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A taxonomic study of the families of Utah coleoptera excluding rhynchophora

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A Taxonomic Study of the Families of Utah Coleoptera Excluding Rhynchophora

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A Thesis

Presented to the

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of the Requirements for the Degree of

Master of Arts

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by

T. Blaine Moore

January 2, 1957

This thesis by T. Blaine Moore is accepted in its present form by the Special Thesis Committee as satisfying the thesis requirements for the degree of Master of Arts.

Signed:

_____
(Committee Chairman)

_____
(Committee Member)

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INTRODUCTION

The order Coleoptera, represented in North America by more than twenty-six thousand species in one hundred nine families according to Sabrosky (1952), is by far the largest order of insects. The members of this large group are characterized by having a horny exoskeleton of chitin, corneous front wings or elytra, and membranous hind wings. They have strong chewing mouth parts and development is by complete metamorphosis.

Although extensive work has been done with the order Coleoptera, there still remains much more to do, especially in taxonomy. Such characters as genital structures, spermathecae and larval forms, along with the more commonly used external structures, will do much to clarify the phylogeny and taxonomy of Coleoptera.

Most Coleopterists seem to be unaware of the novice when they construct their keys and, as a result, beginning students get lost very easily among the complicated terms and indefinite statements so often used.

The purpose of this thesis, therefore, is to construct simplified keys to the families of Coleoptera of Utah. To do this the order will be broken up into sub-orders, series of superfamilies, superfamilies and families, with separate keys to all of these groups. No key will be large, thus reducing to a minimum any cumbersomeness, and the difficulty in using them will be minimized.

Of the one hundred nine families of beetles mentioned above, only sixty-nine of them are listed in this thesis as being represented in Utah. Several other families, most of which are tiny and inhabit ant nests,

mammal nests, fungi or decaying organic matter, may some day be found in the area. However, more extensive collecting and study is needed before a complete list of Utah families can be made with any great assurance.

ACKNOWLEDGMENTS

Inasmuch as a thesis is the result of the combined efforts of so many people who have rendered assistance in one way or another, appreciation is extended to those individuals and groups.

The author especially wishes to give thanks to Dr. Vasco M. Tanner, head of the Department of Zoology and Entomology of Brigham Young University, whose patience and understanding, along with his inspirational guidance, has made the completion of this thesis possible. Dr. Tanner gave freely of his time, as well as the use of his library and collections, to make possible the research in connection with this thesis. He also served as Special Thesis Committee Chairman.

Appreciation is also extended to Dr. Wilmer W. Tanner for the suggestions and help as the work progressed, and for his help as a member of the Special Thesis Committee. Thanks also to Dr. C. Lynn Hayward and Dr. Dorald Allred for their interest, along with the many helpful suggestions rendered the author.

And finally, to those authorities of Coleopterology whose previous works have contributed so much, I am very grateful.

DISCUSSION

In order to make workable keys to the families of Coleoptera, the first thing to consider is usable characteristics, i. e., those which are easiest to see and identify on the specimen. Due to the extremely small

size of the members of some families, this becomes very difficult. Therefore, positive identification of certain characters will be possible only by preparing specimens on slides for study under the compound microscope. The taxonomic characters used in this paper are listed below.

Tarsi:	Comparative sizes of segments, shape of segments, and number of tarsal joints.
Tibiae:	Tibial spurs.
Elytra:	Shape, portion of abdomen exposed or covered, pubescence, etc.
Head:	Comparative width with pronotum and base of elytra; position of head with reference to pronotum; whether or not it projects into a beak; formation of a neck behind the eyes.
Pronotum:	Shape and comparative size with head or base of elytra.
Eyes:	Comparative size, size of facets, and marginal shape.
Antennae:	Number of segments; forms of antennae, i. e., filiform, serrate, lamellate, flabellate, plumose or clubbed.
Abdominal tergite:	Number exposed behind elytra.
Abdominal sternites:	Number visible from beneath.
Coxal cavities:	Open or closed behind.
Coxae:	Shape, comparative size and proximation.
Hind wings:	Marginal hair in one or two families.
Gular suture:	Two separate in some, while in others they are fused as one.

Maxillary palpi:	Relative size and shape.
Pronotum and elytra:	The ways in which they join at base.
Scutellum:	Its presence, or apparent absence.
Epimeron:	Approximation to coxal cavities.

All of the above characters are in general use by Coleopterists in taxonomic studies. Those used were taken from Jaques (1951), Comstock (1949), Essig (1948), Edwards (1954), Borror and De Long (1954).

Tanner (1927) indicates that the majority of students treat the taxonomic and morphological study of insects as distinct and unrelated studies, as well as ends in themselves. This, he mentions, is an inadequate point of view and one not up to the standards advocated by Leconte and Horn in their "Classification of Coleoptera." Although the use of genital structures is of great importance in taxonomic work, they have not been considered here. The reason is that keys of the types used in this paper must have characters that are readily discernable to the beginner without mutilating the specimen. However, this cannot always be followed, for some specimens, due to their small size, have to be mounted on slides to be studied critically.

The classification of Comstock (1949) and Essig (1948), in which they have divided the sub-order Polyphaga into series of superfamilies, is used in this paper. However, their series Rhyncophora is given the rank of sub-order after Leeonte (1847), leaving only six to be considered here. Further divisions, to superfamilies, generally follow Leng (1920) and Boving and Craighead (1930). There are some variations from these publications and they will be discussed preceding the keys to the particular

groups affected by the changes made by the author.

LIST OF FAMILIES OF UTAH COLEOPTERA

In the present study sixty-nine families of Coleoptera are found to be present in Utah. Of these families, all but seven were found in the Coleoptera collection of Brigham Young University. The seven not found in the collection are, however, cited in the literature. They are as follows:

Scydmaenidae	Casey (1893)	Lycidae	Tanner (1927)
Corynetidae	Cott (1955)	Melasidae	Tanner (1927)
Byrrhidae	Tanner (1927)	Lathridiidae	Cott (1955)
Phalacridae	Cott (1955)		

Following is an alphabetical list of the families of Coleoptera found in Utah:

Alleculidae	Coccinelidae	Haliplidae
Amphizoidae	Colydiidae	Heteroceridae
Anobiidae	Corynetidae	Histeridae
Anthicidae	Cryptophagidae	Hydrophylidae
Bostrichidae	Cucujidae	Lampyridae
Buprestidae	Dermestidae	Lathridiidae
Byrrhidae	Dryopidae	Lucanidae
Cantharidae	Dytiscidae	Lycidae
Carabidae	Elateridae	Melandryidae
Cerambyscidae	Elmidae	Melasidae
Chrysomelidae	Erotylidae	Melyridae
Cicindelidae	Georyssidae	Meloidae
Cisidae	Geotrupidae	Monommidae
Cleridae	Gyrinidae	Monotomidae

Mordellidae	Pedilidae	Rhipiceridae
Mycetophagidae	Phalacridae	Rhipiphoridae
Mylabridae	Phengodidae	Scaphidiidae
Nitidulidae	Plastoceridae	Scarabaeidae
Oedemeridae	Platypsyllidae	Scydmaenidae
Omophronidae	Pselaphidae	Silphidae
Orthoperidae	Ptiliidae	Staphylinidae
Ostomidae	Ptinidae	Tenebrionidae
Othniidae	Pythidae	Trogidae

While the families listed above are definitely known to occur in Utah, it is interesting to note that several additional families are found in neighboring states. Since these groups are found in areas similar to many of our own localities, the possibility is great that one day it will be shown that some of them do occur here. Such families as Cephaloidae, Dascyllidae, Endomychidae and Sphindidae are, according to Wickham (1902), found in Colorado. Several other families are known to occur in states surrounding Utah. Following is a list of these families with states in which they are found (only those families found in two or more states are listed):

Cephaloidae	Idaho and Colorado
Clambidae	Arizona and Colorado
Clavigeridae	Arizona, Colorado and New Mexico
Dascillidae	Montana and Arizona
Endomychidae	Colorado, Nevada and New Mexico
Helodidae	Nevada, Arizona and New Mexico
Rhizophagidae	Nevada and Arizona
Throscidae	Nevada, Arizona and New Mexico

LIST OF ABBREVIATIONS

Following is a list of the abbreviations used in this thesis in connection with the drawings accompanying the keys:

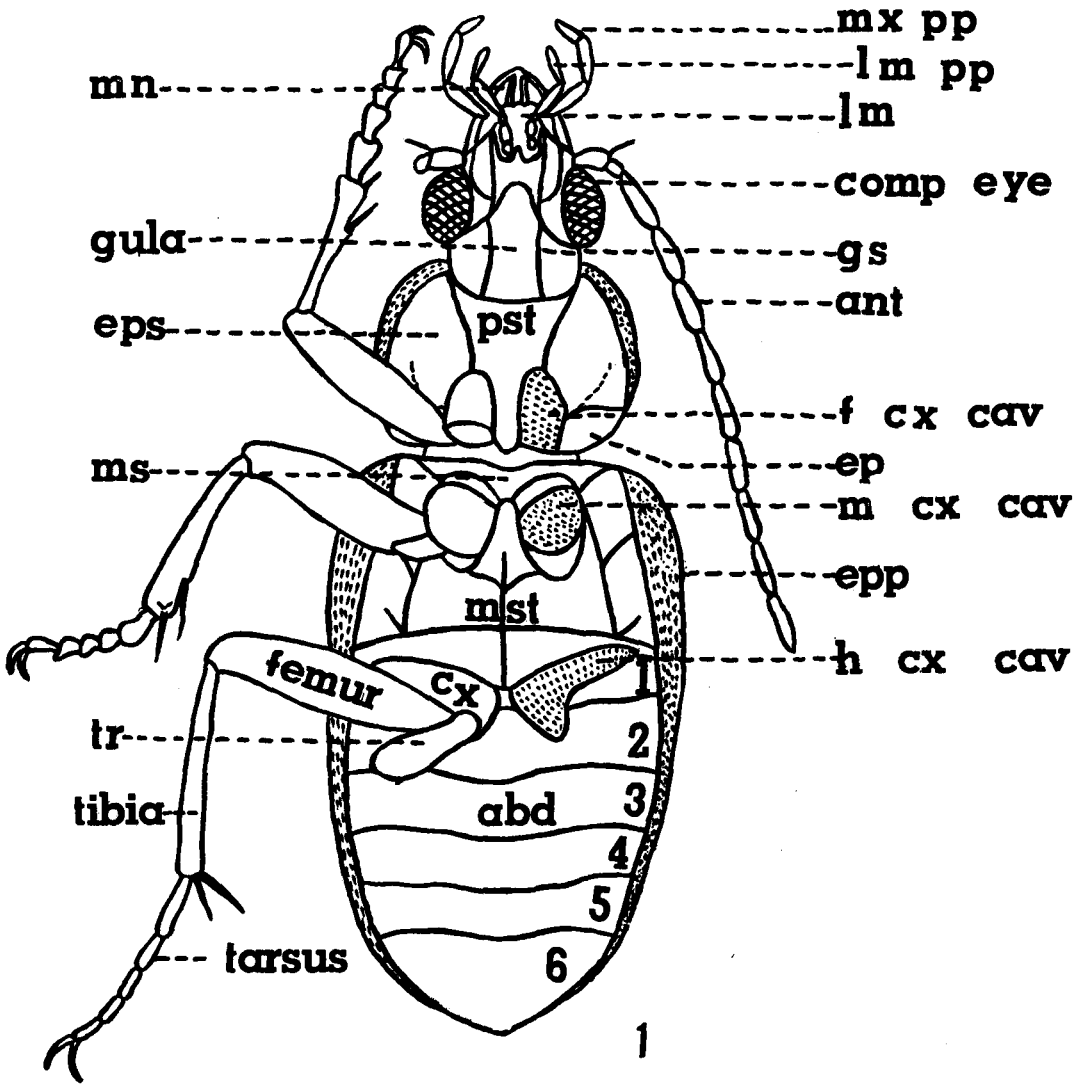
abd	abdomen	m	middle
ann	annulated	mn	mandible
ant	antennae	ms	mesosternum
cav	cavity	mst	metasternum
comp	compound	mx	maxilla
cx	coxa	pct	pectinate
el	elytra	pds	pads
ep	episternum	pm	plumose
epp	epipleura	pn	pronotum
eps	epimeron	pp	palpus
flb	flabellate	pst	prosternum
fm	femur	sct	scutellum
fr	femur	ser	serrate
gs	gular suture	sp	spine or spur
f	front	trs sut	transverse suture
h	hind	tr	trochanter
hd	head	1st seg	1st abdominal segment
lame	lamellate	2nd seg	2nd abdominal segment
lm	labium	3rd seg	3rd tarsal segment

EXPLANATION OF FIGURE I

Since the classification of Coleoptera in this thesis is based entirely upon external characters, a basic knowledge of these structures is essential. Figure 1 of this paper is a simple diagrammatic sketch of a typical beetle (Carabidae) showing the venter with most of the important parts labeled.

