE	20	M59UNKF	17DEPI	3														
093074A9	PHDE	20	M60UNKF	8UNKF	3SEED	1DEPI	13ARTR	1											
093074A5	PHDE	20	M61DEPI	18ARTR	1SIAL	1SAKA	2												
093074A5	PHDE	20	M62DEPI	9ARTR	2SIAL	16SAKA	1												
093074A5	PHDE	20	M63ARTR	1SIAL	18SAKA	3													
093074A5	PHDE	20	M64SIAL	20															
093074A5	PHDE	20	M65SIAL	20UNKG	2														
062474A8	PHDE	20	M66ARTR	19UNKF	1														
062474A8	PHDE	20	M67DEPI	2ARTR	19STTH	2													
053075A3	EUMU	20	M68CHNA	8STTH	16														
053075A3	EUMU	20	M69CHVI	20															
053075A3	EUMU	20	M70CHNA	12STTH	13BRTE	1													
053075A3	EUMU	20	M71ARTR	2STTH	18COMP	1													

Appendix D

Diets of Darkling Beetle Species in Specific Plant Communities

TABLE D.1. Plant Taxa and Frequency of Ingestion by
Coniontis setosa at the Sagebrush/Poa
 (Control) Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
FORBS	
<u>Descurainia pinnata</u>	23
Unknown forb	2
SHRUBS	
<u>Artemisia tridentata</u>	60
<u>Atriplex spinosa</u>	14
MISCELLANEOUS	
Arthropod parts	2

N = 6 slides, 120 observed fields.

TABLE D.2. Plant Taxa and Frequency of Ingestion by
Coniontis setosa at the Lower Old Field
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	9
Unknown grass	<1
FORBS	
<u>Sisymbrium altissium</u>	65
<u>Tragopogon dubius</u>	5
Liliaceae	<1
SHRUBS	
<u>Artemisia tridentata</u>	8
MISCELLANEOUS	
Arthropod parts	4
Seed	1
Pollen	8

N = 26 slides, 520 observed fields.

TABLE D.3. Plant Taxa and Frequency of Ingestion by
Coniontis setosa at the Greasewood
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	9
<u>Poa cusickii</u>	1
FORBS	
<u>Descurainia pinnata</u>	34
SHRUBS	
<u>Artemisia tridentata</u>	2
<u>Chrysothamnus nauseosus</u>	37
<u>Sarcobatus vermiculatus</u>	18

N = 8 slides, 160 observed fields.

TABLE D.4. Plant Taxa and Frequency of Ingestion by
Coniontis setosa at the Hopsage
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	3
FORBS	
<u>Chenopodium leptophyllum</u>	37
<u>Descurainia pinnata</u>	9
<u>Polemonium micranthum</u>	<1
<u>Salsola kali</u>	6
<u>Sphaeralcea munroana</u>	<1
Compositae	1
Unknown forb	7
SHRUBS	
<u>Artemisia tridentata</u>	7
<u>Atriplex spinosa</u>	2
MISCELLANEOUS	
Arthropod parts	6
Cryptogams	16
Pollen	5

N = 22 slides, 440 observed fields.

TABLE D.5. Plant Taxa and Frequency of Ingestion by
Coniontis setosa at the IBP
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	3
Unknown grass	5
FORBS	
<u>Chenopodium leptophyllum</u>	42
<u>Descurainia pinnata</u>	4
<u>Salsola kali</u>	1
<u>Sphaeralcea munroana</u>	<1
Compositae	1
SHRUBS	
<u>Artemisia tridentata</u>	8
<u>Atriplex spinosa</u>	2
<u>Sarcobatus vermiculatus</u>	<1
MISCELLANEOUS	
Cryptogams	33
Seed	1

N = 23 slides, 1160 observed fields.

TABLE D.6. Plant Taxa and Frequency of Ingestion by Eusattus
muricatus at the B-C Crib
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	2
Unknown grass	<1
FORBS	
<u>Amsinckia</u> sp.	2
<u>Balsamorhiza</u> <u>careyana</u>	3
<u>Cryptantha</u> sp.	<1
<u>Descurainia</u> <u>pinnata</u>	27
<u>Polemonium</u> <u>micranthum</u>	1
<u>Sphaeralcea</u> <u>munroana</u>	<1
Compositae	<1
Unknown forb	3
SHRUBS	
<u>Artemisia</u> <u>tridentata</u>	55
<u>Eurotia</u> <u>lanata</u>	<1
MISCELLANEOUS	
Arthropod parts	3
Cryptogams	4
Seeds	<1

N = 58 slides, 1160 observed fields.

