A faunal survey of the elateroidea of Montana
by Catherine Elaine Seibert

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Entomology
Montana State University

Abstract:
The beetle family Elateridae is a large and taxonomically difficult group of insects that includes many economically important species of cultivated crops. Elaterid larvae, or wireworms, have a history of damaging small grains in Montana. Although chemical seed treatments have controlled wireworm damage since the early 1950's, it is- highly probable that their availability will become limited, if not completely unavailable, in the near future. In that event, information about Montana's elaterid fauna, particularity which species are present and where, will be necessary for renewed research efforts directed at wireworm management.

A faunal survey of the superfamily Elateroidea, including the Elateridae and three closely related families, was undertaken to determine the species composition and distribution in Montana. Because elateroid larvae are difficult to collect and identify, the survey concentrated exclusively on adult beetles. This effort involved both the collection of Montana elateroids from the field and extensive borrowing of the same from museum sources.

Results from the survey identified one artematopid, 152 elaterid, six throscid, and seven eucnemid species from Montana. County distributions for each species were mapped. In addition, dichotomous keys, and taxonomic and biological information, were compiled for various taxa. Species of potential economic importance were also noted, along with their host plants.

Although the knowledge of the superfamily' has been improved significantly, it is not complete. It is concluded that the Elateroidea of Montana includes at least 166 species.

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Catherine Elaine Seibert

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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Date 28 July 1993

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LIST OF ABBREVIATIONS

1. CES - author's personal collection
2. CUIC - Cornell University Insect Collection
3. DLG - D. L. Gustafson's personal collection
4. F.I.T. - Flight intercept trap
5. GNP - Glacier National Park Insect Collection
6. GNPP - Glacier National Park - 1988 Red Bench Fire study
7. JGE - J. Gordon Edwards' personal collection
8. L. funnel - Lindgren funnel trap
9. MTEC - Montana State University Entomology Collection
10. NDSU - North Dakota State University Insect Collection
11. OSU - Oregon State University Entomological Museum
12. PES - P. E. Skelley's personal collection
13. SNOW - Snow Entomological Museum
14. USNM - National Museum of Natural History
15. uv light - ultraviolet light trap

ABSTRACT

The beetle family Elateridae is a large and taxonomically difficult group of insects that includes many economically important species of cultivated crops. Elaterid larvae, or wireworms, have a history of damaging small grains in Montana. Although chemical seed treatments have controlled wireworm damage since the early 1950's, it is highly probable that their availability will become limited, if not completely unavailable, in the near future. In that event, information about Montana's elaterid fauna, particularily which species are present and where, will be necessary for renewed research efforts directed at wireworm management.

A faunal survey of the superfamily Elateroidea, including the Elateridae and three closely related families, was undertaken to determine the species composition and distribution in Montana. Because elateroid larvae are difficult to collect and identify, the survey concentrated exclusively on adult beetles. This effort involved both the collection of Montana elateroids from the field and extensive borrowing of the same from museum sources.

Results from the survey identified one artematopid, 152 elaterid, six throscid, and seven eucnemid species from Montana. County distributions for each species were mapped. In addition, dichotomous keys, and taxonomic and biological information, were compiled for various taxa. Species of potential economic importance were also noted, along with their host plants.

Although the knowledge of the superfamily has been improved significantly, it is not complete. It is concluded that the Elateroidea of Montana includes at least 166 species.

INTRODUCTION

The beetle family Elateridae is a large, diverse, and taxonomically difficult group of insects which includes many economically important species of cultivated crops worldwide (Britton 1970, Keaster et al. 1988, Arnett 1990). Elaterid larvae, commonly known as wireworms, typically attack germinating seed or seedlings and have been reported as damaging wheat in Montana. Chemical treatment of seed has controlled wireworm damage since the early 1950's, but the future availability of the primary chemical, lindane, is uncertain. Without lindane, or a comparable and effective alternative, wireworm damage to cereal crops could again become widespread (Morrill 1983, 1984). Therefore, knowledge of the elaterid fauna present in the State will provide baseline information necessary for renewed research efforts directed at wireworm ecology and management.

