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AQUATIC DRYOPOID BEETLES (COLEOPTERA) OF THE UNITED STATES

by

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FOREWORD

This manual was originally published as Identification Manual No. 6, Biota of Freshwater Ecosystems, Water Pollution Control Research Series 18050 ELD04/72, U.S. Environmental Protection Agency. This series of manuals was prepared to improve the quality of the data upon which environmental decisions are based by providing biologists in the USEPA, and other Federal, state and private agencies with improved taxonomic guides for the identification of organisms collected in studies of aquatic ecosystems. Other groups of invertebrates for which manuals were prepared in this series include: branchiuran crustaceans (Argulus), amphipod crustaceans (Gammaridae), isopod crustaceans (Asellidae), decapod crustaceans (Astacidae), leeches (Hirudinea), freshwater nematodes (Nematoda), polychaete worms (Polychaeta), freshwater planarians (Turbellaria), freshwater clams (Sphaeriacea), and freshwater mussels (Unionacea). The preparation of these documents was coordinated by the Oceanography and Limnology Program, Smithsonian Institution.

The manuals in the Biota of Freshwater Ecosystems series supplement identification manuals on the diatoms and midges prepared earlier by the Aquatic Biology Methods Development and Standardization Program, Environmental Monitoring & Support Laboratory-Cincinnati, Office of Research & Development, U.S. Environmental Protection Agency, Cincinnati, Ohio, and will be made available from this office. The Aquatic Biology Section is responsible for the development, evaluation and standardization of methods for the collection of biological field and laboratory data by EPA regional, enforcement, and research programs engaged in inland, estuarine, and marine water quality and permit compliance monitoring, and other studies of the effects of pollutants on aquatic organisms, including the phytoplankton, zooplankton, periphyton, macrophyton, macroinvertebrates, and fish. The program addresses methods for: sample collection; sample preparation; organism identification and enumeration; the measurement of biomass, metabolic rates, and the bioaccumulation and pathology of toxic substances; bioassay; and the computerization, analysis, and interpretation of biological data. Biological methods recommended for use in the Federal water pollution control program are included in the manual, Biological Field and Laboratory Methods for Measuring the Quality of Surface Waters and Effluents, published by our program.

Identification manuals have also been prepared or are currently in preparation or revision by our program for the following groups: naidids, tubificids, leeches, crustacean zooplankton, stoneflies, mayflies (Stenonema), centric diatoms, and blue-green algae. As companions to the biological methods manual and the taxonomic keys, water quality profiles have been developed or are in preparation for the freshwater diatoms, blue-green algae, midges, mayflies, stoneflies, caddisflies, and crustacean zooplankton.

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ABSTRACT

An illustrated key is given for all known species of adult dryopoid beetles of the United States which have aquatic stages and might be useful as indicators of water quality. A key is also given to the genera of larvae. For each species the known habitat and range are given. Life histories are briefly outlined and methods for collection, preservation, storage and identification are suggested. Two new species, *Optioservus ozarkensis* Collier and *Optioservus sandersoni* Collier, are described. The genera included in the keys are: Chelonariidae--*Chelonarium;* Elmidae--Tribe Larini: *Lara, Phanocerus;* Tribe Elmini: *Ampumixis, Ancyronyx, Atractelmis, Cleptelmis, Cylloepus, Dubiraphia, Elsianus, Gonielmis, Heterelmis, Heterlimnius, Hexacylloepus, Macronychus, Microcylloepus, Narpus, Neocylloepus, Neoelmis, Optioservus, Ordobrevia, Oulimnius, Promoresia, Rhizelmis, Stenelmis, Zaitzevia;* Dryopidae--*Dryops, Helichus, Pelonomus;* Limnichidae--Limnichinae: *Limnichus, Lutrochus, Physemus;* Cephalobyrrhinae: *Throscinus;* Psephenidae--Eubriinae: *Acneus, Dicranopselaphus, Ectopria;* Eubrianacinae: *Eubrianax;* Psepheninae: *Psephenus;* Ptilodactylidae--*Anchycteis, Anchytarsus, Stenocolus.* The bibliography includes selected useful references in addition to the literature cited.

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SECTION I

INTRODUCTION

For practical purposes, one may consider any non-swimming aquatic beetle found in the United States to be a dryopoid. Although a few, such as *Psephenus* and *Lutrochus*, may be relatively conspicuous on rocks projecting from riffles, the majority are very small, inconspicuous, and slow-moving. Since the typical habitat of almost all dryopoids is in riffles, rapids, or comparable lotic situations, the common name "riffle beetle" is generally appropriate. Furthermore, since one author or another has applied this name to the dryopoids alone, the elmids alone, or the psephenids alone, while others have used it indiscriminately for all, it might as well be used for the entire group of aquatic dryopoids.

The Superfamily Dryopoidea, in the Suborder Polyphaga, includes members (the Limnichidae) that are very close to the Byrrhoidea, and others that are closely allied to the Dascilloidea (most of the genera listed under Psephenidae and Ptilodactylidae are treated as members of the family Dascillidae by Arnett (1963)). Crowson (1967) considers the Superfamily Dryopoidea as being comprised of the families Psephenidae, Eurypogonidae, Ptilodactylidae, Chelonariidae, Heteroceridae, Limnichidae, Dryopidae, and Elmidae. The Eurypogonidae and Heteroceridae are omitted from treatment here since none of our representatives of these families are known to be aquatic, although the heterocerids burrow in mud along the margins of streams, ponds, and lakes. By far the most promising as indicators of water quality are the elmids, but the psephenids, adults of *Helichus* (Dryopidae), and larvae of *Lutrochus* (Limnichidae) should also be useful for this purpose.

Although somewhat detailed information concerning habitats of individual genera and species is presented in the species list, a few general facts concerning dryopoid life histories and ecology may be helpful. The elmids of the tribe Elmini are the most completely aquatic of all beetles. The eggs, so far as is known, are deposited on submerged rocks or wood, usually on the under side. Here the larvae develop, creeping about and feeding chiefly upon the algae which tend to encrust such substrates or upon decaying waterlogged wood. Respiration is accomplished by tufts of filamentous tracheal gills which are extruded from a caudal chamber. The gills may be retracted and the chamber closed by a trapdoor-like operculum. Mature larvae crawl out of the water and pupate in small cavities beneath loose bark or rocks close to the water's edge. Newly emerged adults of many species apparently fly at night, and are attracted to lights. Upon returning to the water, most individuals will never again emerge into the air, spending the rest of their lives (several years in some species) in the same habitat and utilizing the same food as the larvae. Their respiratory

requirements are met through the use of a plastron (Thorpe, 1950; Thorpe and Crisp, 1949). Various parts of the legs and body, especially on the ventral side, are covered with a hydrofuge tomentum or pile which maintains a film of air when the beetle is submerged. This film, which is in contact with the air reservoir beneath the elytra, provides adequate gaseous exchange in the well-aerated lotic situations occupied by the beetles. Small bubbles of oxygen photosynthetically produced by algae and other aquatic plants provide an additional source of oxygen and can be incorporated into the plastron. Since the gaseous film is essential to these beetles, it is not difficult to understand why they cannot tolerate excessive pollution by such wetting agents as soaps and detergents.