All insects have three main body regions; head, thorax and abdomen. In the order Coleoptera, however, the seemingly second division, or body region, is only a part of the thorax which is actually divided into three parts. The first section, or prothorax, is covered dorsally by a chitinous shield called a pronotum. The mesothorax and metathorax, which are the other two divisions of the thorax, are both covered, along with the abdomen, by the elytra, or outer horny first wings. These outer wings are hinged to the fore part of the middle segment, or mesothorax, and are held out at an angle while the beetle is in flight. The membranous hind wings, which are attached to the metathorax, are used for flight and are folded under the elytra when the insect is at rest.

The head, as seen from the ventral side, shows the compound eyes, antennae, labium, labial palpi, maxillary palpi and mandibles. The gular region with the two gular sutures are in evidence, identifying the species as representing Coleoptera Genuina. The compound eyes may be variously formed, some being completely divided as in Gyrinidae, while others are deeply notched by the base of the antennae. While many insects possess three ocelli in addition to the compound eyes, the presence of these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structures in beetles is rare.

Attached to the thorax are the three pairs of legs, each segment supporting one of the pairs. These legs are numbered from front to rear as one, two and three, or given the designation of the segment to which they are attached, i. e., mesothoracic leg, etc. Beginning from the proximal end of the leg the parts are: coxa, trochanter, femur, tibia and tarsus. The coxae fit into the coxal cavities as "ball and socket" joints. The femur is usually the largest and heaviest of the segments, and the tibia is quite long and slender. The tarsus, or foot, is composed of from three to five segments (sometimes fewer, or wanting), the last segment usually bearing two claws.

The abdomen is covered with nine or ten telescopic chitinous rings. Of these only five to eight of them are visible from the venter (sometimes fewer), the remainder being drawn within the tip of the body. The genitalia, which are prominent in most insects, are usually hidden in the beetles.

EXPLANATION OF DRAWINGS

Most of the drawings have been made by the author from specimens in the Brigham Young University collection. Those few which have been obtained from other sources will be indicated below in the list of drawings.

No.	Family	Genus and/or species
1	Carabidae	(From Jaques, page 3)
2	Elateridae	(From Jaques, page 12)
3	Carabidae	Carabus (From Jaques, page 10)
4	Curculionidae	(From Jaques, page 10)
5	Gyrinidae	Gyrinus consobrinus Lec.

7	Haliplidae	(From Jaques, page 13)
8	Cicindelidae	Cicindela (From Borror and De Long, page 308)
9	Cicindelidae	Cicindela montana Lec.
10	Omophronidae	Homophron tanneri proximum Chandler
11	Carabidae	Carabus sp.
12	Dytiscidae	Hydroporus sp.
13	Silphidae	Necrophorus marginatus Fab.
14	Hydrophylidae	Hydrous triangularis (Say)
15	Scarabaeidae	Polyphylla decemlineata (Say)
16	Lucanidae	Pseudolucanus mazama (Lec.)
17	Cerambyscidae	Rosalia funebris Mots.
18	Silphidae	Necrophorus marginatus Fab.
19	Histeridae	Saprinus fimbriatus Lec.
20	Ptiliidae	Not known
21	Ptiliidae	Not known
22	Histeridae	Saprinus fimbriatus Lec.
23	Histeridae	Saprinus fimbriatus Lec.
24	Scydmaenidae	(From Edwards, page 14)
25	Scaphidiidae	Scaphisoma castaneum Mots.
26	Silphidae	Necrophorus marginatus Fab.
27	Silphidae	Necrophorus marginatus Fab.
28	Silphidae	Silpha ramosa Say
29	Scarabaeidae	Polyphyla decemlineata (Say)
30	Lucanidae	Pseudolucanus mazama (Lec.)
31	Trogidae	Trox sonorae Lec.
32	Scarabaeidae	Canthon simplex var. convinus Fall

33	Cerambyscidae	Rosalia funebris Mots.
34	Mylabridae	Mylabris pisorum (L.)
35	Bostrichidae	Dendrobiella sericans (Lec.)
36	Anobiidae	Vrilletta expansa Lec.
37	Elateridae	Ludius sp.
38	Elateridae	Ludius sp.
39	Plastoceridae	Aplastus cylindricus Van Dyke
40	Cucujidae	Cucujus puniceus (Mann.)
41	Erotylidae	Languria convexicollis Horn
42	Tenebrionidae	(From Borror and De Long, page 304)
43	Meloidae	(From Borror and De Long, page 304)
44	Alleculidae	Hymenorus porosicornis Csy.
45	Tenebrionidae	Tenebrio obscurus Fab.
47	Tenebrionidae	Tenebrio obscurus Fab.
48	Tenebrionidae	Tenebrio obscurus Fab.
49	Melandryidae	Serropalpus barbatus (Schall.)
50	Melandryidae	Serropalpus barbatus (Schall.)
51	Meloidae	Epicauta ferruginea (Say)
52	Rhipiphoridae	Rhipiphora sp.
53	Rhipiphoridae	Rhipiphora sp.
54	Rhipiphoridae	Rhipiphora sp.
55	Mordellidae	Mordella sp.
56	Anthicidae	Notoxus bifasciatus Lec.
57	Meloidae	Epicauta ferruginea Say
58	Oedemeridae	Copidita obscura (Lec.)
59	Monommidae	Hyporhagus gilensis Horn
60	Phengodidae	Mastinocerus sp.

61	Phengodidae	Mastinocerus sp.
62	Phengodidae	Podabrus sp.
63	Lampyridae	Lucidota californica Mots.
64	Cantharidae	Chauliognathus basalis Lec.
65	Cleridae	Trichodes ornatus Say
66	Cleridae	Trichodes ornatus Say
67	Melyridae	Collops bipunctata Say
68	Corynetidae	Necrobia sp.
69	Melyridae	Collops bipunctata Say
70	Ptinidae	Ptinus fur Linne
71	Cisidae	Octotemnus dixiensis Tanner
72	Cisidae	Octotemnus dixiensis Tanner
73	Bostrichidae	Polycaon stouti (Lec.)
74	Bostrichidae	Dendrobiella sericans (Lec.)
75	Anobiidae	Vrilletta expansa Lec.
76	Elateridae	Ludius sp.
77	Elateridae	Ludius sp.
78	Buprestidae	Acmaeodera variegata Lec.
79	Buprestidae	Acmaeodera variegata Lec.
80	Buprestidae	Acmaeodera variegata Lec.
81	Plastoceridae	Aplastus cylindricus Van Dyke
82	Rhipiceridae	Sandalus californicus Lec.
83	Rhipiceridae	Sandalus californicus Lec.
84	Plastoceridae	Aplastus cylindricus Van Dyke
85	Plastoceridae	Aplastus cylindricus Van Dyke
86	Byrrhidae	Byrrhus (From Edwards, page 16)
87	Cryptophagidae	Cryptophagus sp.

88	Elmidae	Helmus sp.
89	Nitidulidae	Nitidula sp.
90	Coccinelidae	Hippodamia sp.
91	Orthoperidae	This species not determined to genus
92	Monotomidae	(From Edwards, page 10)
93	Heteroceridae	(From Edwards, page 30)
94	Heteroceridae	(From Edwards, page 30)
95	Ostomidae	Ostoma ferruginea (L.)
96	Nitidulidae	Nitidula sp.
97	Erotylidae	Languria convexicollis Horn
98	Phalacridae	Phalacrus sp.

EXPLANATION OF TERMS

The terms used in this thesis and not explained in the text will be defined here.

Emarginate . . . . With an obtuse, rounded or quadrate section cut from a margin.

Eruciform . . . . Like a caterpillar in form or appearance.

Phytophagus . . . . Feeding upon plants.

Pubescent . . . . Clothed with soft, short, fine, closely set hair.

Scutellum . . . . A triangular piece between and at the base of the elytra.

Series of superfamilies . . . . The sub-order Polyphaga is divided into six groups of closely related superfamilies called series.

Sternite . . . . The ventral piece in a ring or segment.

Tergite . . . . A dorsal sclerite or part of segment.

DESCRIPTION OF SUB-ORDERS

According to Leng (1920), most of the arguments relating to questions of phylogeny are necessarily matters of theory and deduction. The phylogenetic systems of Leconte, Sharp, Lameere and others seek to arrange the families and series of Coleoptera so that the more primitive beetles shall precede the more derivative. In such systems certain characters are assumed to indicate a stage in progressive modification of the Coleoptera, rather than a relationship.

The use of such characters as tarsi, wing veination, number of abdominal segments, etc. may cause conflicts to occur in grouping the various families, depending, of course, upon the values attached to the use of such characters as indices of phylogenetic rank.

In Leng's work he has treated the Rhyncophora as a series instead of a sub-order. His reason for doing so is vague to the author inasmuch as he has admitted at least three times that this group seems to be more nearly of sub-ordinal rank than even the best defined series of Polyformia, and also feels that Leconte's characters for this separation strongly support it.

All students of Coleoptera studied seem to be in agreement as to the isolation of Adephaga as a sub-order, and all characters, both internal and external, support this division. With the other groups, however, there seems to be much disagreement. Inasmuch as Leconte (1847) has such a good argument in his favor in separating Rhyncophora from Polyphaga, and because Leng and others cannot, with any degree of assurance, give reasons against

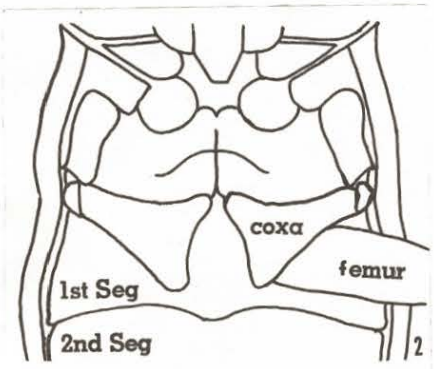
this grouping, in this paper the order Coleoptera will be divided into the three sub-orders listed in the key which follows.

KEY TO THE SUB-ORDERS OF COLEOPTERA

1. a. First abdominal sternite divided by the hind coxal cavities (fig. 1); all tarsi five-segmented; antennae filiform . . . . . ADEPHAGA . . . page 16

   b. First abdominal sternite not divided by the hind coxal cavities (fig. 2); tarsi and antennae variable 2

2. a. Front of head not prolonged into slender cylindrical snout or beak; gular sutures separate and distinct (fig. 3) . . . . . POLYPHAGA . .page 19



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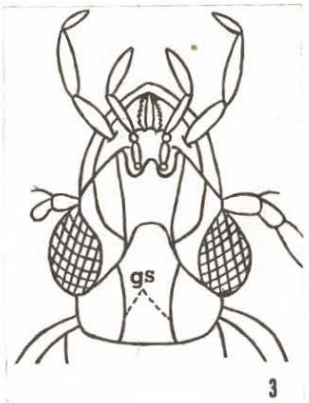

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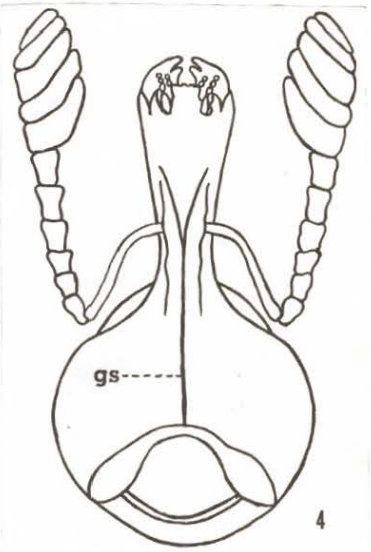

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   b. Front of head prolonged into slender snout or beak; gular sutures fused into one (fig. 4) or lacking . . . . . RHYNCOPHORA[1]

ADEPHAGA

Crowson (1955) places all of the families of the sub-order Adephaga into one superfamily, Caraboidea. According to his view, if any family is to be removed to constitute a separate superfamily, it should be that which first split off from the ancestral Adephagan stock rather than that which

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[1]This sub-order will not be keyed to its families in this paper.

he claims has achieved the most spectacular modifications in its later evolution.