TABLE D.7. Plant Taxa and Frequency of Ingestion by Conisattus nelsoni at the Manipulation Plot Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	13
<u>Stipa comata</u>	4
Unknown grass	<1
FORBS	
<u>Chenopodium leptophyllum</u>	2
<u>Descurainia pinnata</u>	41
<u>Draba verna</u>	1
<u>Sphaeralcea munroana</u>	2
Unknown forb	7
SHRUBS	
<u>Artemisia tridentata</u>	16
<u>Sarcobatus vermiculatus</u>	1
MISCELLANEOUS	
Arthropod parts	7
Cryptogams	4
Seed	<1
Pollen	1

N = 77 slides, 1540 observed fields.

TABLE D.8. Plant Taxa and Frequency of Ingestion by
Eleodes obscura at the Winterfat
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	34
FORBS	
<u>Crepis atrabarba</u>	23
<u>Salsola kali</u>	35
<u>Townsendia florifer</u>	<1
MISCELLANEOUS	
Anthropod parts	6
Cryptogams	1

N = 8 slides, 160 observed fields.

TABLE D.9. Plant Taxa and Frequency of Ingestion by
Eleodes humeralis at the Greasewood
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
SHRUBS	
<u>Artemisia tridentata</u>	14
<u>Chrysothamnus nauseosus</u>	86

N = 8 slides, 160 observed fields.

TABLE D.10. Plant Taxa and Frequency of Ingestion by
Eleodes nigrina at the Winterfat
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	8
<u>Festuca octoflora</u>	1
<u>Poa sandbergii</u>	2
FORBS	
<u>Castilleja</u> sp.	3
<u>Crepis atrabarba</u>	9
<u>Descurainia pinnata</u>	4
<u>Erysimum asperum</u>	<1
<u>Helianthus</u> sp.	1
<u>Salsola kali</u>	4
Unknown forb	2
SHRUBS	
<u>Artemisia tridentata</u>	7
<u>Eurotia lanata</u>	35
MISCELLANEOUS	
Arthropod parts	14
Cryptogams	9
Seed	

N = 19 slides, 380 observed fields.

TABLE D.11. Plant Taxa and Frequency of Ingestion by
Eleodes nigrina at the Greasewood
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	3
Unknown grass	2
FORBS	
<u>Antennaria dimorpha</u>	2
<u>Descurainia pinnata</u>	37
<u>Draba verna</u>	1
SHRUBS	
<u>Artemisia tridentata</u>	17
<u>Chrysothamnus nauseosus</u>	6
<u>Sarcobatus vermiculatus</u>	19
MISCELLANEOUS	
Arthropod parts	1
Cryptogams	13
Seed	<1

N = 16 slides, 320 observed fields.

TABLE D.12. Plant Taxa and Frequency of Ingestion by
Eleodes nigrina at the Manipulation
Plots Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
FORBS	
<u>Chenopodium leptophyllum</u>	29
<u>Descurainia pinnata</u>	2
<u>Sphaeralcea munroana</u>	33
Unknown forb	1
SHRUBS	
<u>Artemisia tridentata</u>	15
<u>Sarcobatus vermiculatus</u>	3
MISCELLANEOUS	
Arthropod parts	12
Cryptogams	6

N = 13 slides, 260 observed fields

TABLE D.13. Plant Taxa and Frequency of Ingestion by
Eleodes novoverrucula at the Hopsage
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	6
<u>Poa sandbergii</u>	1
Unknown grass	6
FORBS	
Descurainia pinnata	17
Unknown forb	2
SHRUBS	
<u>Artemisia tridentata</u>	27
<u>Chrysothamnus nauseosus</u>	8
<u>Sarcobatus vermiculatus</u>	3
MISCELLANEOUS	
Arthropod parts	2
Cryptogams	8
Pollen	21

N = 6 slides, 120 observed fields.