Elmids of the tribe Larini are less thoroughly aquatic. The adults are essentially riparian, usually occurring at or just above the water line in rapids and creeping beneath the surface only for oviposition (presumably). They take flight readily, often after dropping onto the water surface and being swept a short distance downstream. Otherwise, the life history is like that of the Elmini.

Psephenus and *Eubrianax*, in the family Psephenidae, exhibit a pattern very much like that of the Larini, except that the females may remain submerged for days as they go about their task of oviposition beneath rocks. Mature larvae (water pennies) crawl out and pupate beneath the larval carapace. Details are unknown for the members of the Eubriinae, but since the adults are found in shrubbery rather than at the water's edge, it is quite possible that the adults never enter the water, perhaps ovipositing on objects overhanging the stream as do such neuropterans as the sisyrids and dobsonflies. Pupation, at least in *Ectopria*, is comparable to that in *Psephenus*.

In the family Limnichidae, *Lutrochus* has a life history that is also very much like that of the Larini, although the adults of some species may enter and remain under water for indefinite periods of time. Females insert their eggs in such substrates as travertine. The other genera of limnichids occurring within the United States are apparently not aquatic even as larvae. Their life histories are unknown. The adults are included in the key only because they may be taken near water (in fact, *Limnichus* commonly falls onto the water from trash lodged in the stream, and readily flies from the water surface as do *Lutrochus*, *Psephenus*, *Phanocerus*, and *Lara*).

Chelonarium (Chelonariidae) is aquatic only in the larval stage, as are those members of the Ptilodactylidae listed here. Other ptilodactylids are not aquatic at all.

Helichus, of the family Dryopidae, is unique among insects in that the adults are aquatic, behaving rather like elmids, whereas the larvae are terrestrial, inhabiting soil or decaying wood. The adults are not permanently bound to the water once they return to it. They probably emerge and fly at night, at least upon occasion. The females have sharp-tipped ovipositors with which they probably insert their eggs into appropriate materials. The larvae of *Dryops* and *Pelonomus* are also soil-dwellers, the adults being terrestrial or, at most, riparian. *Dryops* frequents trash lodged in streams, but does not appear to enter the water.

COLLECTING

With a few notable exceptions, such as *Psephenus* and *Eubrianax* among the psephenids and such flightless elmids as *Ancyronyx* and *Macronychus* most of our dryopoid adults can be effectively collected with light traps and black lights. To be successful with this method, of course, one must use it when the adults have emerged from pupation. The best time will vary with locality, seasonal and weather conditions, and species. For example, in Oklahoma in an average year, *Ectopria* may be taken in abundance at lights on humid nights in very late May and early June; at other times they are unlikely to be taken. Specimens collected at lights are ideal for taxonomic purposes, at least in that they are not encrusted with mineral deposits or bedecked with epizoic organisms such as diatoms and ciliates.

Perhaps the most useful general method of collecting the aquatic larvae and adults that inhabit gravelly and rocky riffles is to hold a delta net against the bottom in such a way as to catch the organisms dislodged while turning over rocks just upstream from the net, or vigorously stirring up the gravel by hand, heel, alpenstock, or whatever is at hand. (A small rake serves rather well.) This is probably the best method for most of the elmids and *Helichus*.

Nets are not effective for most of the species that cling tightly to submerged wood or plants. Usually one must remove logs or sticks from the water, turn them over, let them drain briefly, then laboriously pick off the specimens as they creep downward. The same can be done with rocks, and this is often very productive. Or one can place the stick or rock over a white pan or old sheet and let the specimens collect themselves (they will accompanied, of course, by caddis worms and most of their other former neighbors). These techniques are best for such genera as *Ancyronyx*, *Macronychus*, *Gonielmis*, and *Heterelmis*. Most larval psephenids must be picked off the rocks.

For species that inhabit such things as submerged plants or roots, a Berlese funnel may be the most productive collecting device. Quantities of the plant materials can be transported in large plastic bags to the laboratory and placed in the funnel beneath some source of heat (light bulbs are adequate). A screen of hardware cloth prevents the larger objects from falling below, but the beetles will drop into a waiting receptacle of preservative. This is a good method for getting large numbers of *Dubiraphia*.

Disturbing trash (leaves, etc.) lodged on sticks or rocks in streams while holding a net downstream to catch the dislodged specimens being swept down afloat is effective for collecting *Dryops*, *Limnichus*, *Phanocerus*, *Psephenus*, and *Lutrochus*. For dislodged specimens swept downstream underwater, it is good for getting *Helichus*, *Heterelmis*, and *Microcylloepus*.

For agile fliers such as *Psephenus* and *Lutrochus* on rocks protruding from rapids or riffles, a net or plastic bag may be useful for catching the specimens that tumble onto the water to be swept downstream briefly before taking flight, but many specimens can be taken by aspirator or by hand (it is best to wet your fingers first). Approach the beetle carefully, without sudden movements, and pin it down lightly with a forefinger. The thumb and middle finger can then be used to grasp it.

Sweeping foliage of trees and shrubs near streams may yield adults of the Eubriinae, Chelonariidae, and Ptilodactylidae. This is not very efficient, but no better method is known for collecting some of these.

PRESERVATION AND STORAGE

For routine collecting, a supply of 4-dram vials almost full of 80% ethyl alcohol is handy. Fine-tipped forceps, preferably of the curved type, are indispensable. If not young and near-sighted, the collector should have either magnifying glasses or glasses enabling him to read fine print.

For ordinary purposes, 70-80% ethyl alcohol is satisfactory for killing, transport, and storage of both larvae and adults. If one anticipates detailed dissection of internal parts, it may be better to preserve initially in Pampl's fluid, which contains acetic acid for rapid penetration. Specimens should be removed from Pampl's fluid to 70-80% alcohol for storage. Whether the insects have been killed in alcohol or in Pampl's fluid and then transferred to alcohol, if is best to change the alcohol after a few days. It is also sometimes desirable to add about 5% glycerol to the alcohol in which specimens are stored. This serves a dual function: it helps keep the appendages flexible and, should the cap not prove airtight, prevents complete drying of the specimen if all the alcohol evaporates.