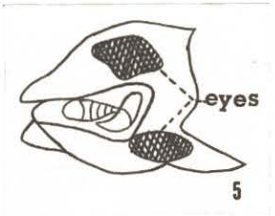
Although Crowson may have grounds for argument, the author will use the classification of Jeannel and Paulian (Bradley, 1947), Leng (1920), Boving and Craighead (1930), and group them into two superfamilies, Gyrinoidea and Caraboidea. These two superfamilies are readily separated by the presence of two pairs of compound eyes in Gyrinoidea.

The sub-order Adephaga is readily distinguished from other groups of Coleoptera by having the first abdominal sternite divided by the hind coxal cavities. The tarsi are all five-segmented and the antennae are filiform.

Following is a key to the superfamilies of the sub-order Adephaga:

KEY TO THE SUPERFAMILIES OF ADEPHAGA

1. a. Two pairs of compound eyes, one dorsal and one ventral (fig. 5); antennae short and stout (fig. 6); beetles often seen swimming rapidly in circles on the surface of water . . . . . GYRINOIDEA[2]



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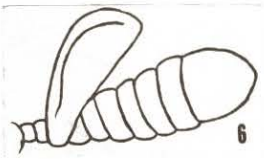
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b. Only one pair of compound eyes; antennae variable, usually long and slender, but never as in fig. 6 . . . . . CARABOIDEA . . page 17

CARABOIDEA

The families listed in this superfamily are placed here because

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[2]The superfamily Gyrinoidea contains only one family, Gyrinidae.

of the following characters: The first abdominal segment is divided by the hind coxal cavities. There is only one pair of compound eyes present, and the body shape is usually long and slender. All forms are predaceous and are usually found near or in the water. The antennae are almost always filiform.

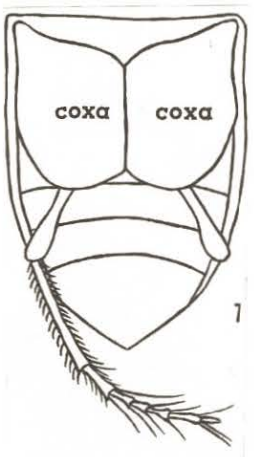
Following is a key to the six families of Caraboidea:

KEY TO THE FAMILIES OF CARABOIDEA

1. a. Hind coxae expanded into large plates which conceal much of the abdomen (fig. 7); antennae 10-segmented; small aquatic beetles, 4 mm. long or less . . . . . HALIPLIDAE

   b. Hind coxae not so expanded; antennae 11-segmented; size and shape variable 2

2. a. Metasternum with a transverse suture just in front of the hind coxae (fig. 8); terrestrial beetles 3



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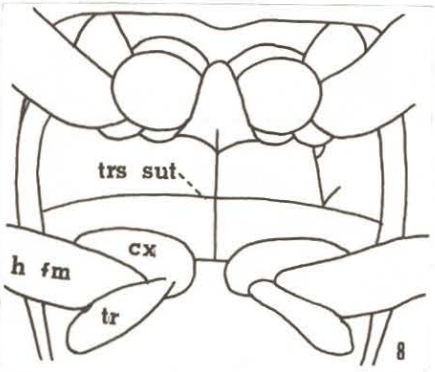

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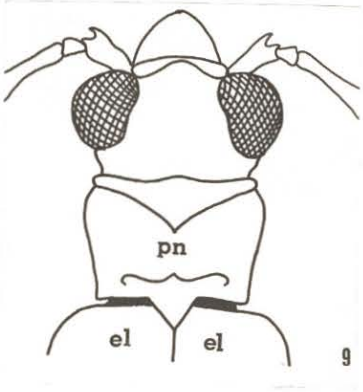

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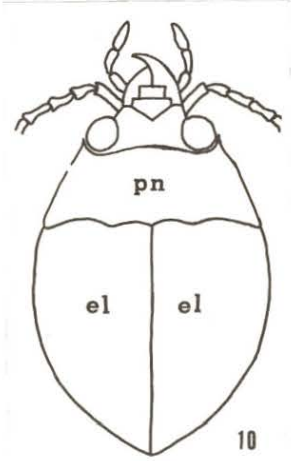
   b. Metasternum without a transverse suture in front of the hind coxae; aquatic beetles 5

3. a. Head, including eyes, wider than thorax (fig. 9); antennae inserted in front above the base of the mandibles . . . . . CICINDELIDAE

   b. Head narrower than thorax (fig. 10); antennae arising between the eyes and the base of the mandibles 4

4. a. Shore-inhabiting beetles of round convex form; scutellum apparently absent (fig. 10); not over 8 mm. long . . . . . OMOPHRONIDAE

   b. Beetles elongate in form (4-35 mm.); scutellum always present and visible from above (fig. 11); antennae long and slender, pubescent . . . . . CARABIDAE



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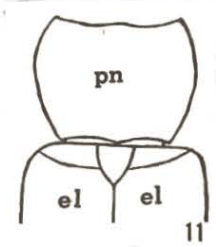

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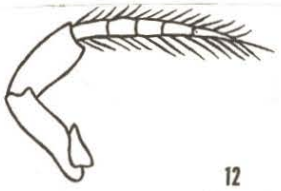
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5. a. Body ob-ovate; antennae slender, extending beyond the base of the pronotum; hind legs fringed with hairs, flattened, modified for swimming (fig. 12) . . . . . DYTISCIDAE

   b. Body oval but bluntly pointed at each end; antennae thick, glabrous, short, not reaching base of pronotum; legs not modified for swimming . . . . . AMPHIZOIDAE

POLYPHAGA

All of the beetles which do not have the first abdominal segments divided by the hind coxal cavities and have two gular sutures belong to this group. This sub-order is here divided into six series which contain a total of sixty-two families, or more than eighty-five per cent of all families of beetles found in Utah.

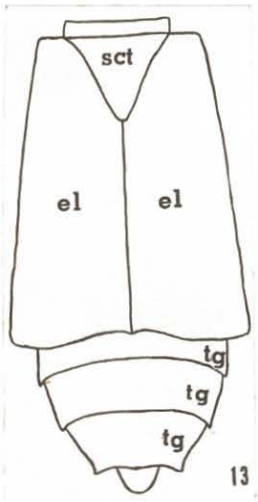
In the present work, the six series of Leng are used, but some changes have been made as to the placement of certain families. Reasons for these variations will be presented with the introduction of each

series of superfamilies.

Following is a key to the series of superfamilies of Utah Polyphaga:

KEY TO THE SERIES OF SUPERFAMILIES OF POLYPHAGA

1. a. Abdomen with at least three corneous segments dorsally and exposed more or less by a short elytra (fig. 13) . . . . . BRACHELYTRA[3] ..page 21



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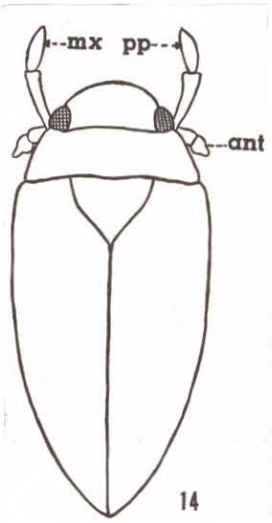

14

b. Abdomen with less than three corneous segments dorsally and completely covered by elytra (fig. 14); (Note: If the tip of the last abdominal segment is exposed from above, use this choice). . . . . 2[4]

2. a. Maxillary palpi as long or longer than antennae (fig. 14) . . . . . PALPICORNIA[5]

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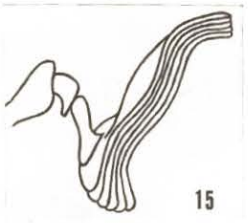
[3]The families Rhipiphoridae of Mordelloidea and Phengodidae of Cantharoidea have short elytra, but the abdominal tergites are not corneous. Therefore try Polyformia and Clavicornia on page 24.

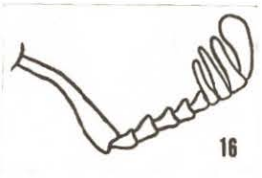
[4]We find certain exceptions in this group. The elytra of the family Scydmaenidae of Brachelytra completely cover the abdomen. These beetles are small (less than 2 mm. long), are very hairy, and have a somewhat superficial resemblance to certain ants. Head, and sometimes thorax, is much narrower than the elytra (fig. 24, page 23).

[5]Only one family, Hydrophylidae, is represented in this series.

b. Antennae always longer than maxillary palpi 3

3. a. Antennae lamellate (fig. 15 and 16). . LAMELLICORNIA. . .page 41





b. Antennae variable, but if clubbed, not lamellate 4

4. a. Tarsi apparently all 4-segmented, but are actually 5.5.5, the 4th segment of each tarsus being reduced in size, attached firmly to the 5th, and hidden in the lobe of the 3rd. The 1st 3 segments of all tarsi dilated and brush-like beneath, the 3rd being bilobed (fig. 17) . . . . . PHYTOPHAGA . page 42

b. Tarsi varying, but if 5-segmented, not like in 4-a, the joint between the 4th and 5th segments being flexible . . . . POLYFORMIA and CLAVICORNIA . . . page 24

BRACHELYTRA

This series is characterized by beetles which have at least three corneous abdominal tergites and the abdomen is more or less exposed from above by a short truncate elytra. The only exception to the truncate elytra is in the case of Scydmaenidae, in which case the elytra completely cover the abdomen. However, one cannot miss the identification of this family by reading the description (footnote, page 20).

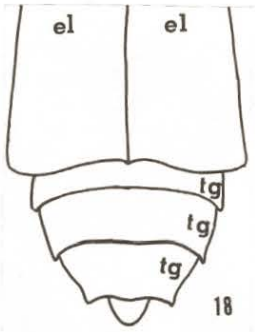
The number of tarsal segments in this series varies with the families, being from a 3.3.3 formula to a 5.5.5. The antennae are simple to clavate, and the wings are without cross-veins.

This series is composed of two superfamilies, Silphoidea and Staphylinoidea, containing nine Utah families. Since the number of superfamilies and families are so few, only one key is used in this paper for all.