TABLE D.14. Plant Taxa and Frequency of Ingestion by
Eleodes novoverrucula at the Greasewood
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	3
Unknown grass	1
FORBS	
<u>Chenopodium leptophyllum</u>	3
<u>Descurainia pinnata</u>	1
<u>Salsola kali</u>	9
Compositae	<1
Unknown forb	1
SHRUBS	
<u>Artemisia tridentata</u>	2
<u>Atriplex spinosa</u>	11
<u>Eurotia lanata</u>	<1
MISCELLANEOUS	
Arthropod parts	6
Cryptogams	63

N = 16 slides, 320 observed fields

TABLE D.15. Plant Taxa and Frequency of Ingestion by
Eleodes novoverrucula at the Winterfat Site
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	8
Unknown grass	
FORBS	
<u>Cryptantha</u> sp.	2
<u>Descurainia pinnata</u>	1
<u>Townsendia florifer</u>	1
Compositae	1
SHRUBS	
<u>Artemisia tridentata</u>	20
<u>Chrysothamnus nauseosus</u>	7
<u>Eurotia lanata</u>	18
MISCELLANEOUS	
Arthropod parts	22
Cryptogams	12

N = 9 slides, 180 observed fields.

TABLE D.16. Plant Taxa and Frequency of Ingestion by
Oxygonodera hispidula at the Winterfat
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	1
FORBS	
<u>Salsola kali</u>	2
SHRUBS	
<u>Artemisia tridentata</u>	10
MISCELLANEOUS	
Arthropod parts	24
Cryptogams	63

N = 13 slides, 260 observed fields.

TABLE D.17. Plant Taxa and Frequency of Ingestion by
Oxygonodera hispidula at the Greasewood
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
Unknown grass	25
SHRUBS	
<u>Chrysothamnus nauseosus</u>	25
<u>Sarcobatus vermiculatus</u>	25
MISCELLANEOUS	
Cryptogams	25

N = 6 slides, 120 observed fields.

TABLE D.18. Plant Taxa and Frequency of Ingestion by
Oxygonodera hispidula at the Lower Snively
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus Tectorum</u>	33
FORBS	
<u>Helianthus</u> sp.	33
<u>Liliaceae</u>	33

N = 13 slides, 260 observed fields.

TABLE D.19. Plant Taxa and Frequency of Ingestion by
Stenomorpha puncticollis at the Upper Snively
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	38
<u>Poa cusickii</u>	1
FORBS	
<u>Descurainia pinnata</u>	1
<u>Draba verna</u>	12
SHRUBS	
<u>Artemisia tridentata</u>	11
<u>Chrysothamnus nauseosus</u>	2
<u>Sarcobatus vermiculatus</u>	<1
MISCELLANEOUS	
Cryptogams	35

N = 12 slides, 240 observed fields.

TABLE D.20. Plant Taxa and Frequency of Ingestion by
Stenomorpha puncticollis at the Lower Snively
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	4
<u>Poa cusickii</u>	4
FORBS	
<u>Sisymbrium altissimum</u>	83
SHRUBS	
<u>Artemisia tridentata</u>	10

N = 25 slides, 500 fields.

TABLE D.21. Plant Taxa and Frequency of Ingestion by
Stenomorpha puncticollis at the Greasewood
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	38
<u>Poa cusickii</u>	<1
Unknown grass	1
FORBS	
<u>Chenopodium leptophyllum</u>	1
<u>Descurainia pinnata</u>	8
<u>Draba verna</u>	<1
<u>Microsteris gracilis</u>	2
<u>Sisymbrium altissimum</u>	3
<u>Compositae</u>	<1
<u>Liliaceae</u>	<1
SHRUBS	
<u>Artemisia tridentata</u>	2
<u>Sarcobatus vermiculatus</u>	28
MISCELLANEOUS	
Arthropod parts	<1
Cryptogams	16
Seed	1

N = 52 slides, 1040 observed fields.

TABLE D.22. Plant Taxa and Frequency of Ingestion by Stenomorpha puncticollis at the Hopsage Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	8
<u>Poa cusickii</u>	1
FORBS	
<u>Chenopodium leptophyllum</u>	27
<u>Descurainia pinnata</u>	18
<u>Microsteris gracilis</u>	6
<u>Polemonium micranthum</u>	1
<u>Unknown forb</u>	1
SHRUBS	
<u>Artemisia tridentata</u>	<1
<u>Atriplex spinosa</u>	6
<u>Eurotia lanata</u>	1
MISCELLANEOUS	
<u>Cryptogams</u>	32

N = 12 slides, 240 observed fields.

TABLE D.23. Plant Taxa and Frequency of Ingestion by Stenomorpha puncticollis at the Winterfat Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	13
FORBS	
<u>Amsinckia</u> sp.	<1
<u>Astragalus</u> sp.	4
<u>Descurainia pinnata</u>	14
<u>Helianthus</u> sp.	4
SHRUBS	
<u>Eurotia lanata</u>	64
MISCELLANEOUS	
Cryptogams	1
Seed	<1

N = 22 slides, 440 observed fields.