Pampl's Fluid

Glacial acetic acid	4 ml
Distilled water	30 ml
Formalin (40% formaldehyde)	6 ml
95% ethyl alcohol	15 ml

A common and sensible museum storage method for specimens preserved in alcohol is to place the specimens in vials, along with appropriate data and alcohol, to plug with cotton or cotton wool, then to place upside down for storage in a larger jar half filled with alcohol. Cheap shell vials are satisfactory for this, and many can be kept in a single jar. If vials are to be stored instead in narrow trays, it is probably best to use patent lip vials with rubber stoppers. Cork stoppers are totally unreliable, and a discouraging percentage of screw-cap vials allow evaporation of the alcohol because of imperfections of either the lip or the cap liner.

For standard dry preservation of adults in Schmitt boxes or cabinet drawers, virtually all of our dryopoid beetles are small enough for the use of points. In fact, most are so small that they cannot be pinned otherwise, even with minuten nadeln.

PREPARATION AND EQUIPMENT NEEDED FOR IDENTIFICATION

For identification of genera or species, a stereoscopic microscope, spot lamp, forceps, and fine needles are necessities. Disposable hypodermic syringe needles (e.g., No. 26) attached to any convenient handle make excellent micro-scalpels. All dissections and most examination of material, particularly of larvae, should be done with the specimen immersed in water or alcohol. For specific determination in some genera, such as *Stenelmis*, it is necessary to extract the male genitalia and to mount them on a microscope slide for examination under a compound microscope. Glycerol (glycerine) is satisfactory for temporary microscopic preparations. Hoyer's mounting medium (obtainable from Ward's Natural Science Establishment, Rochester, New York) is quite convenient for temporary and semi-permanent mounts. Canada balsam is perhaps best for permanent mounts, though it is time-consuming, since specimens must be completely dehydrated through a graded series of alcohol concentrations, then saturated with a suitable solvent such as xylol or toluol, before placing in the balsam.

Most specimens as brought in from streams are well covered with either mineral deposits (sometimes far exceeding the weight of the insect) or epizoic organisms such as diatoms and peritrich ciliate protozoa. A sonic cleaning tank is helpful, but removes only the rather loosely-adhering "dirt". A closely-trimmed camel's-hair brush is also quite useful in cleaning specimens, but often only breaking of the mineral "armor" with forceps or scraping with a needle can reveal the surface of the insect. Care must be exercised in such scraping, for it is easy to scrape through the cuticle and artificially produce misleading markings or coloration.

When required for specific determination, genitalia may be removed in at least two ways: (1) using a stereoscopic microscope to observe, hold the specimen between the thumb and forefinger of one hand; with fine-tipped watchmaker's forceps in the other hand, insert the tips between the last abdominal sternite and elytral apex (Figs 1, 2); grasp and extract whatever you can. With a little experience, one can usually remove the genitalia by this means. The other method is usually more destructive to the specimen. (2) Remove either the abdomen (it can often be glued back into place if necessary) or the elytra. This exposes the soft dorsal tergites of the abdomen, through which an incision can be made - or the whole dorsum torn off - to expose the underlying visceral organs. Usually the only prominent sclerotized structure in the abdomen of the male is the genital complex. This can be removed and teased apart in appropriate fashion. As a rule, the soft enclosing tissues must be torn away, along with the penial spicules (Fig. 10) in order to expose the genitalia. Further cleaning and clearing can be accomplished by placing the genitalia in a hot aqueous solution of strong potassium hydroxide for about 15 minutes. After rinsing in distilled water, then 70% alcohol, the specimen may be

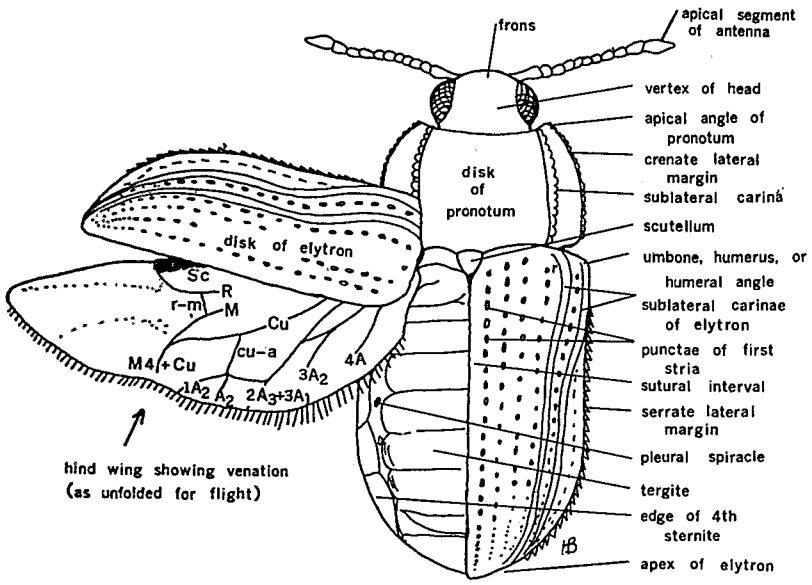


Fig. 1. Dorsal features of adult elmid beetle.