Following is a key to the families of Brachelytra:

KEY TO THE FAMILIES OF BRACHELYTRA

1. a. Elytra short, often leaving most of the abdomen exposed (fig. 18); dorsal part of abdominal segments entirely horny (Staphylinoidea) 2



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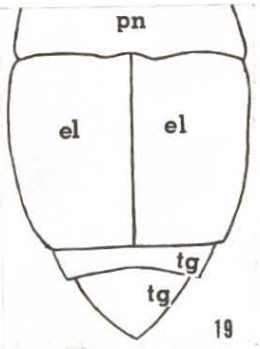

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   b. Elytra usually covering the greater part of the abdomen (fig. 19); dorsal part of the abdominal segments partly membranous (Silphoidea). 5

2. a. Eyes and hind wings absent; elytra about the same length as the thorax; small beetles, 2.5 mm. long, oval and very much flattened; parasitic on beaver and often mistaken for fleas . . .PLATYPSYLLIDAE

   b. Eyes and hind wings present 3

3. a. Length less than 1 mm.; hind wings narrow with long hairs fringing them (fig. 20); numerous long slender hairs on antennae (fig. 21); body usually hairy . . . . . PTILIIDAE

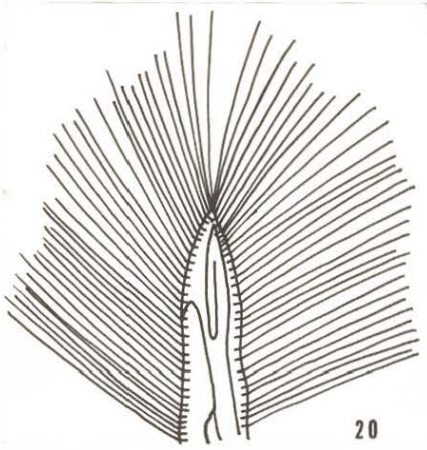
   b. Beetles 1 mm. long or longer; hind wings, if fringed, are much more broad and rounded than in fig. 20 4

4. a. Abdomen flexible and with 7 or 8 abdominal sternites visible below . . . . . STAPHYLINIDAE

   b. Abdomen rigid and with only 5 or 6 sternites visible from below . . . . . PSELAPHIDAE

5. a. Antennae elbowed and clavate (fig. 22); elytra very hard and truncate, leaving 2 (rarely 1) abdominal segments exposed (fig. 23) . . . . . HISTERIDAE

   b. Antennae rarely elbowed, and then not clavate 6



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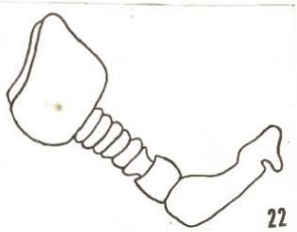

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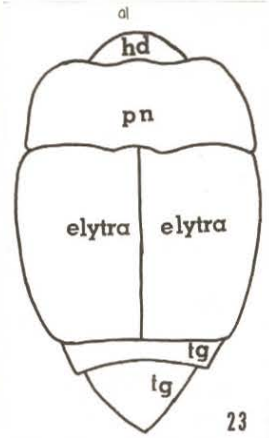

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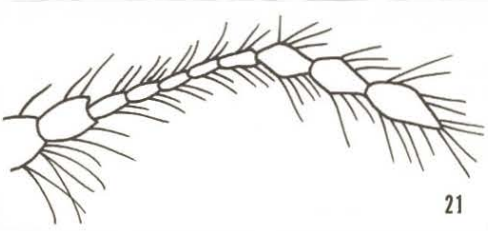

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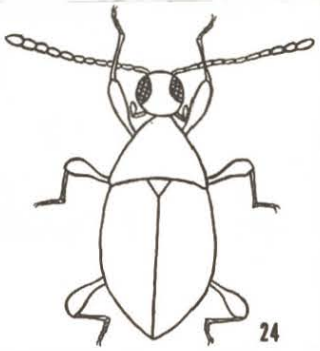

24

6. a. Abdomen completely covered by elytra, body often resembling that of certain ants (fig. 24) . . . . . SCYDMAENIDAE

   b. Abdomen not completely covered by elytra 7

7. a. Tarsi dilated and hairy beneath; last segment longer and narrow; antennae with 3-segmented club . . . . . NITIDULIDAE[6]

   b. All tarsal segments cylindrical and not dilated; antennae either gradually enlarging towards tip, or club with at least 4 segments present 8

8. a. Small oval or round-oval, shining beetles living in fungi; elytra truncate at the tips, leaving at least the last segment and often part of the 2nd from the last segment exposed (fig. 25) . . . . . SCAPHIDIIDAE

   b. Generally much larger with a somewhat soft flattened body; tibiae bear large spurs at

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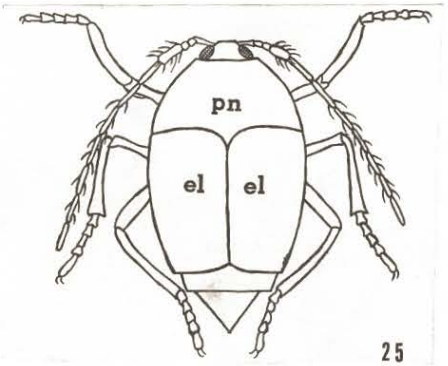
[6]Refer to the superfamily Cucujoidea of the series Clavicornia.

the tips (fig. 26); antennae variable, some having an abrupt terminal club (fig. 27), and others being very gradually broadened toward the tips (fig. 28); front and hind coxae arise so close together that they are contiguous (touch one another) . . . . . SILPHIDAE



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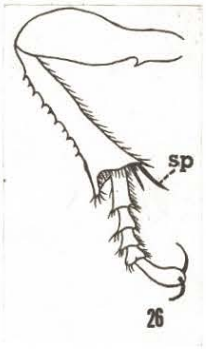

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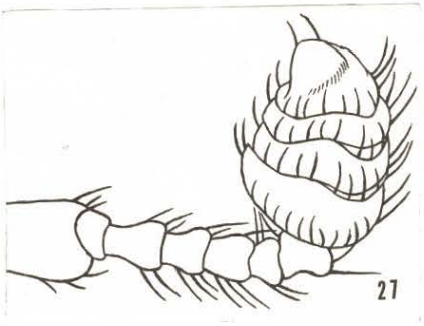
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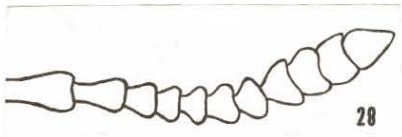

28

POLYFORMIA AND CLAVICORNIA

These two groups are so varied in structure that it is impossible for the author to separate them distinctly. They are here combined as in Comstock (1949: 471) and are divided into nine superfamilies. These, as will be noted, are not arranged exactly as they appear in Leng (1920), Boving and Craighead (1930) or Jeannel and Paulian (Bradley, 1947), but are parts of all. As each superfamily is discussed, the reasons for the distinctions made in grouping them as they are will be brought out.

According to Essig (1948) the members of the series polyformia are characterized by having more or less soft bodies. This characteristic is not strong enough, however, to use in separating the two groups. In the eight superfamilies contained in the above-mentioned series, there are forty-two families.

Following is a key to the superfamilies of Polyformia and Clavicornia:

KEY TO THE SUPERFAMILIES OF POLYPHAGA AND CLAVICORNIA

1. a. Tarsal formula 5.5.4, i.e., the front and middle tarsi with 5 segments; hind tarsi with only four joints. . . . . TENEBRIONOIDEA . . page 36

   b. Tarsi variable, but never as in 1-a. 2

2. a. Abdominal segments 7 or 8 in number; all tarsi 5-segmented, all segments being distinctly visible. . . . . CANTHAROIDEA . . page 26

   b. Abdomen with not more than six visible sternites 3

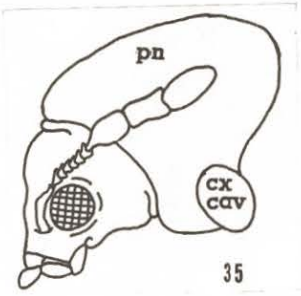
3. a. Abdomen with 6 sternites visible. . . . .CLEROIDEA . . page 28

   b. Abdomen with only 5 visible sternites 4

4. a. Head retracted within prothorax or partly covered by pronotum (fig. 35 & 36); antennae serrate, sometimes the last three segments being greatly enlarged. . . . . .BOSTRICHOIDEA . . page 40

   b. Head not covered by pronotum, or if so, antennae never serrate 5

5. a. Body elongate, tapering at each end (fig. 37); antennae serrate (fig. 38) to pectinate (fig. 39), some males having flabellate antennae (fig. 54). . . . . ELATEROIDEA . . page 29



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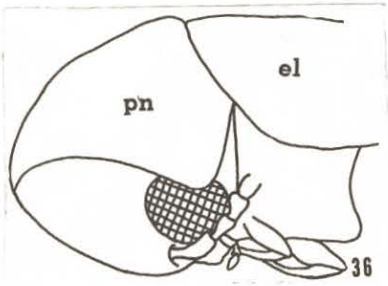

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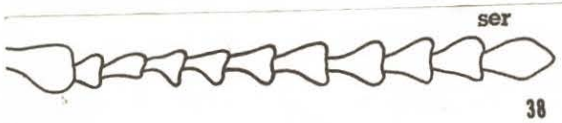

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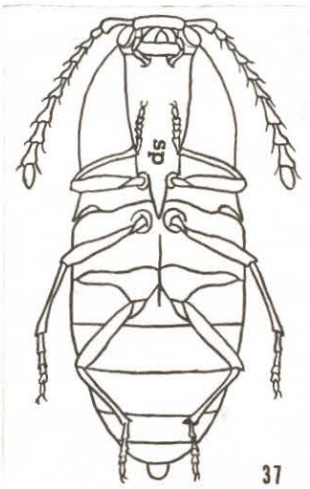
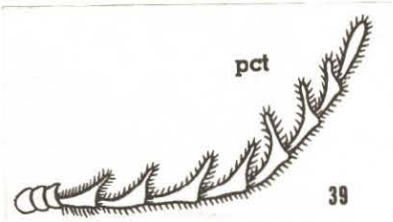
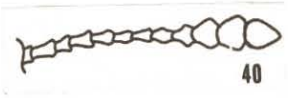
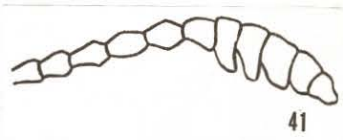


37

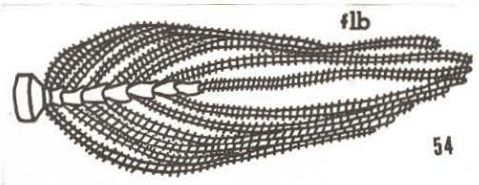
b. Body shape variable; antennae either gradually becoming enlarged (fig. 40), or with a distinct club (fig. 41). 6

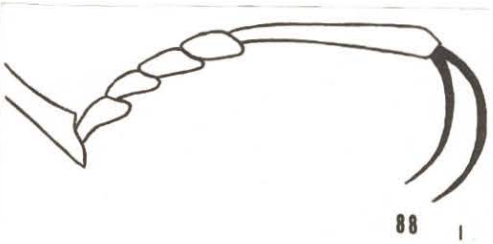






6. a. Beetles brightly colored, covered with dense pubescence . . . . . .CLEROIDEA . . page 28





b. Not as in 6-a. 7

7. a. Last tarsal segment as long as all others; claws well developed and large (fig. 88). . . . . .DRYOPOIDEA . . page 30

b. Last tarsal segment not as long as others; claws normal 8

8. a. Elytra clothed with small scales. . . . .BYRRHOIDEA. . page 32

b. Elytra never clothed with scales . . . . CUCUJOIDEA. . page 32

CANTHAROIDEA

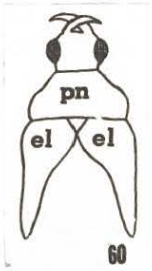
This superfamily differs from the Cantharoidea of Leng in that the families Cleridae, Melyridae and Corynetidae are recognized as comprising a separate superfamily, Cleroidea. They are separated and given the rank of superfamily in accordance with Boving and Craighead (1930) who separate them according to their larval characters.

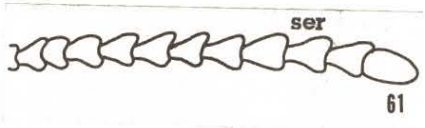
Cantharoidea is characterized in having seven or eight visible sternites, while the families of Cleroidea have only six. There are five tarsal segments to each tarsus. Antennae are variable, filiform to clavate.