The Elateridae is a family where no recent revision of the North American species is available and the identification of adults and larvae of many genera is quite difficult, if not impossible (Bousquet 1991). Taxonomic confusion associated with this group is in large part why there has never been a checklist of Montana elaterids. The short-lived adult and long-lived larval biology of these insects, in addition to the large size and low population density of the State, have also been limiting factors in compiling an accurate faunal picture.

Not surprisingly, few taxonomic works are available which contribute to the determination of Montana's elaterid fauna. Mank (1934) published a list of beetles of Glacier National Park which included twenty-two elaterids. Russell (1968) listed thirty-seven elateroid species as occurring west of the Continental Divide. Lastly, Lane (1941, 1965, 1971) recorded sixteen mostly western species from the State. A few Montana specimens were recorded in taxonomic studies by LeConte (1861a, 1866), Horn (1871, 1891), Blanchard (1889), Van Dyke (1932), Fall (1934), Brown (1935a,b), Glen (1950), Arnett (1952), Becker (1956a, 1974), Quate and Thompson (1967), Lanchester (1971), Stibick (1976b, 1991), Ramberg (1979), and Wells (1989, 1991). All records, excluding recent papers by Wells, summed to only seventy species (see APPENDIX B). From a regional perspective this figure appeared low in comparison to 131 species known in British Columbia, excluding Vancouver Island (Lane 1952), and at least 113 in Idaho (Scott 1985).

The aforementioned discrepancy suggested the known number, composition, and distribution of Montana Elateridae was woefully incomplete and in 1987 the author initiated a faunal survey of the Elateridae, and three closely related families, as part of Montana Agricultural Experiment Station project 101156. The objectives of the survey were to gather as much compositional and distributional information as possible on the elateroid species occurring in Montana. The intended results were to include as complete a species list as possible and dichotomous keys to species where possible, or to more inclusive taxonomic groupings, eg. genus or tribe.

The superfamily Elateroidea includes the Artematopidae, Elateridae (click beetles), Throscidae, and Eucnemidae (false click beetles). These four families were formerly associated within the Elateroidea by Lawrence (1982). Unlike the Elateridae, few if any members of the other families are economically important. They may however resemble elaterids, and because of this were included in the faunal survey.

Montana's elateroid fauna was determined from borrowed specimens, collected in Montana, and from bettle specimens collected from the field using a variety of sampling techniques. Although wireworms are commonly collected by bait trapping (Ward and Keaster 1977, Toba and Turner 1983, Kirfman et al. 1986, Bynum and Archer 1987), this study concentrated on the collection and identification of adults and therefore utilized other techniques.

Pitfall traps are known to collect elaterids (Doane 1961, 1977b; Brown and Keaster 1986) and are easy to construct, inexpensive, and inconspicuous. Lindgren funnel traps were designed to collect bark beetles (Lindgren 1983), but were also known to collect elateroids (M. A. Ivie, per. comm.). Flight intercept traps have also been used to capture both elaterids and eucnemids (Perry and Arias 1982). These traps, in addition to light and hand collecting, provided the majority of field-collected material.

The combination of borrowing specimens and collecting Montana click beetles yielded 6,105 elateroid specimens for examination. This material, in addition to compiled literature records, has greatly increased the present knowledge base of this State's elateroid number, composition, and distribution. At least 166 species of elateroid beetles are now known to inhabit the State (see APPENDIX B) and known distributions are presented for each (see APPENDIX F). In addition, dichotomous keys are presented for Montana 1) families and subfamilies of Elateroidea, 2) species within the Throscidae and Eucnemidae, and 3) species within the Pyrophorinae, Hypnoidinae, Elaterinae, and Melanotinae subfamilies of the Elateridae.