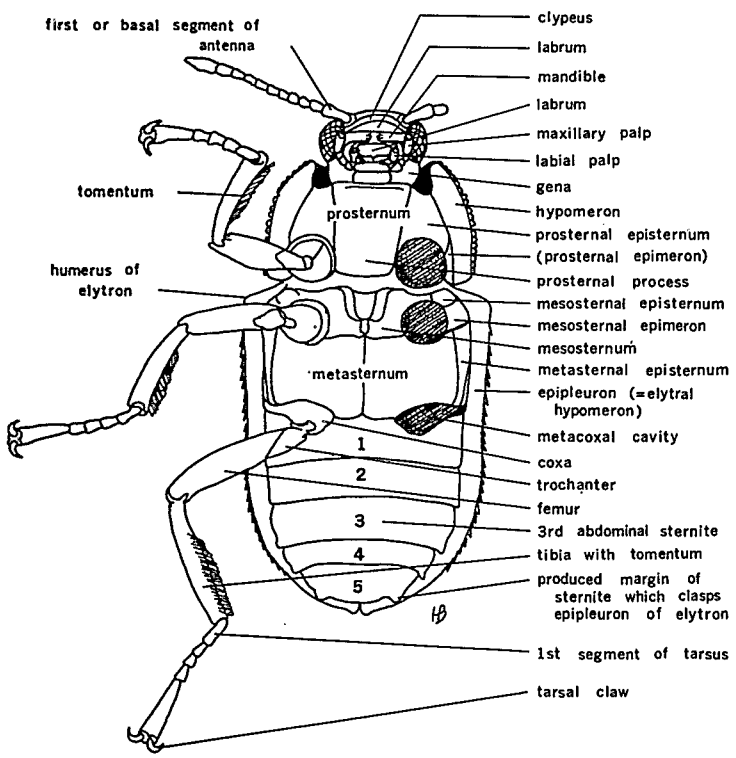
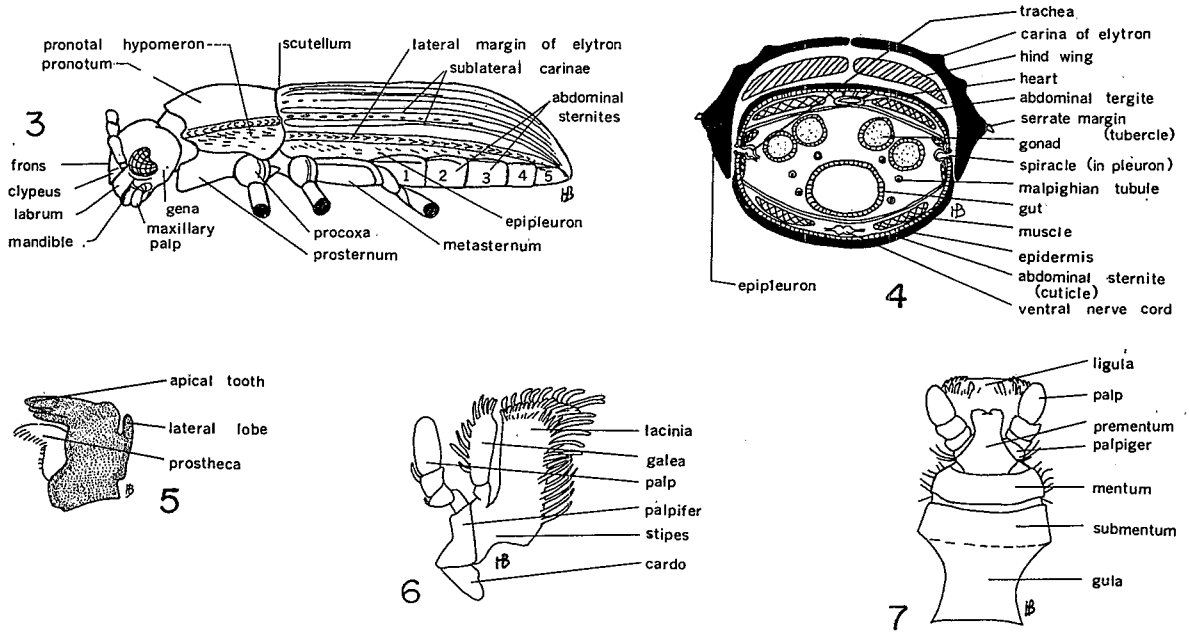


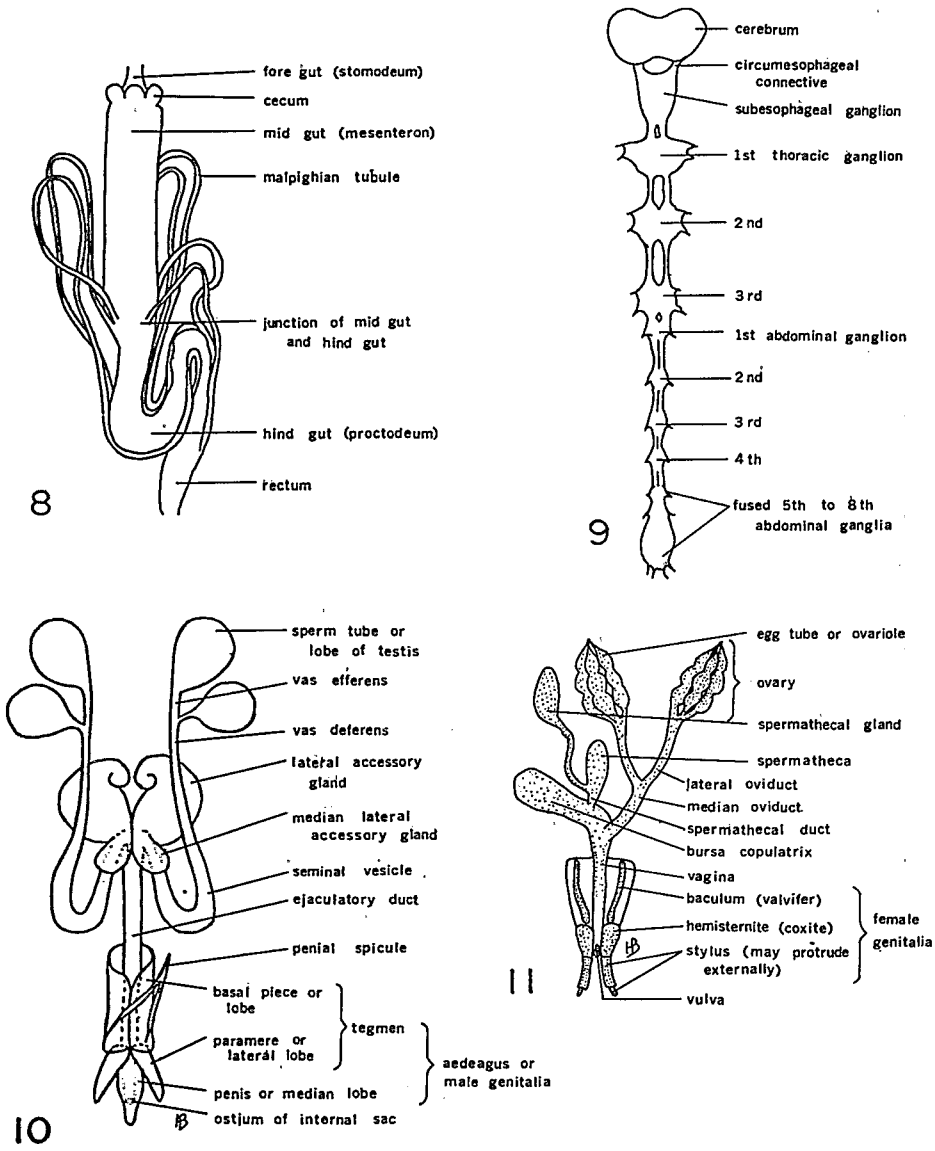
Fig. 2. Ventral features of adult elmid beetle.