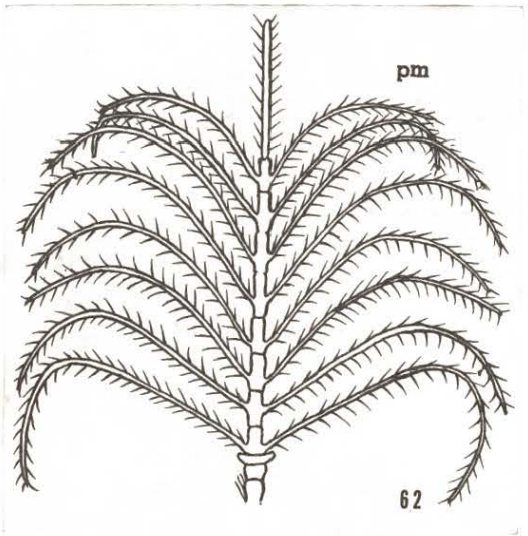
Following is a key to the families of Cantharoidea:

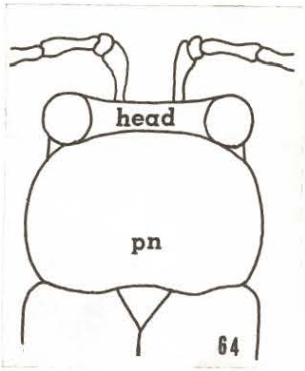
KEY TO THE FAMILIES OF CANTHAROIDEA

1. a. Very short pointed elytra present (fig. 60); abdomen being covered only by the membranous hind wings; antennae deeply serrate (fig. 38 & 61) or plumose (fig. 62 . . . . . PHENGODIDAE









b. Elytra covering abdomen; antennae not as in fig. 2-c. 2

2. a. Elytra costate (with longitudinal ridges) and usually have cross-ridges between them; elytra much wider at apex than at base . . . . . LYCIDAE

b. Elytra not as above, but is relatively smooth 3

3. a. Head completely concealed by pronotum (fig. 63). . . LAMPYRIDAE

b. Head large and prominent, partially concealed, but extending beyond pronotum (fig. 64). . . . . CANTHARIDAE

CLEROIDEA

The superfamily Cleroidea is separated from Cantharoidea, where Leng (1920) places the three families, Cleridae, Corynetidae and Melyridae, by the presence of only six visible sternites.

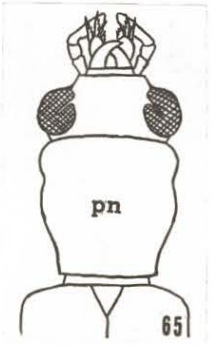
Following is a key to the families of Cleroidea:

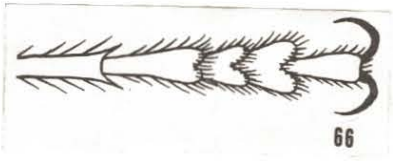
KEY TO THE FAMILIES OF CLEROIDEA

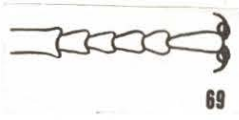
1. a. Pronotum narrower than head or base of elytra (fig. 65); all but the last tarsal segment lobed beneath (fig. 66). . . . . CLERIDAE

b. Pronotum as wide or wider than head (fig. 67) 2

2. a. Fourth tarsal segment much smaller than others and often very difficult to see (fig. 68); beetles extremely pubescent . . . . . CORYNETIDAE







b. All tarsi long and slender, not lobed beneath (fig. 69); membranous lobe beneath claws of each tarsus (fig. 69). . . . . MELYRIDAE

ELATEROIDEA

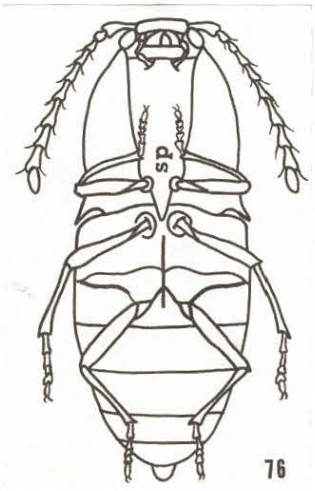
The families represented in this superfamily are placed here in agreement with Leng (1920), Boving and Craighead (1930). They are characterized in having both ends tapering, and the antennae are serrate, pectinate, or flabellate. There are five visible sternites present, five tarsal segments, and they have prosternal spines or processes fitting into the mesosternum.

Following is a key to the families of Elateroidea:

KEY TO THE FAMILIES OF ELATEROIDEA

1. a. Long slender spine on the underside of the prothorax which extends back and fits loosely into a deep cavity on the underside of the mesothorax (fig. 76); base of elytra and prothorax suddenly become thinner from top to bottom at the point of attachment (fig. 77). . . . . ELATERIDAE

   b. Spine, if present, fits snugly into groove of mesothorax (fig. 78); base of elytra and prothorax do not become thinner dorsoventrally (fig. 79). 2



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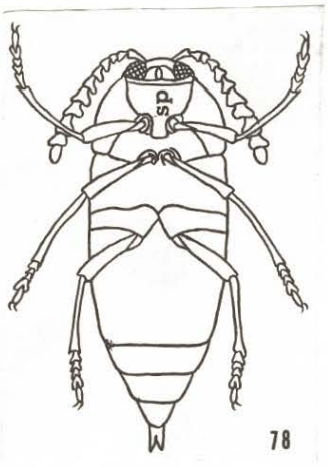

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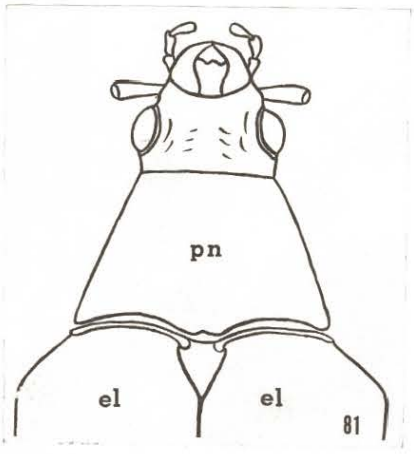

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2. a. Head buried to eyes in prothorax (fig. 78); short lobes beneath first four tarsal segments (fig. 80) . . . . . BUPRESTIDAE

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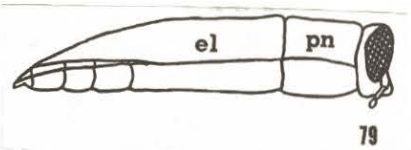

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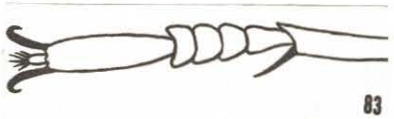
b. Head not buried to eyes in prothorax (fig. 81); tarsi simple, not lobed 3

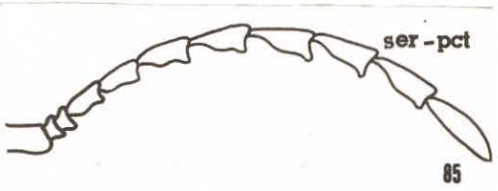

80

82


83

3. a. Antennae with tight pectinate club (fig. 82); fifth tarsal segment as long or longer than all others (fig. 83); short oval body. . . . . RHIPICERIDAE

84



85

b. Antennae very loosely pectinate in males (fig. 84 & 85); females wingless forms which live deep in the ground, coming out only to mate; males large pubescent beetles with prominent mandibles projecting in front . . . . . PLASTOCERIDAE

DRYOPOIDEA

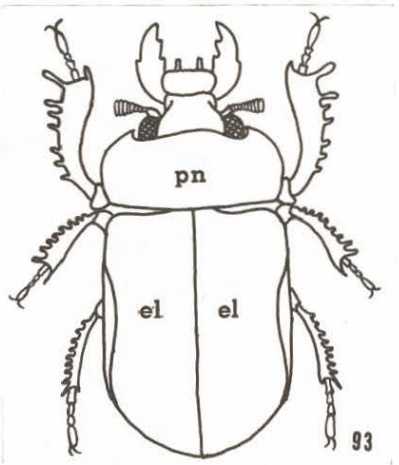
This superfamily is characterized by having very stout claws which are the result of a very extraordinary development according to Leng (1920). There are four families in this group, all of which are aquatic or semi-aquatic, two families walking around on stream bottoms leading a phytophagous existence, while the others live in the sandy shore-lines of

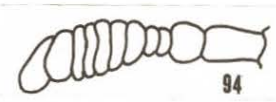
streams and lakes.

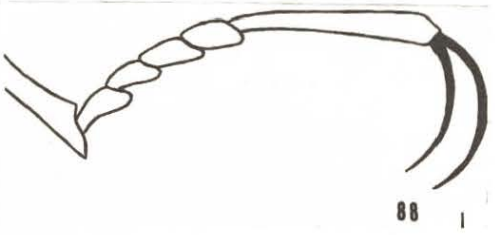
Following is a key to the families of Dryopoidea:

KEY TO THE FAMILIES OF DRYOPOIDEA

1. a. All tarsi are 5-segmented, the 5th segment being extremely long, much longer than all others combined and tarsal claws are very stout (fig. 88); tarsi almost as long as tibia; beetles found walking around on stream bottoms 2







b. Tarsi 4-segmented; other characters not as in 1-a 3

2. a. Beetles clothed with dense silken pubescence; anterior coxae transverse; trochantin present . . . . DRYOPIDAE

b. Pubescence much less dense or elytra may be smooth; anterior coxae rounded with no trochantin present . . . . . ELMIDAE

3. a. Antennae with last three segments forming a club; head deflexed; beetles carry protecting cover of mud or sand on backs; very small, rare beetles . . . . . GEORYSSIDAE

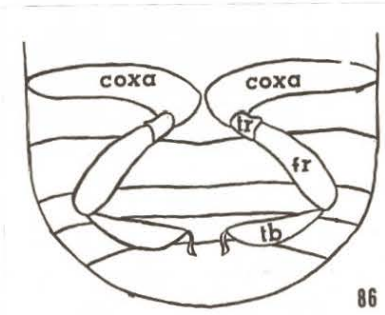
b. Very flattened, oblong beetles; fromt and middle tibiae greatly dilated, being very broad and having spines along the outer edges (fig. 93); antennae with outer 7 segments much thicker than the first 4 (fig. 94) . . . . . HETEROCERIDAE

BYRRHOIDEA

The beetles of this superfamily are in two families, Byrrhidae and Dermestidae. They may be separated from closely related forms by the presence of small scales on the elytra. Some members of the family Byrrhidae may lack scales but are clothed with hair. However, they can readily be distinguished by the presence of a furrow in the tibia for reception of the tarsus (Comstock, 1949, page 508).

KEY TO THE FAMILIES OF BYRRHOIDEA

1. a. Head bent downward under thorax and hidden by it; hind coxae very wide, extending to lower edge of elytra and often partly covering the hind femora (fig. 86); convex oval beetles; furrow in tibia for reception of tarsus . . BYRRHIDAE



86

   b. Head not covered by prothorax; stout robust beetles with stout clubbed antennae; no furrow in tibia . . . . . DERMESTIDAE

CUCUJOIDEA

This superfamily consists of a heterogeneous group. No two authors studied have this superfamily listed alike, but Boving and Craighead (1930), in their larval studies, agree with Leng for the most part, although even they have made some changes. They place the superfamily Tenebrionoidea, including all heteromerous forms, in this group. That would include Leng's Tenebrionoidea, Mordelloidea, and Othniidae of Cantharoidea. Perhaps more studies of larval structures and genitalia will

substantiate this placement. However, to facilitate shortening the key as much as possible, the author has used Leng's classification in this paper, with only one change. The change made is the addition of Orthoperidae to this group, taking it out of Brachelytra, as many others have done.