TABLE D.24. Plant Taxa and Frequency of Ingestion by
Philolithus densicollis at the Winterfat
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	5
<u>Festuca octoflora</u>	<1
<u>Poa sandbergii</u>	8
<u>Stipa comata</u>	1
Unknown grass	1
FORBS	
<u>Ambrosia acanthicarpa</u>	3
<u>Amsinckia</u> sp.	4
<u>Descurainia pinnata</u>	4
<u>Erysimum asperum</u>	4
<u>Helianthus</u> sp.	11
<u>Sisymbrium altissimum</u>	<1
<u>Townsendia florifer</u>	2
SHRUBS	
<u>Artemisia tridentata</u>	5
<u>Eurotia lanata</u>	35
MISCELLANEOUS	
Arthropod parts	<1
Cryptogams	15
Hair	<1
Seed	<1
Pollen	1

N = 71 slides, 1420 observed fields.

TABLE D.25. Plant Taxa and Frequency of Ingestion by
Philolithus densicollis at the Hopsage
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
FORBS	
<u>Chenopodium leptophyllum</u>	5
<u>Descurainia pinnata</u>	38
<u>Cryptantha</u> sp.	1
<u>Polemonium micranthum</u>	6
<u>Liliaceae</u>	1
SHRUBS	
<u>Artemisia tridentata</u>	5
<u>Atriplex spinosa</u>	21
<u>Sarcobatus vermiculatus</u>	2
MISCELLANEOUS	
Cryptogams	22

N = 30 slides, 600 observed fields.

TABLE D.26. Plant Taxa and Frequency of Ingestion by
Philolithus densicollis at the Greasewood
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	16
<u>Poa cusickii</u>	<1
<u>Stipa thurberiana</u>	<1
Unknown grass	<1
FORBS	
<u>Descurainia pinnata</u>	9
<u>Draba verna</u>	3
<u>Helianthus</u> sp.	1
<u>Microsteris gracilis</u>	1
<u>Sisymbrium altissimum</u>	<1
<u>Liliaceae</u>	1
SHRUBS	
<u>Artemisia tridentata</u>	<1
<u>Sarcobatus vermiculatus</u>	29
MISCELLANEOUS	
Anthropod parts	1
Cryptogams	37
Seed	<1

N = 43 slides, 840 observed fields.

TABLE D.27. Plant Taxa and Frequency of Ingestion by
Philolithus densicollis at the B-C Crib
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
FORBS	
<u>Ambrosia acanthicarpa</u>	9
<u>Amsinckia sp.</u>	18
<u>Castilleja sp.</u>	7
<u>Descurainia pinnata</u>	34
<u>Polemonium micranthum</u>	<1
Unknown forb	<1
SHRUBS	
<u>Artemisia tridentata</u>	17
MISCELLANEOUS	
Arthropod parts	7
Cryptogams	7

N = 15 slides, 300 observed fields.

TABLE D.28. Plant Taxa and Frequency of Ingestion by
Philolithus densicollis at the Manipulation
Plots Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
FORBS	
<u>Chenopodium</u> sp.	1
<u>Descurainia</u> <u>pinnata</u>	39
<u>Cryptantha</u> sp.	9
<u>Salsola</u> <u>kali</u>	1
<u>Sphaeralcea</u> <u>munroana</u>	23
<u>Liliaceae</u>	1
SHRUBS	
<u>Artemisia</u> <u>tridentata</u>	12
MISCELLANEOUS	
Cryptogams	13

N = 9 slides, 180 observed fields.

TABLE D.29. Plant Taxa and Frequency of Ingestion by
Eleodes hispilabris at the Winterfat
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	10
<u>Poa sandbergii</u>	2
Unknown grass	3
FORBS	
<u>Chenopodium leptophyllum</u>	1
<u>Descurainia pinnata</u>	3
<u>Erigeron filifolius</u>	1
<u>Erysimum asperum</u>	3
<u>Helianthus</u> sp.	1
<u>Plantago patagonica</u>	<1
<u>Salsola kali</u>	3
<u>Liliaceae</u>	<1
SHRUBS	
<u>Artemisia tridentata</u>	3
<u>Chrysothamnus viscidiflorus</u>	1
<u>Eurotia lanata</u>	33
MISCELLANEOUS	
Arthropod parts	14
Cryptogams	13
Seed	6
Pollen	3

N = 28 slides, 560 observed fields.