Figs 3-7 Adult elmid beetle: 3- lateral aspect; 4- diagrammatic cross section through abdomen; 5- mandible of *Heterelmis* 6- maxilla, right side, ventral aspect, of *Neocylloepus;* 7- labium, ventral aspect, of *Neocylloepus*.

mounted in Hoyer's medium and examined promptly. By jiggling of the cover glass with a needle, one can usually get the specimen into the necessary position for observation (at times a dorsal view is needed, at other times, a lateral or ventral view may be desired). Since Hoyer's medium is soluble in either alcohol or water, the specimens may be readily removed even after months on the slide.

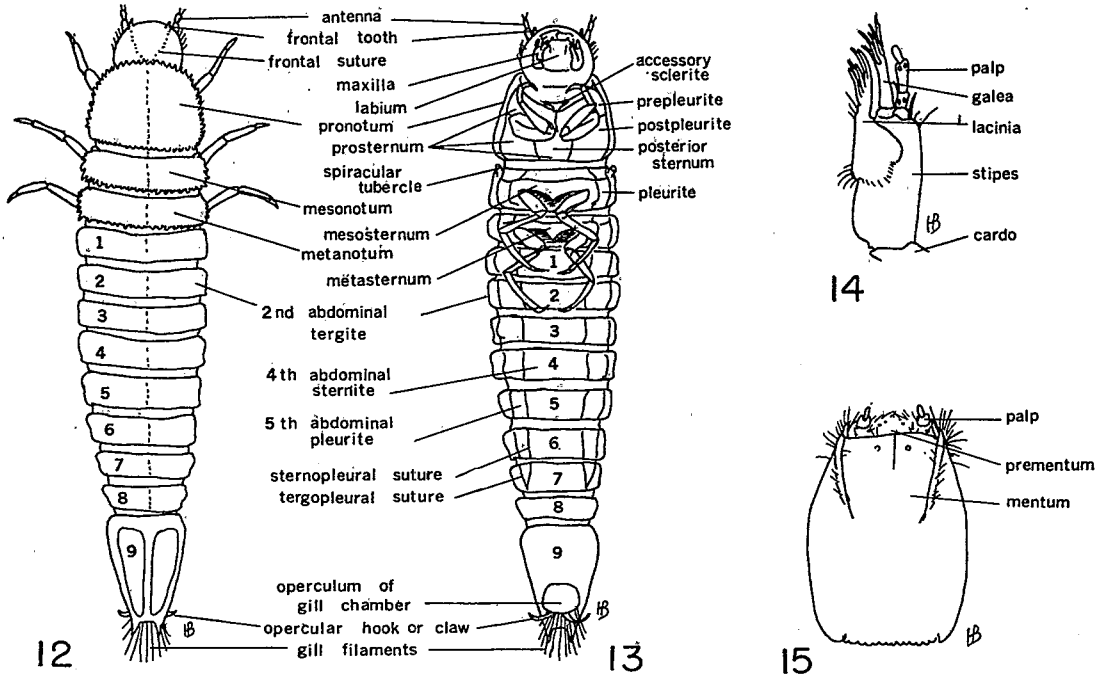
A formidable vocabulary has arisen for the description and classification of beetles. This is not surprising, in view of the fact that they represent the largest order of plants or animals. Nor is it surprising that some terms have been used in diverse ways or that a number of different terms have been used for a particular structure. Figures 1-15 should assist the reader not only in making use of the following keys but also in understanding the more detailed references he may consult. These are diagrams or simplified figures of representative dryopoid beetles, illustrating the major morphological features and the terms most commonly applied to them. The figures should be useful even though some of the terms are not employed in the keys. It will be worthwhile to study Figs 1-15 with care before attempting to use the keys. These figures serve as an illustrated glossary, though a standard form of glossary is appended (p. 73).



Figs 8-11 Adult elmid beetle: 8- dorsal aspect of digestive tract of *Neocylloepus;* 9- central nervous system of *Neocylloepus;* 10- male reproductive system, dorsal aspect, of *Neocylloepus;* 11- female reproductive system, dorsal aspect.

If the reader is unfamiliar with insects, he would be well advised to consult a general textbook of entomology. For general coverage of aquatic insects, two books are outstanding. The sections of these books dealing with the Coleoptera are cited in the bibliography: Leech and Chandler (1956), and Leech and Sanderson (1959). Both were extremely helpful to me in the preparation of the keys which follow, as was the work of Sanderson (1953-54).

Among the beetles treated in these keys are groups of species which need revision. In the absence of described characters which clearly distinguish species, geographical location is used in the key so that identification may be made according to published accounts.



Figs 12-15 Elmid larva (*Neocylloepus*): 12- dorsal aspect; 13- ventral aspect; 14- left maxilla, ventral aspect; 15- labium, ventral aspect.

SECTION II

SPECIES LIST AND RANGES

In this section two new species, *Optioservus ozarkensis* and *O. sandersoni*, are described by Joe Edward Collier. He submitted his Ph. D. thesis (Collier, 1969) to the Graduate School of the University of Minnesota in August, 1969 but died of cancer that same month. His Major Professor, Dr. Edwin F. Cook, has authorized publication here of Collier's descriptions as a means of validating Collier's authorship of these two species. The descriptions presented here are taken from Collier's thesis and authorship is to be ascribed solely to Joe Edward Collier.

Family CHELONARIIDAE (Lacordaire, 1854)

Genus *Chelonarium* Fabricius, 1801

Chelonarium lecontei Thomson, 1867. Though probably not really aquatic, larvae in damp moss may be washed into streams; adults usually on vegetation or taken at lights in southeastern states from Florida to North Carolina, Tennessee, and Alabama.

Family ELMIDAE (ELMINTHIDAE) (Westwood, 1838)

Tribe Larini

Genus *Lara* LeConte, 1852

Lara avara avara LeConte, 1852. Rapid, clear mountain and foothill streams from British Columbia to southern California and eastward through Idaho and Utah to Wyoming and Colorado. Larvae on submerged wood and debris; adults usually on logs just above churning or rushing water, either beneath or on the downstream side of the log.