MATERIALS AND METHODS

Montana Elateroidea Material

Elateroid beetle specimens utilized in this faunal survey included material from three sources and, with few exceptions, material collected through 1991. The primary source of specimens was the Montana Entomology Collection (MTEC) at Montana State University, Bozeman, Montana. Secondary sources of Montana elateroid specimens came from other institutions, universities, or private collections and included specimens examined while visiting the United States National Museum, Washington, DC, in June, 1990, and specimens examined between 1990 and 1992 from the following sources: Catherine E. Seibert, Montana State University, (CES); Cornell University Insect Collection, Ithaca, New York (CUIC); Daniel L. Gustafson, Montana State University, (DLG); Glacier National Park Insect Collection, Glacier National Park, Montana (GNP); Michael A. Ivie, Glacier National Park Project, Montana State University, (GNPP); J. Gordon Edwards, San Jose State University, San Jose, California (JGE); North Dakota State University Insect Collection, Fargo, North Dakota, (NDSU); Oregon State University Entomological Museum, Corvallis, Oregon, (OSU); Paul E. Skelley, Florida State at Gainesville, Florida, (PES); Snow Entomological Museum, Lawrence, Kansas

(SNOW); and National Museum of Natural History, Washington, District of Columbia, (USNM).

The third source of adult elateroid material was generated through this survey's trapping efforts, conducted primarily between April 5 and November 3, 1988.

Trap Collection of Montana Elateroidea

The field collection of adult elateroids in this survey utilized three trapping methods, in addition to occasional hand and ultraviolet light collecting. Trapping methods included the use of pitfall, Lindgren funnel (L. funnel), and flight intercept (F.I.T.) traps.

Pitfall traps were constructed from plastic, two-liter soda bottles. The top one-third of each bottle was cut off and inserted upside down into the remaining lower portion after the latter was placed in a hole dug into the ground and filled with approximately one-half liter of preservative (see recipe below). A 6" square piece of 1/2" hardware cloth was placed over the set pitfall trap to exclude small rodents. Traps were typically placed beneath rocks or wood debris.

Eight- and sixteen-unit Lindgren funnel traps were hung from tree branches in forested or wooded locations. A lid-less, glass jar was placed inside each funnel trap's collecting receptacle to allow collection of insects into the liquid preservative.

Each flight intercept trap was constructed by stretching a 30" x 68" piece of olive-green mosquito netting between two wooden posts driven into the ground. A tent-like, rain roof was constructed of clear plastic and secured above the mosquito netting and wooden posts. Three aluminum roasting pans, each 16.5" x 12" x 2.5", were positioned next to each other, directly beneath the netting. Each pan was filled to approximately one-half full with liquid preservative.

Individual traps were checked every four to eight weeks and their insect-laden contents labeled and exchanged with fresh preservative composed of approximately one-third antifreeze (ethylene glycol) and two-thirds Kahle's solution as specified in Borror et al. (1989).

Trap residue materials were stored in glass jars until their contents could be sorted. Sorting of trap residues was performed using a Wild 3A dissecting microscope. Arthropod material from the trap residues was sorted to order and/or family, with most retained material being transferred to seventy percent ethanol in stoppered, glass vials for indefinite storage in the MTEC. Elateroid specimens sorted from trap residues were pinned, labeled, and identified to genus before being housed in the MTEC until further identification to species was accomplished.

Traps were placed in eleven Montana counties, at twenty-six different sites (see APPENDIX D, fig. 61) in the spring of 1988. They were set up between April 5 and June 18, and dismantled between July 20 and November 3, 1988. Forty-six pitfall, nineteen Lindgren funnel, and four flight intercept traps were used during the 1988 field season.

The specific sites where traps were positioned fell into four broad categories; forest (f), grassland (g), adjacent to or within a wheat field (w), and woodland located within grassland habitat (x). The majority of traps were located in riparian areas. Montana counties within which traps were set, trap site codes indicating number within county and type of habitat, site locations, number and kinds of traps used at each location, and corresponding collection dates are listed in APPENDIX E.