There are twelve families in this group. However, because of the difficulty in making distinct separations between Cucujoidea and some families of Byrrhoidea and Dryopoidea, these families were added to the key which follows in addition to the keys of the superfamilies wherein they belong. Following is a key to the families of Cucujoidea:

KEY TO THE FAMILIES OF CUCUJOIDEA

1. a. All tarsi distinctly 5-segmented. 2

   b. Tarsi appear to have less than 5 segments; if fourth segment is visible, but very inconspicuous, use this choice. 4

2. a. Head bent downward under prothorax; hind coxae very wide, extending to lower edge of elytra, and often partly covering hind femora (fig. 86); furrow in tibia for reception of tarsus; convex, oval beetles. . . . . BYRRHIDAE[7]

   b. Not as in 2-a. 3

3. a. Very small beetles, not more than 2.5 mm. to 3 mm. long; side of pronotum usually toothed (fig. 87), the teeth sometimes being so small that they are inconspicuous; antennae with a 3-segmented club; densely hairy beetles with a silken appearance. . . . . CRYPTOPHAGIDAE

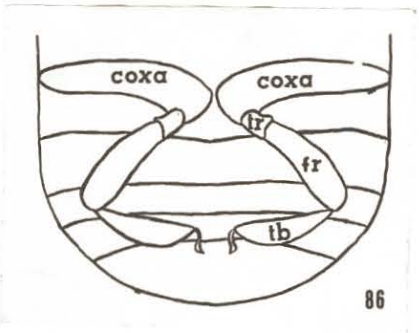
   b. Size variable but larger than 3 mm.; side of pronotum never toothed or notched; body extremely flattened, usually red, yellowish, or brown in color; abdomen with 6 ventral segments visible. . . . . CUCUJIDAE

4. a. Tarsi 3-segmented, or at least appear to be so 5

---

[7]This family belongs to Byrrhoidea, but may key out here due to the presence of hair on the elytra of some species rather than scales.

b. All tarsi appear 4-segmented; some may really be 5, the 4th segment of all tarsi being inconspicuous (fig. 89). 8



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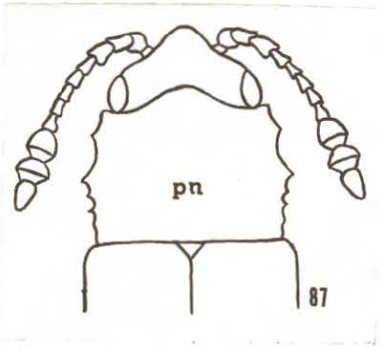

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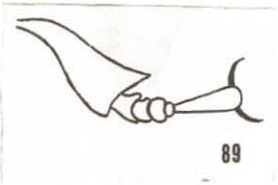
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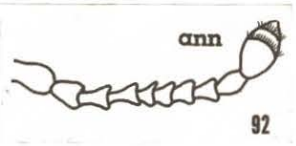
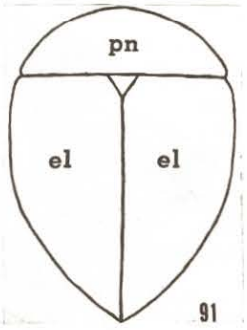


92

5. a. Tarsi really 4-segmented, the 3rd segment very small, concealed in notch of second (fig. 90) 6

b. All tarsi actually 3-segmented; small beetles less than 2.5 mm. long 7

6. a. Pronotum as wide as base of elytra and partially conceals head; elytra usually smooth and shining; tooth or notch present on underside of each tarsal claw (fig. 90). . COCCINELIDAE



91

b. No tooth or notch on underside of tarsal claws; very small, round or oval, .5 to 1.7 mm. long (fig. 91); mostly pubescent, although a few may be smooth; broad wings fringed with long hairs . . . . . ORTHOPERIDAE

7. a. Oval or oblong-linear beetles with 6 to 8 rows of punctures on elytra; pronotum marked with elevated lines or ridges; antennae 9-11 segmented, the last 3 forming a club . . . . . LATHRIDIIDAE

b. Small depressed beetles; antennae 10-segmented, the last 2 forming a club; and the 10th segment being annulated, giving an appearance of 3 segments (fig. 92) . . . . . MONOTOMIDAE

8. a. All tarsi distinctly 4-segmented; small beetles, less than 5 mm. long 9

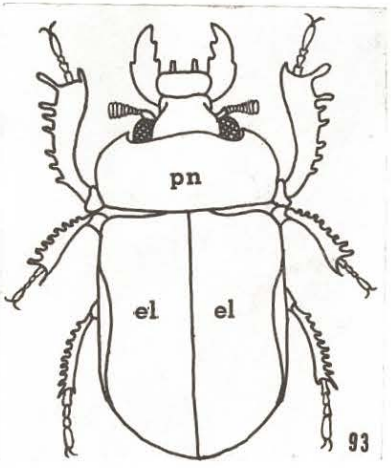
b. All tarsi 5-segmented, the 4th segment being inconspicuous 13

9. a. Antennae 10-segmented, the last 2 forming a club; segment 10 annulated (ringed) giving it the appearance of 3 segments (fig. 92); elytra abruptly rounded, exposing the tip of the abdomen . . . . . MONOTOMIDAE

b. Antennae 11-segmented, or if 10-segmented, none are annulated as in 9-a 10

10. a. Very flattened, oblong beetles; front and middle tibiae greatly dilated, being very broad and having spines along the outer edges (fig. 93); antennae with outer 7 segments much thicker than the first 4 (fig. 94) . . . . . HETEROCERIDAE[8]

b. Tibia not dilated; no spines along outer edges as in fig. 93 11



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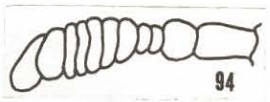
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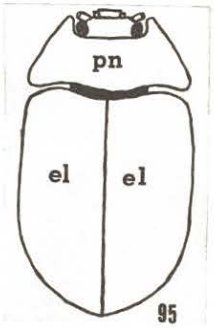

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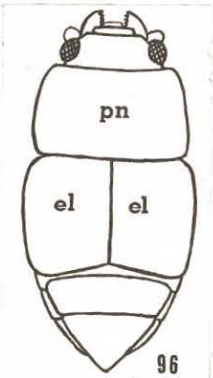

96

11. a. Elytra densely pubescent and punctured; small oval, slightly convex beetles . . . . . MYCETOPHAGIDAE

b. Beetles not pubescent 12

12. a. Antennae with last 2 segments forming a club . . . . . COLYDIIDAE

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[8]This family belongs in the superfamily Dryopoidea. It is here listed because of difficulty one might have in keying it to that group.

b. Antennae with last 3 segments forming a club; head deflexed; beetles carrying protective cover or mud or sand on backs; very small rare beetles . . . . . GEORYSSIDAE[9]

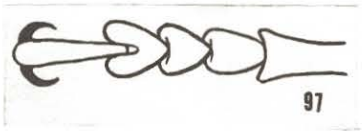
13. a. Pronotum joined with base of elytra only in center (fig. 95); antennae short, last 3 segments gradually enlarging to form a club . . . . . OSTOMIDAE

b. Elytra base and pronotum closely joined throughout width (fig. 96) 14

14. a. Elytra short and truncate at tip, exposing last one or two segments of abdomen (fig. 96) . . . . . NITIDULIDAE

b. Elytra entire, completely covering abdomen 15

15. a. Small, oblong cylindrical beetles with 4th tarsal segment firmly united with the 5th, making it very hard to see (fig. 97); head plainly visible from above . . . . . EROTYLIDAE



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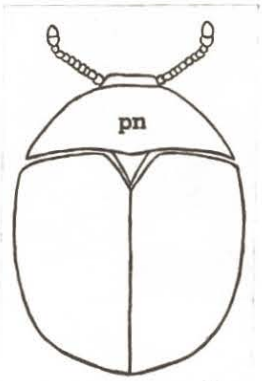

98

b. Small, round, convex beetles with head very slightly or not at all visible from above (fig. 98); less than 3 mm. long . . . . . PHALACRIDAE

TENEBRIONOIDEA

Not being able to make a distinct separation between Tenebrionoidea and Mordelloidea of Leng (1920), the author has, for the sake of convenience, placed the two superfamilies under the one heading,

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[9]This family also belongs to the superfamily Dryopoidea and is here because of possible difficulty in keying it to the proper group.

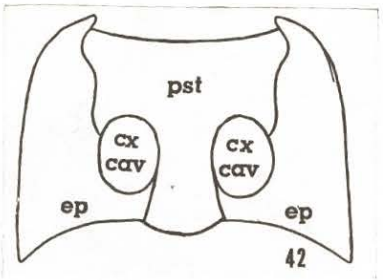
Tenebrionoidea, as in the Jeanell and Paulian classification (Bradley, 1945). The key which follows will include these two groups as well as the family Othniidae of the superfamily Cantharoidea.

The families of this group have in common a 5.5.4 tarsal formula, i.e., the front and middle tarsi are five segmented and the last tarsal pair contains only four segments. The antennae are variable and the elytra cover the abdomen, exposing no more than part of the last tergite. There may be five or six visible sternites.

Following is a key to the families of the superfamily Tenebrionoidea.

KEY TO THE FAMILIES OF TENEBRIONOIDEA

1. a. Front coxal cavities closed behind (fig. 42) 2



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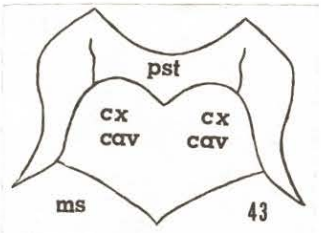

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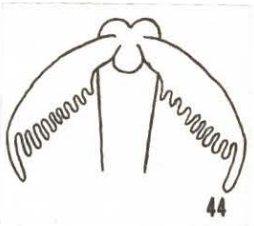
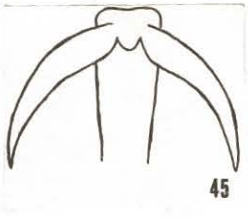

44

b. Front coxal cavities open behind (fig. 43) 4

2. a. Tarsal claws comb-like (fig. 44); body elongate and rather soft . . . . . ALLECULIDAE

b. Tarsal claws simple, smooth (fig. 45) 3

3. a. Ventral abdominal segments in part grown together; front of each eye emarginate (fig. 48). . TENEBRIONIDAE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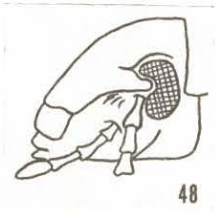
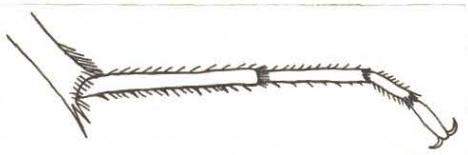
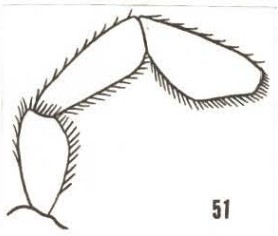

48


49

b. Ventral abdominal segments freely moveable; front of eyes not emarginate . . . . . OTHNIIDAE

4. a. Maxillary palpi long and much dilated (fig. 49); first segment of tarsi always much elongated (fig. 50); usually as long as all others combined . . . . . MELANDRYIDAE



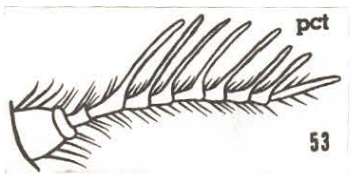


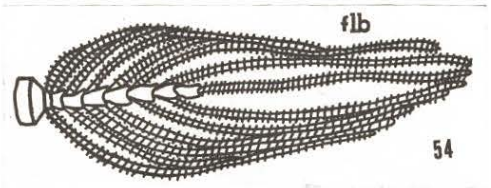
b. Maxillary palpi normal (fig. 51); first tarsal segment not as long as in 4-a, but is considerably shorter than all others combined 5

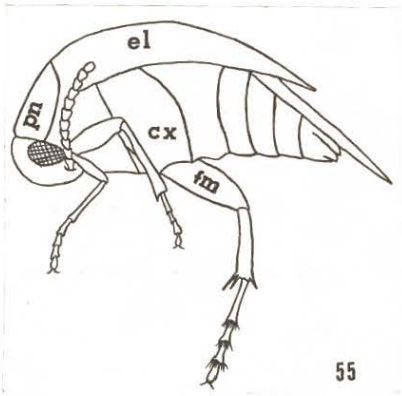
5. a. Head strongly and suddenly constricted at base (fig. 52 and 55) 6

b. Head not strongly and suddenly constricted at base 10

6. a. Elytra shorter than abdomen and narrower behind (fig. 52), sometimes becoming very short rounded pads; antennae pectinate (fig. 53) or flabellate (fig. 54) in males and serrate in females . . . . . RHIPIPHORIDAE







b. Elytra completely covering abdomen; antennae not as in 6-a 7

7. a. Body arched, head being bent downward (fig. 55); abdomen prolonged into slender point; hind coxae plate-like (fig. 55); black pubescent beetles . . . . . MORDELLIDAE