Lara avara amplipennis Darlington, 1929. Habitat as above from British Columbia and Washington.

Lara gehringi Darlington, 1929. Habitat as for *L. avara* from Washington south to central California.

Genus *Phanocerus* Sharp, 1882

Phanocerus clavicornis Sharp, 1882. Rapids and riffles from Central America and Mexico northward to Val Verde Co., Texas (known in the United States from Devil's River and San Felipe Creek in Del Rio). Larvae typically on submerged plant material; adults just above or just below water line on objects protruding from water in rapids or small falls.

Tribe Elmini

Genus *Ampumixis* Sanderson, 1954

Ampumixis dispar (Fall, 1925). In sandy and gravelly bottoms of rapid, clear, cool or cold streams in foothills and mountains from Washington south to California.

Genus *Ancyronyx* Erichson, 1847

Ancyronyx variegata (Germar, 1824). On submerged wood or trash (larvae may be under decaying bark) in streams throughout the eastern states from Maine to Florida, westward to Wisconsin and the eastern portions of Kansas, Oklahoma, and Texas. Sensitive to sewage and industrial wastes.

Genus *Atractelmis* Chandler, 1954

Atractelmis wawona Chandler, 1954. Rare in riffles of rapid, clear mountain streams in California at elevations from 2,000 to 5,000 feet (actually reported from only two localities - the South Fork of the Merced River near Wawona in Yosemite National Park and Middle Fork of Cottonwood Creek, Shasta County).

Genus *Cleptelmis* Sanderson, 1954

Cleptelmis addenda (Fall, 1907). On roots and moss or rocks and gravel in rapid, cold mountain or foothill streams from California and southeast Oregon to New Mexico and South Dakota.

Cleptelmis ornata (Schaeffer, 1911). On roots, moss, rocks, and gravel in rapid mountain or foothill streams from central California to British Columbia and eastward to Arizona, Colorado and Montana.

Genus *Cylloepus* Erichson, 1847

Cylloepus abnormis (Horn, 1870). Beneath rocks and in sandy gravel in riffles of creeks and rivers throughout Mexico, but extending into Arizona (San Pedro River) and Texas (Limpia Creek in the Davis Mountains, small stream near Camp Wood). Common in Mexico (known as *Cylloepus sexualis* Hinton) but rare in the United States.

Cylloepus parkeri Sanderson, 1953. Known only from small, rocky streams in Bloody Basin, Yavapai Co., Arizona.

Genus *Dubiraphia* Sanderson, 1954

(This genus is currently under revision by Dr. William Hilsenhoff. Some of these species may be combined. Others will be added.)

Dubiraphia bivittata (LeConte, 1852). On submerged roots, aquatic plants, or other plant material in streams and lakes of eastern states, and upper Mississippi River drainage.

Dubiraphia brunnescens (Fall, 1925). Among submerged willow roots along rocky, wave-washed shore of Clear Lake, Lake Co., California.

Dubiraphia giulianii (Van Dyke, 1949). Described from vegetation and rocks in the slow part of Russian River, California. Also reported from eastern Oregon and southern Idaho.

Dubiraphia quadrinotata (Say, 1825). On submerged roots, aquatic plants, or other plant material (including rocks encrusted with algae) in streams, ponds, and lakes throughout the eastern and central states where it is often abundant, and in scattered streams westward to New Mexico, Utah, and Idaho. Sensitive to chlorides; occurs in recovery zone below sewage treatment plants.

Dubiraphia vittata (Melsheimer, 1844). As above.

Genus *Elsianus* Sharp, 1882

(This genus is currently under revision by Dr. Howard Hinton.)

Elsianus moestus (Horn, 1870). Beneath rocks in Arizona streams.

Elsianus shoemakei Brown, 1971. In gravel or beneath rocks in San Felipe Creek in Del Rio, Texas and the upper Rio Salado in Coahuila, Mexico.

Elsianus texanus Schaeffer, 1911. In gravel or under rocks in streams with a high calcium content from Austin, Texas to southeastern New Mexico and southward into Mexico.

Genus *Gonielmis* Sanderson, 1954

Gonielmis dietrichi (Musgrave, 1933). On submerged wood and roots in sandy streams from eastern Tennessee, Georgia, and Florida to Mississippi. Tolerant of moderate organic enrichment, turbidity, and siltation, but sensitive to paper mill effluent.

Genus *Heterelmis* Sharp, 1882

(A new species is being described from the Santa Rita Mountains of Arizona.)

Heterelmis glabra (Horn, 1870). On submerged wood and trash and under stones, especially in lowland streams from southern Nevada, through Arizona, much of Mexico, and in the Rio Grande River along the Texas border.

Heterelmis obesa Sharp, 1882. On submerged wood and under stones in cold, fast streams of Arizona and New Mexico, especially at higher elevations.

Heterelmis vulnerata (LeConte, 1874). On submerged wood and debris and under rocks in streams of Oklahoma and Texas.

Genus *Heterlimnius* Hinton, 1935

Heterlimnius corpulentus (LeConte, 1874). In gravel and under rocks in rapid mountain streams from New Mexico to California and northward to South Dakota, Montana, and British Columbia.

Heterlimnius koebelei (Martin, 1927). In rapid mountain streams from northern California to British Columbia.

Genus *Hexacylloepus* Hinton, 1940

Hexacylloepus ferrugineus (Horn, 1870). On travertine, under rocks, in gravel, and sometimes on wood, chiefly in riffles of streams with a calcium content from Mexico through central Texas into the Arbuckle Mountain region of south central Oklahoma and into southeastern New Mexico.

Genus *Macronychus* Muller, 1806

Macronychus glabratus Say, 1825. On submerged wood and debris in streams of the eastern and central states from Florida to Maine and eastern Texas and Oklahoma to Wisconsin. Sensitive to sewage and many industrial wastes, such as those from plating, textile, and viscose rayon plants.

Genus *Microcylloepus* Hinton, 1935
(Other species will soon be described, including one from springs in Death Valley, California.)