Elateroidea Identification and Data Analysis

Adult Elateroidea specimens were identified to species using dichotomous keys. This process occasionally involved the examination of internal organs of reproduction, or genitalia, usually of male specimens. When genitalia were examined, the dry, pinned specimens were first rehydrated in hot water. Male genitalia were removed from relaxed specimens with fine forceps and then, if necessary, cleared in lactic acid for twenty minutes to one hour.

Female genitalia were taken from relaxed specimens by first removing the entire abdomen. The soft tergites were then cut along the margins and lifted away to reveal the internal organs. These were removed using dull forceps and the reproductive organs were then separated from the other organs, principally digestive, with the latter being discarded. After examination, genitalia of both sexes were stored in polyethyene microvials containing glycerin. Each microvial was secured to the pin beneath the specimen whose genitalia it contained.

All adult elateroids identified to species were entered into a database file using the software program dBASE III Plus. Each databased specimen was provided with a determination label, produced using HPLABEL software (Darling and Plowright 1990), which stated the species name under which they were entered into the database and the corresponding date. The database file was used for each species to summarize 1) material examined, 2) elevation records, 3) percentage of total specimens collected by each method, and 4) collection dates. A collection date within parentheses represents the endpoint date of a trapped specimen, where the actual day of collection is unknown. All trapped specimens with a date of collection range greater than three months, and some additional specimens with ranges between two and three months, were not considered when the species collection dates were summarized.

SUPERFAMILY ELATEROIDEA

Introduction

The Elateroidea superfamily classification used here is based on Lawrence (1982) in which he included the following seven families; Artematopidae, Cerophytidae (rare click beetles), Elateridae (click beetles), Cebrionidae, Throscidae, Perothopidae, and Eucnemidae (false click beetles). Britton (1970) estimated the number of known Elateroidea in the world at 8,200 species.

The most characteristic elateroid features are the usually acute and produced posterior angles of the pronotum and the form of the prosternum which is prolonged posteriorly into a median process that is received into a groove on the mesosternum. The latter characteristic provides the specialized mechanism by which most elateroid members leap, or "click". This snapping response, sometimes referred to as elasis (Allen 1951), is used to startle predators or adjust body position and has been observed in elaterids, eucnemids, and throscids (Lawrence 1982, Lawrence and Newton 1982). In addition, elateroids usually possess five visible abdominal sternites and all are pentamerous (Arnett 1968).

The Elateroidea generally are found in riparian areas, have a long-lived larval/short-lived adult life cycle, and are mostly phytophagous. Predation has developed in some elateroids, particularly within the Elateridae (Crowson 1960, Lawrence and Newton 1982).

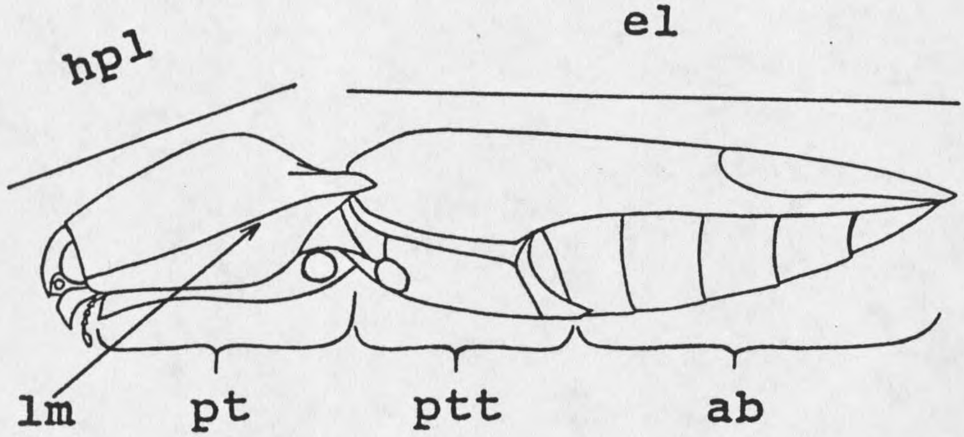
The Elateroidea of Montana includes the following four families; Artematopidae, Elateridae, Throscidae, and Eucnemidae (see APPENDIX A). Although all species that occur in the State are probably not known at present, the total number of Montana elateroid species is at least 166. A key is provided to all families of Elateroidea known to occur in Montana (see below).