56

57

b. Not as in 7-a 8

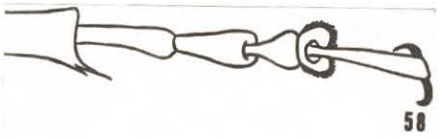
8. a. Next to last tarsal segment bilobed (fig. 56); claws simple 9

b. Next to last tarsal segment not bilobed; tarsal claws cleft or toothed (fig. 57) . . . . . MELOIDAE

9. a. Hind coxae contiguous (close together); eyes large and finely faceted . . . . . PEDILIDAE

b. Hind coxae separated, eyes small and coarsely faceted . . . . . ANTHICIDAE

10. a. Middle coxae very prominent; next to last tarsal segment dilated and bears a dense hairy pad beneath (fig. 58) . . . . . OEDEMERIDAE



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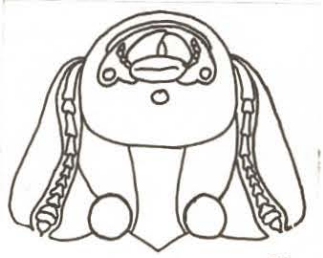


59

b. Middle coxae not prominent; next to last tarsal segment not as in 10-a 11

11. a. Antennae received in grooves on underside of pronotum (fig. 59); two or three segments to antennal club . . . . . MONOMMIDAE

b. Antennae free, not clubbed . . . . . PYTHIDAE

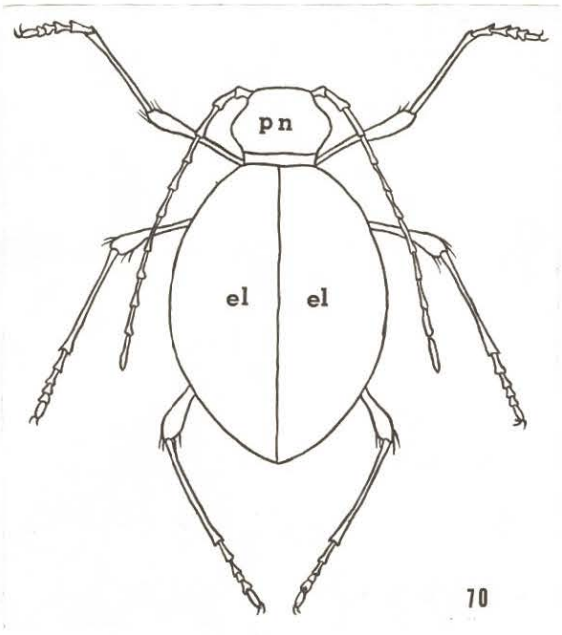
BOSTRICHOIDEA

This superfamily contains four Utah families, all of which are characterized in having tarsal formulae of 5.5.5, antennae variable but usually serrate to clavate, elytra covering abdomen, five visible abdominal sternites, and eruciform larvae. They are terrestrial beetles which are wood-borers and have heads which are usually retractable (Essig, 1947: 540-541).

Following is a key to the families of Bostrichoidea.

KEY TO THE FAMILIES OF BOSTRICHOIDEA

1. a. Tarsi distinctly 5-segmented; head and pronotum much narrower than elytra; legs very long and cannot be retracted under body; spider-like beetles (fig. 70) . . . . . PTINIDAE



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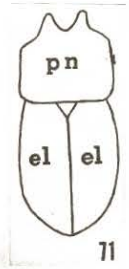

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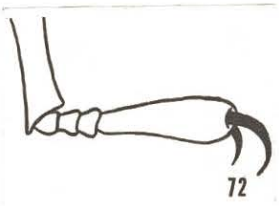
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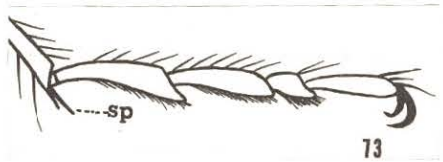


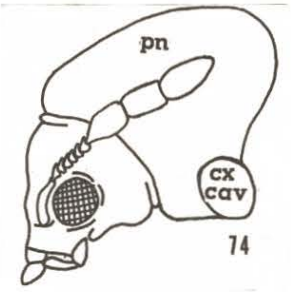
73

b. Tarsi apparently 4-segmented; pronotum at least as wide as base of elytra (fig. 71) 2

2. a. Tarsi 4-segmented, the first 3 joints short and equal and the 4th segment quite long (fig. 72); small beetles, not more than 3 mm. long . . . . . CISIDAE

   b. Tarsi appear 4-segmented, but are in reality 5-segmented, the first joint inconspicuous at the base of the 2nd (fig. 73) 3

3. a. Tibia with spurs (fig. 73); head deflexed beneath pronotum (fig. 74) . . . . . BOSTRICHIDAE



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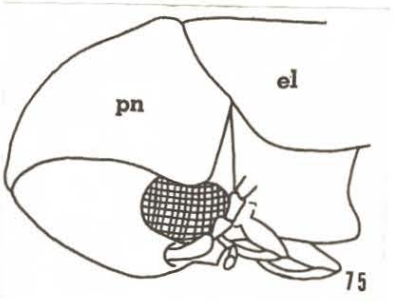

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   b. Tibia without spurs; head bent under and partly inclosed within thorax (fig. 75) . . . . . ANOBIIDAE

LAMELLICORNIA

The series Lamellicornia contains only one superfamily, Scarabaeoidea. This group of beetles is separated because of its very distinctive lamellate antennae. In one group, the Lucanidae, the antennae are not capable of close apposition, while in the other groups, the terminal plates of the antennae are very much flattened and capable of closing as the pages of a book. The abdomen may have five segments, but in most cases six visible sternites are present. All tarsi are distinctly five-segmented and the elytra completely cover the abdomen. Larvae of this group are eruciform, the habitat is terrestrial, and they are all either phytophagous or scavengers.

Leng (1920) lists only three families in this superfamily (series Lamellicornia), but the sub-family Geotrupinae of Leng is raised to the

rank of family in accordance with the work of Boving and Craighead (1930). Thus the series as here shown will contain four families.

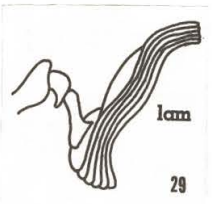
Following is a key to the families of Lamellicornia:

KEY TO THE FAMILIES OF LAMELLICORNIA
(SUPERFAMILY SCARABAEOIDEA)

1. a. Terminal plates of antennal club flattened and capable of close apposition (fig. 20). 2

   b. Antennae elbowed; plates of antennal club not capable of close apposition (fig. 30); usually large black beetles with very prominent mandibles . . . . . LUCANIDAE

2. a. Elytra with rough tubercles and ridges; abdomen with 5 visible ventral segments; epimera of mesothorax not reaching coxae (fig. 31). . . . . TROGIDAE



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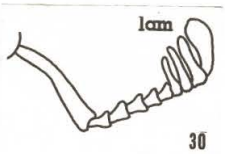

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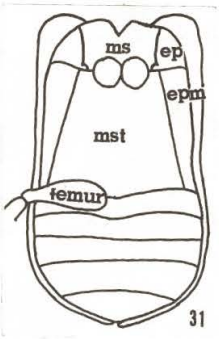

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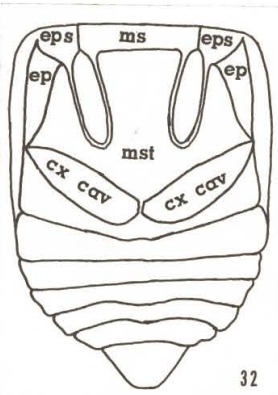


32

   b. Elytra not as in 2-a; abdomen with 6 visible ventral segments, or if only 5, epimera of mesothorax reaching coxae (fig. 32). 3

3. a. Antennae 11-segmented; elytra striate. . . . . GEOTRUPIDAE

   b. Antennae 9 or 10 segmented; elytra variable. . . .SCARABAEIDAE

PHYTOPHAGA

This series consists of one superfamily, Cerambyscoidea. Within

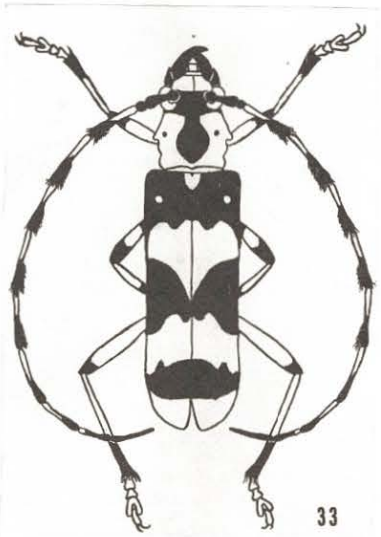
this superfamily there are three very important families, all of which are plant feeders and are represented in Utah by many important species. One family, Cerambyscidae, consists of insects which are borers as larvae. The beetles of the family Mylabridae spend their larval stages in the seeds of legumes, thus the common names pea weevil and bean weevil. The Chrysomelidae, on the other hand, feed upon the leaves of plants, both as larvae and as adults.

This superfamily is characterized by having apparently a 4.4.4 tarsal formula, but which is in reality 5.5.5, the 4th segment being closely fused with the 5th and hidden in the lobe of the 3rd.

The following key will easily separate the three families of this superfamily:

KEY TO THE FAMILIES OF PHYTOPHAGA
(SUPERFAMILY CERAMBYSCOIDEA)

1. a. Body elongate; antennae always long, may be as long or longer than the body (fig. 33). . . . . CERAMBYSCIDAE



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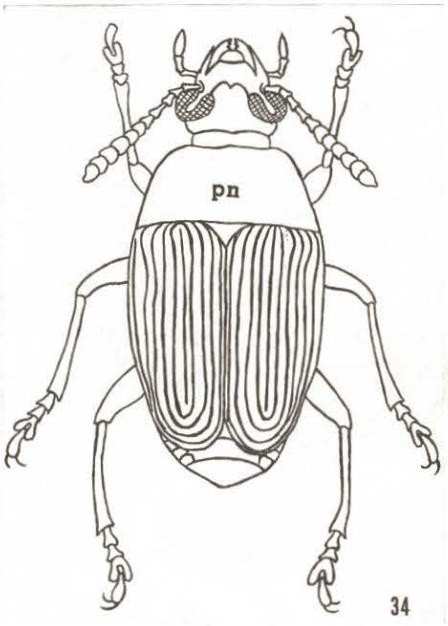

34

b. Body short, more or less oval; antennae always much shorter than body. 2

2. a. Mouthparts modified into broad quadrate beak; elytra exposing tip of abdomen (fig. 34). . . . . .MYLABRIDAE

b. Mouthparts not as in 2-a; elytra completely covering the tip of the abdomen. . . . . .CHRYSOMELIDAE

GENERAL DISCUSSION OF KEYS

Students of Coleoptera in this country for many years have been accustomed to the Leconte system of Classification. This system was used by many later workers including Blatchley, Smith, Henshaw, Van Dyke, and others. However, this system has been under fire both in Europe and America according to Leng (1920), but it has held its ground. Since, Leng states further, such men as F. V. Melsheimer, F. E. Melsheimer, Crotch, Henshaw and others use their own systems, there is certainly a wide variety of opinion concerning the phylogeny of Coleoptera.

While the author was not greatly concerned about these differences of opinion, he soon learned that some decisions had to be made before actual work could be started on the keys. The systems of Leng (1920), Jeannel and Paulian (Bradley, 1947), Tanner (1927), Boving and Craighead (1930) and Arnett (1955) were then studied to determine the course to follow.