Microcylloepus browni (Hatch, 1938). Warm spring in Montana.
Microcylloepus moapus La Rivers, 1949. Warm springs in southeastern Nevada.
Microcylloepus moapus fraxinus La Rivers, 1949. Warm springs in southeastern Nevada.
Microcylloepus pusillus (LeConte, 1852). Versatile and common on submerged wood and debris, under rocks, or in gravel of streams from Mexico east to Florida, west to California, and north to Oregon, Idaho, Wyoming, South Dakota, Missouri, Tennessee, and among the eastern states to Maine. Tolerant of siltation and turbidity, but sensitive to sewage and such industrial wastes as those from rayon plants and plating mills.
Microcylloepus pusillus aptus (Musgrave, 1933). Northern Florida to Virginia.
Microcylloepus pusillus pusillus (LeConte, 1852). Virginia to New York.
Microcylloepus pusillus lodingi (Musgrave, 1933). Southeastern (Gulf) coastal plain.
Microcylloepus pusillus perditus (Musgrave, 1933). Peninsular Florida.
Microcylloepus pusillus similis (Horn, 1870). West of the Rocky Mountains.
Microcylloepus thermarum (Darlington, 1928). Warm springs in northwestern Nevada.

Genus *Narpus* Casey, 1893
(A new species will soon be described.)

Narpus angustus Casey, 1893. In gravelly or rocky rapids of clear streams in the coastal range of California.

Narpus arizonicus (Brown, 1930). In rapid streams of the White Mountains of eastern Arizona. (This may be but a variant of *N. concolor*)

Narpus concolor (LeConte, 1881). In clear, rapid, cool or cold streams of western states from New Mexico to California and north into Canada.

Genus *Neocylloepus* Brown, 1970

Neocylloepus boeseli Brown, 1970. In gravel and rocks of rapids in Devil's River northwest of Del Rio, Texas and West Clear Creek east of Camp Verde, Arizona.

Genus *Neoelmis* Musgrave, 1935

Neoelmis caesa (LeConte, 1874). In gravel and under rocks in riffles of clear streams with a high calcium content in south-central and southwestern Texas, the Arbuckle Mountain region of south-central Oklahoma and southeastern New Mexico.

Genus *Optioservus* Sanderson, 1954

Optioservus ampliatus (Fall, 1925). In riffles of gravelly or rocky, clear streams from Virginia northward into Canada. Relatively tolerant of sewage and chlorides.

Optioservus canus Chandler, 1954. Known only from Chalone Creek in Pinnacles National Monument of west central California.

Optioservus cryophilus (Musgrave, 1932). On moss-covered stones in fast, spring-fed brooks of the Great Smoky Mountains.

Optioservus divergens (LeConte, 1874). In gravelly or rocky riffles of clear streams from New Mexico to California and north into Canada.

Optioservus fastiditus (LeConte, 1850). In gravelly or rocky riffles or on wood in fast streams in upper New York and from Michigan to Minnesota.

Optioservus immunis (Fall, 1925). In gravelly or rocky streams of Connecticut, New Jersey, and Pennsylvania. (Records from Georgia and Tennessee may represent *O. cryophilus*, which greatly resembles *O. immunis*).

Optioservus ovalis (LeConte, 1863). In gravel or among moss-covered stones in clear, riffly streams from North Carolina north to Vermont and west to Alabama and Ohio.

Optioservus ozarkensis Collier, n. sp. (*see* page 13) (Fig. 83)

Type locality: Holotype, male, Roaring River State Park, Cassville, Missouri. Collected 30 December 1968 by Joe E. Collier.

Location of Type: Holotype, male, Department of Entomology, Fisheries, and Wildlife, University of Minnesota; four paratypes, Snow Entomological Museum, University of Kansas, Lawrence, Kansas; ten paratypes will be deposited in California Academy of Sciences Collection.

DIAGNOSIS: This species resembles *Optioservus trivittatus* (Fig. 81) in appearance but is larger and has very different markings.

DESCRIPTION: Holotype male: Length 2.3 mm, width 1.2 mm; head and thorax shiny black, scutellum ochreous; elytra fuscous brown with yellow-orange markings; venter fuscous brown; entire body covered with short depressed hairs which are much more abundant on ventral surface.

Head: Black; maxillary palpi four-segmented; antennae testaceous, eleven-segmented, length 0.5 mm, segment eleven twice as long as nine or ten, segment three four-fifths as long as eleven, segments one and two almost as wide as long.

Pronotum: Length 0.6 mm, width 0.8 mm; sides arcuately convergent anteriorly, disc covered with very shallow punctuations, basal sublateral carinae 0.2 mm long extending anteriorly.

Elytra: (Fig. 83) Wider than thorax, widest near middle; length 1.7 mm, width 1.2 mm; strial punctures shallow, separated by distance greater than their width; humeral spot reaching seventh stria and extending to suture, then posteriorly two-thirds of way along elytron; second elongate spot extending from just below middle almost to apex of elytron.

Venter: Covered with heavy hydrofuge pubescence, especially on abdomen. Legs ochreous yellow throughout entire length.

DISTRIBUTION: Missouri

SPECIMENS EXAMINED: Holotype (male), four paratypes from Roaring River State Park, Missouri, and ten paratypes from Big Spring State Park, Missouri, taken June 1954, July 1954 and December 1968.

Optioservus pecosensis (Fall, 1907). In clear, cool or cold, gravelly or rocky streams from New Mexico to California and north to Wyoming and Washington (according to Collier). (May well be confused with *O. divergens*.)

Optioservus quadrimaculatus (Horn, 1870). In gravelly or rocky riffles from Colorado west to California and North to Montana and British Columbia.

Optioservus sandersoni Collier, n. sp. (*see* page 13) (Fig. 82)

Type locality: Washington Co., Arkansas, 16 June 1962; Lot No. 193.

Location of type: Holotype, male, and three paratypes, will be deposited in Illinois Natural History Survey Collection.

DIAGNOSIS: This species resembles *Optioservus trivittatus* (Fig. 81) and *Optioservus ozarkensis* (Fig. 83), but may be separated from all other *Optioservus* by the two spots and one sutural vitta on each elytron (Fig. 82). This type of marking has not been found on any other *Optioservus*.

DESCRIPTION: Holotype male: Length 2.6 mm, width 1.3 mm; head and thorax black with yellowish-grey pubescence; scutellum yellowish-orange; elytron dark red-brown with yellowish-orange spots and sutural vitta, striae not deeply punctured on elytron.

Head: Black; clypeus covered with greyish pubescence; maxillary

palpi four-segmented, red-brown in color; labial palpi red-brown, three-segmented; antennae eleven-segmented, reddish-yellow, first three segments equal to length of next six.
Pronotum: Black; sparse yellowish pubescence; very shallow punctures; sides very slightly converging toward apex from base, carinae extending from base nearly to middle, parallel to lateral margin of thorax.
Elytra: (Fig. 82) Dark red-brown; each elytron containing one rounded humeral spot and one elongated apical spot with sutural vitta extending from scutellum to apical third of elytra; spots and vitta yellow-orange in color.
Venter: Epipleuron and most of thorax and abdomen covered with short grey pubescence; legs reddish-yellow; most of underside just slightly darker than legs in color.
Female: As for male.
DISTRIBUTION: Arkansas and Oklahoma.
SPECIMENS EXAMINED: Holotype (male), three paratypes from Washington Co., Arkansas, four paratypes from Ottawa Co., Oklahoma, taken in June 1930 and 1962.