TABLE D.30. Plant Taxa and Frequency of Ingestion by
Eleodes hispilabris at the Hospage
 Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
Unknown grass	1
FORBS	
<u>Chenopodium leptophyllum</u>	12
<u>Descurainia pinnata</u>	12
<u>Salsola kali</u>	9
Unknown forb	2
SHRUBS	
<u>Atriplex spinosa</u>	6
<u>Chrysothamnus nauseosus</u>	2
MISCELLANEOUS	
Arthropod parts	13
Cryptogams	16
Seed	14
Pollen	14

N = 21 slides, 420 observed fields.

TABLE D.31. Plant Taxa and Frequency of Ingestion by
Eleodes hispilabris at the Greasewood
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	7
<u>Poa sandbergii</u>	1
FORBS	
<u>Chenopodium</u> sp.	1
<u>Descurainia pinnata</u>	54
<u>Draba verna</u>	3
<u>Salsola kali</u>	5
SHRUBS	
<u>Artemisia tridentata</u>	<1
<u>Chrysothamnus nauseosus</u>	<1
<u>Sarcobatus vermiculatus</u>	4
MISCELLANEOUS	
Arthropod parts	8
Cryptogams	15
Seed	1
Pollen	2

N = 12 slides, 240 observed fields.

TABLE D.32. Plant Taxa and Frequency of Ingestion by Eleodes hispilabris at the Manipulation Plots Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
Unknown grass	1
FORBS	
<u>Chenopodium leptophyllum</u>	2
<u>Descurainia pinnata</u>	12
<u>Sphaeralcea munroana</u>	55
Unknown forb	2
SHRUBS	
<u>Artemisia tridentata</u>	7
<u>Atriplex spinosa</u>	3
<u>Eurotia lanata</u>	4
MISCELLANEOUS	
Arthropod parts	10
Cryptogams	3

N = 41 slides, 820 observed fields.

TABLE D.33. Plant Taxa and Frequency of Ingestion by
Eleodes hispilabris at the B-C Crib
Site on the Hanford Site

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	1
FORBS	
<u>Ambrosia acanthicarpa</u>	<1
<u>Amsinckia</u> sp.	1
<u>Castilleja</u> sp.	3
<u>Cryptantha</u> sp.	4
<u>Descurainia pinnata</u>	46
<u>Lomatium macrocarpum</u>	7
<u>Lupinus</u> sp.	<1
Unknown forb	1
SHRUBS	
<u>Artemisia tridentata</u>	7
MISCELLANEOUS	
Arthropod parts	28
Cryptogams	1

N = 15 slides, 300 observed fields.

TABLE D.34. Plant Taxa and Frequency of Ingestion by
Eleodes granulata at the Winterfat
Site on the Hanford Reservation

<u>Plant Taxon</u>	Consumption Frequency ()
GRASSES	
<u>Bromus tectorum</u>	17
<u>Poa cusickii</u>	1
<u>Stipa thurberiana</u>	<1
Unknown grass	<1
FORBS	
<u>Crepis atrabarba</u>	1
<u>Descurainia pinnata</u>	14
<u>Erysimum asperum</u>	4
<u>Salsola kali</u>	6
Unknown forb	<1
SHRUBS	
<u>Artemisia tridentata</u>	3
<u>Atriplex spinosa</u>	<1
<u>Eurotia lanata</u>	18
MISCELLANEOUS	
Arthropod parts	6
Cryptogams	23
Seed	1
Pollen	4

N = 44 slides, 880 observed fields.

TABLE D.35. Plant Taxa and Frequency of Ingestion by
Eleodes granulata at the IBP
 Site on the Hanford Reservation

<u>Plant Taxon</u>	<u>Consumption Frequency (%)</u>
GRASSES	
<u>Bromus tectorum</u>	17
<u>Poa cusickii</u>	2
<u>Poa sandbergii</u>	5
<u>Stipa thurberiana</u>	4
FORBS	
<u>Descurainia pinnata</u>	29
<u>Erysimum asperum</u>	7
<u>Phacelia linearis</u>	1
<u>Salsola kali</u>	1
SHRUBS	
<u>Artemisia tridentata</u>	5
<u>Chrysothamnus nauseosus</u>	3
<u>Eurotia lanata</u>	1
MISCELLANEOUS	
Arthropod parts	14
Cryptogams	12

N = 17 slides, 340 observed fields.

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