Taxonomic Characters

A brief review of characters utilized in the taxonomy of the superfamily Elateroidea is provided here to facilitate the use of this paper's dichotomous keys. Abbreviations for morphological parts refer to figures 1 through 4.

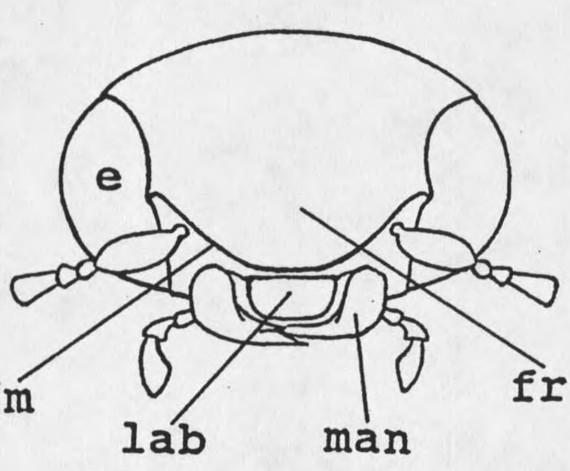
Adult beetle members of the Elateroidea share the following diagnostic morphological features; five-segmented tarsi (fig. 3, ts), five visible abdominal sternites (fig. 4, st), trilobed aedeagus (figs. 32, 33), elytra typically with nine or ten striae (fig. 3, str), pronotal angles prolonged posteriorly (fig. 3, ppa), and prosternum also prolonged posteriorly into a median process (fig. 4, ps) which is received in the mesosternum (fig. 4, ms).

The elateroid head (fig. 3, hd) is oval or flattened, with visible or concealed labrum (fig. 2, lab), generally with



1

bl = el + hpl



2

Figures 1-2. Fig. 1, lateral habitus, *Ampedus apicatus*. Fig. 2, head, cephalic view, *Megapenthes angularis*. ab, abdomen; bl, body length; e, eye; el, elytral length; fm, frontal margin; fr, frons; hpl, head and pronotal length; lab, labrum; lm, lateral margin; man, mandible; pt, prothorax; ptt, pterothorax.

well-developed mandibles (fig. 2, man), and antennae (fig. 3, an) various, arising on the frons (fig. 2, fr) near or between the eyes (fig. 2, e) and frequently inserting underneath a frontal margin (fig. 2, fm). Antennal segments are counted beginning basally.

The elateroid thorax is an important area taxonomically, both between families and between genera of Elateridae. The posterior angles (ppa) of the prothorax (fig. 1, pt) are typically carinate and the lateral margin (figs. 1, 4, lm) of the prothorax may or may not be complete. The hypomeron (fig. 4, h) extends medioventrally from the lateral margin (lm) to the prosternopleural suture (fig. 4, pps). The prosternum (fig. 4, p) is usually lobed anteriorly and positioned ventrally between the prosternopleural sutures (pps). The prosternal spine (figs. 4, 6, ps) is variable between families, broad and flat in throscids, usually narrow and tapering in elaterids.

Pronotal length (fig. 3, pl) and width (fig. 3, pw) are frequently measured for identification purposes and the presence, type, and arrangement of the setae and punctation, particularily that of the prothorax, are often utilized for determining species within the Elateridae.

The procoxa (figs. 1, 4, pc) and mesocoxa (figs. 1, 4, mc) of an artematopid have an exposed and visible trochantin (fig. 5, tr) while trochantins of other elateroids are highly reduced and concealed. The shape of the metacoxal plate