It was found that the systems of Leng and of Boving and Craighead were much more alike than were any of the others, although this, in itself, does not make their systems the last word in phylogeny. Although there was some agreement as to the sub-orders, even here there are several differences. Leconte (1847) divided the orders into three groups, Adephaga, Polyphaga and Rhyncophora, while Leng does not recognize Rhyncophora as a sub-order but as at most a series of superfamilies. Tanner, in his genitalia study, listed Scarabiformes as the third sub-order, and states that the genital structures of this group are, in many

respects, so distinct from the other families that they may justifiably be considered as a sub-order. Crowson (1955) lists Adephaga and Polyphaga as sub-orders, but feels that the families Sphaeridae, Hydroscaphidae and Lepiceridae should be placed in a sub-order he calls Myxophaga. He also adds a fourth, Archostemata, as suggested by Kolbe, Forbes, Boving and Craighead. These would include the families Cupesidae and Micromalthidae.

There was found to be great diversity in the placement of the families in their respective superfamilies, and in many cases the superfamily names were different. When Boving and Craighead (1930) completed their larval study, they were very surprised to note that the larval characters placed the families very close to the same arrangement that Leng had in his study of the imagines. This seemed to be a definite indication that these characters, when taken separately, are of great value in the determination of phylogeny, but the value would appear to be much greater if all phases were to be taken into consideration.

Tanner (1927), whose work was the first of its kind, brought about some very interesting changes in the age-old concept of phylogenetic arrangement of the Coleoptera. First, he places the family Hydrophilidae in the sub-order Adephaga. This family is placed in the first superfamily of Leng's (1920) Polyphaga. The genitalia studies indicated that Hydrophilidae and Dytiscidae are closely related to the Carabidae. His Silphoid series is in accordance with Leng and others, but such families as Platypsyllidae, Scydmaenidae and Pselaphidae were not available for study.

The Cantharid and Cucujoid series of Tanner suggest a great unconformity in the groupings generally employed by other workers. These groups

include the families of Leng's Polyformia and Clavicornia, less Tenebrionoidea. This would seem to further substantiate the greater need for more critical study of phylogeny from every angle possible. Tanner's division of Polyformia and Clavicornia may shed some light on a way to a better division of these large groups which, the author has found, have been very difficult to work with.

Leng's arrangement of sub-orders, series of superfamilies and superfamilies was used in this paper with a few changes, as were indicated in the discussions of the separate keys. The main difference between this system and that of Boving and Craighead is in the grouping of certain families in their respective superfamilies. They (Boving and Craighead) placed several of Leng's superfamilies under one group. For example, their Cucujoidea contains most of the families of Leng's Cucujoidea, Mordelloidea, and Tenebrionoidea. They have also raised such families as Cerambyscidae to the rank of superfamily. The placement of these families in the keys was with great reservation, for much additional work is necessary before conclusive evidence will settle this problem.

The characters used in the keys to the sub-orders and series of superfamilies were taken primarily from Comstock (1949) and Essig (1948). Both authors have workable keys to these groups.

The key to the superfamilies of Adephaga was taken primarily from Essig (1948), while the key to the superfamilies of Polyformia and Clavicornia of Polyphaga is original, and only certain family characters used therein have been taken from other sources. Much time was spent going over various characteristics until those which seemed to most clearly

separate the superfamilies were found and incorporated in the key. The other series contained so few families that it was unnecessary to make special keys to their superfamilies. Usually there was only one, or at most two, to consider. There was a definite need to break up the above-mentioned series, for it contains forty-six Utah families in nine superfamilies. This need was obvious and was in keeping with the purpose of the author in writing this paper.

The keys to the families, while not being copied from any particular source, are primarily the results of much work done by many people. Materials used in these keys were taken from Comstock (1949), Essig (1947), Essig (1948), Edwards (1954), Jaques (1951), Borror and De Long (1954) and others. The drawings used in all the keys, with the exception of thirteen, are original and were taken from specimens in the Brigham Young University Entomological collection. There are ninety-eight drawings accompanying the keys.

While studying some of the characteristics of the families of Coleoptera, the author found a certain error that seemed to predominate in most of the keys studied. This was in connection with the family Coccinelidae. Blatchley (1910) states that the most distinctive character of this family is the three-jointed tarsi and broad hatchet-shaped terminal segment of the maxillary palpi. Edwards (1954) said they all agree (referring to Coccinelidae) in having three-segmented tarsi with the second segment dilated and spongy-hairy beneath, and with a tooth or notch present on the underside of each tarsal claw. In his key Essig (1947) indicates this family has three tarsal segments, but in his discussion of the family he mentions the fact that there are four. Comstock (1949) indicates

in his key that there are three or apparently three tarsal segments. In studying the tarsal segments of four different species of Coccinelidae, the author found that there are definitely four segments, although the third is quite hidden in some species, as was indicated in the key of Edwards (1954) and the discussion of Essig (1948). Mention is made of this at the present time primarily to indicate that errors such as this are easily overlooked, and that great care can minimize such mistakes.

As a result of searching the literature, the author was able to find nothing which would indicate a serious attempt as the construction of simplified keys to the large order Coleoptera. The work of Essig (1948) and Comstock (1949), however, seem to be steps in the right direction, but more research in this area is necessary before any definite conclusions can be made. There have been no attempts, as far as the author could determine, to work out a set of keys to the families of Utah Coleoptera. The keys listed in this paper are probably the first of their kind, and it is hoped that they will be of some service to future students of Entomology who might one day be studying the Coleoptera of Utah.

SUMMARY

1. The present study includes the determination of the number of families of Coleoptera found in Utah, and construction of simplified keys to these groups of beetles by using the major subdivisions of the order, i. e., sub-orders, series of superfamilies, superfamilies and families.

2. Very little or no work has been done with respect to the construction of good keys to the families of Utah Coleoptera. The author has found that there are sixty-nine families of beetles excluding Rhyncophora definitely represented in the state, with the possibility that several additional families might be found to occur here.

3. After considerable deliberation, the classification systems of Leng and Boving and Craighead were used as a basis for this study. The names of the series of superfamilies and superfamilies were taken from Leng (1920). These seemed to be more natural groupings according to the structural characteristics used in the keys.

4. In order to make the keys as simple as possible, characters which are readily seen and recognized were used, along with many illustrations drawn by the author. However, some of the drawings were taken from other sources, as was indicated in the list of drawings. To break the order down into more workable units the author has constructed sixteen keys, the largest of which contains only fifteen families. Wherever possible definite statements were used in the keys, avoiding the use of relative sizes, shapes or forms of structures if those relationships could not be definitely shown.

5. The results of this study indicate that much work must be done, correlating external and internal morphology, before a satisfactory phylogenetic classification of Coleoptera can become a reality. All authors studied by the writer, with the exception of Crowson (1955), have approached the problem from only one aspect, i. e., imagines, larvae, or genitalia, but none have tried to use several or all characters in their work.

6. It has been found by the author that the families of Utah Coleoptera can be determined much more readily by using the keys found in this paper, rather than the large cumbersome keys of such workers as Edwards (1954), Essig (1947, 1948), Comstock and others who list all North American families and generally have only one key for the entire group.

LITERATURE CITED

Arnett, R. H. Jr. 1955. The Beetle Families, Entomological Research Branch, U. S. Department of Agriculture.

Borror, D. J., and De Long, D. M. 1954. An Introduction to the Study of Insects. Rinehart and Co., New York.

Boving, A. G., and Craighead, F. C. 1930. An Illustrated Synopsis of the Principal Larval Forms of the Order Coleoptera, Entomologica Americana, XI:I, pp. 1-334.

Bradley, J. C. 1947. Classification of Coleoptera. The Coleopterists' Bulletin, I. pp. 79-85.

Casey, T. L. Oct., 1893. Coleopterological Notices. Annals of the New York Academy of Sciences, VII, p. 19.

Chandler, H. P. 1941. New Species of Coleoptera from Utah (Omophronidae and Dytiscidae). Great Basin Naturalist, II:2, pp. 99-104.

Comstock, J. H. 1949. An Introduction to Entomology. Comstock Publishing Company, Ithaca, New York.

Cott, E. H. 1955. Ecology of the Great Salt Lake Desert, Southern Extension, Checklist of the Insects, Second Revision. University of Utah Ecological Research, pp. 6-8.

Crowson, R. A. 1955. The Natural Classification of the Families of Coleoptera. Nathanial Lloyd and Co., Ltd., London.

Essig, E. O. 1947. College Entomology. The Macmillan Company, New York.

Essig, E. O. 1948. Insects of Western North America. The MacMillan Company, New York.

Edwards, J. G. 1949. Coleoptera or Beetles East of the Great Plains. Edwards Brothers Inc., Ann Arbor, Michigan.

Hayward, C. L. 1945. Biotic Communities of the Southern Wasatch and Uinta Mountains, Utah. Great Basin Naturalist, VI:I-IV, pp. 117-118.

Jaques, H. E. 1951. How to know the Beetles. Wm. C. Brown Co., Dubuque, Iowa.

Leconte, J. L., and Horn, G. H. 1883. Classification of the Coleoptera of North America. Smithsonian Institution, part I.

Leng, C. W. 1920. Catalogue of Coleoptera of America North of Mexico. John D. Sherman, Jr., Mount Vernon, N. Y.

Linsley, E. G., and Mac Swain, J. W. 1951. The Rhipiphoridae of California. Bulletin of the California Insect Survey, I: 3, p. 87.

Metcalf, C. L., and Flint, W. P. 1939. Destructful and Useful Insects, Their Habits and Control. McGraw-Hill Book Co., New York.

Sabrosky, C. W. 1952. Insects. Yearbook of Agriculture, United States Department of Agriculture, Washington, D. C., United States Government Printing Office, Washington D. C.

Tanner, V. M. 1927. A Preliminary Study of the Genitalia of Female Coleoptera. Transactions of the American Entomological Society, LIII: 5-50.

Tanner, V. M. 1928. The Coleoptera of Zion National Park, Utah. The Entomological Society of America, Vol. XXI, No. 2, pp. 269-281.

Tanner, V. M. 1941. Interesting Coleoptera Records for Utah. Great Basin Naturalist, II: 1, page 36.

Torre-Bueno, J. R. De La. 1937. A Glossary of Entomology. Brooklyn Entomological Society, Brooklyn, N. Y., 336 pp.

A Taxonomic Study of the Families of Utah Coleoptera Excluding Rhyncophora

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Abstract of

A Thesis Submitted to the

Department of Zoology and Entomology

of

Brigham Young University

In Partial Fulfillment

of the Requirements for the Degree of

Master of Arts

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by

T. Blaine Moore

January 2, 1957

During the years 1950-51 work was begun on a study of the Coleoptera by the author. In 1955, due to the lack of a workable set of keys to the Coleoptera of Utah, a study was undertaken to find a way to more easily classify the beetles of the state to their respective families.

The collection of Brigham Young University was used as the basis for determining the families of beetles actually found in Utah. Then a thorough search of the literature was made to find positive records of Utah families not represented in that collection.

It was found that of the one hundred two families of Coleoptera (less Rhyncophora) listed for North America by Leng (1920) sixty-nine of them are definitely represented in Utah, with the possibility of adding more to the list when more extensive collecting is done.

While two authors studied (Comstock, 1949 and Essig, 1948) place the families of Coleoptera into groups called series of superfamilies according to various structural similarities, few attempts have been made to break down the order into smaller groups for taxonomic work. Even though they mention the superfamilies, no attempt has been made to make keys to these groups. Inasmuch as the order is so large, it would seem advisable to construct a more workable group of keys to the Coleoptera. This would undoubtedly be very beneficial to the beginning Coleopterists, for it breaks an otherwise unwieldy group down into more workable divisions. Also, by limiting this problem to the Coleoptera of Utah, some thirty-one families will be eliminated for, according to records available to the author, they are not represented in this state.

Illustrations are used extensively to make it easier for the student to understand the characters used to separate the families or groups

of families.