Optioservus seriatus (LeConte, 1874). In gravelly or rocky riffles from north coastal California to British Columbia and in scattered localities in New Mexico, Utah, and Idaho.

Optioservus trivittatus (Brown, 1930). In gravel, under rocks, or on wood in fast streams from the Great Smoky Mountains north to Vermont and Quebec, and in Michigan and Wisconsin. Relatively tolerant of sewage and chlorides.

Genus *Ordobrevia* Sanderson, 1953

Ordobrevia nubifera (Fall, 1901). In gravel and under rocks of foothill streams from California to Washington.

Genus *Oulimnius* Des Gozis, 1886

Oulimnius latiusculus (LeConte, 1866). In gravel or under rocks in riffles of clear streams (often very small brooks) from Alabama, eastern Tennessee, and South Carolina northeast to Canada, ranging from cool lowland streams to elevations higher than any of the other local elmids.

Genus *Promoresia* Sanderson, 1954

Promoresia elegans (LeConte, 1852). In gravel and under rocks in riffles of cool streams from the Great Smoky Mountains northeast to lower New England. *Promoresia* is unusual among members of its subfamily in that it often takes flight when removed from the water, a feature which is characteristic of the Larinae and of Limnichidae and Psephenidae.

Promoresia tardella (Fall, 1925). In gravel and among moss and rocks of riffles of cool streams in the Great Smoky Mountains and in New England and eastern Canada.

Genus *Rhizelmis* Chandler, 1954

Rhizelmis nigra Chandler, 1954. In fast, cool, shaded streams from 2,000 to 5,000 feet elevation in central and northern California.

Genus *Stenelmis* Dufour, 1835

(Several new species will soon be described; surprising records have appeared from southern Idaho and from eastern Oregon.)

Stenelmis antennalis Sanderson, 1938. Commonly on submerged wood and debris (especially under loose bark) in sandy southeastern streams from Mississippi to Florida.

Stenelmis beameri Sanderson, 1938. Cool, clear Ozark streams of Arkansas, Missouri, and Oklahoma; also reported from central and eastern Tennessee.

Stenelmis bicarinata LeConte, 1852. Gravelly or rocky streams from Vermont to South Carolina, west to Wisconsin and Texas and southeastern New Mexico.

Stenelmis calida calida Chandler, 1949. In warm spring pool in southern Nevada.

Stenelmis calida moapa La Rivers, 1949. In warm streams of southern Nevada.

Stenelmis concinna Sanderson, 1938. In eastern streams from North Carolina to Quebec.

Stenelmis convexula Sanderson, 1938. In sandy, gravelly or rocky streams, often on submerged wood, from northwestern Florida west to Texas and southern Oklahoma.

Stenelmis crenata (Say, 1824). In stream riffles from Alabama and northwestern Florida northeastward to New Brunswick and westward to Texas and Wisconsin. Tolerant of chlorides but sensitive to sewage and phosphate wastes.

Stenelmis decorata Sanderson, 1938. In streams from South Carolina to Maryland and west to Kansas and Wisconsin. Tolerant of sewage and phosphate wastes.

Stenelmis douglasensis Sanderson, 1938. On wood in lakes in Michigan and Wisconsin.

Stenelmis exigua Sanderson, 1938. In clear streams of western Arkansas and eastern Oklahoma.

Stenelmis exilis Sanderson, 1938. In clear streams of western Arkansas and eastern Oklahoma.

Stenelmis fuscata Blatchley, 1925. From the sandy streams of northern and central Florida to wave-washed lake margins in Lake Co. to drainage canals of the Everglades.

Stenelmis grossa Sanderson, 1938. In sandy streams from Mississippi to Texas and Arkansas, usually beneath sunken logs.

Stenelmis humerosa Motschulsky, 1859. In streams from Massachusetts south to South Carolina and Tennessee.

Stenelmis hungerfordi Sanderson, 1938. Under rocks in fast streams (with high calcium content) from northwestern Florida to South Carolina.

Stenelmis knobeli Sanderson, 1938. In streams of southwestern Arkansas.

Stenelmis lateralis Sanderson, 1938. In streams from Virginia and Pennsylvania to northeastern Oklahoma.

Stenelmis markeli Motschulsky, 1854. In streams from Massachusetts south to Tennessee and west to Wisconsin and Oklahoma.
Stenelmis mera Sanderson, 1938. In streams from Quebec south to North Carolina and west to Wisconsin and Arkansas.
Stenelmis mirabilis Sanderson, 1938. In eastern streams from Connecticut to South Carolina.
Stenelmis musgravei Sanderson, 1938. In streams from New York to South Carolina and west to Wisconsin and Texas.
Stenelmis parva Sanderson, 1938. In streams in southeastern Oklahoma and eastern Texas.
Stenelmis quadrimaculata Horn, 1870. In lakes and marl bogs from Quebec to Maryland and west to Indiana and Michigan.
Stenelmis sandersoni Musgrave, 1940. In streams from Ontario and West Virginia to northeastern Oklahoma.
Stenelmis sexlineata Sanderson, 1938. In streams from Tennessee and Kentucky to Indiana, Kansas, Oklahoma, and Texas. Tolerant of moderate pollution by sewage, phosphate, and a variety of wastes.
Stenelmis sinuata LeConte, 1852. In sandy streams from Florida to South Carolina and west to Mississippi.
Stenelmis vittipennis Zimmerman, 1869. In streams from Quebec to South Carolina and west to North Dakota and Kansas.

Genus *Zaitzevia* Champion, 1923

Zaitzevia parvula (Horn, 1870). Usually in gravel or under rocks in fast mountain streams of western states from New Mexico to California and north to South Dakota, Montana, and British Columbia.
Zaitzevia thermae (Hatch, 1938). In warm springs of Montana. (Perhaps this is only an ecological variant of *Zaitzevia parvula*.)

Family DRYOPIDAE (Erichson, 1847)

Genus *Dryops* Olivier, 1791

Dryops arizonensis Schaeffer, 1905. Usually just above the water line in debris caught on sticks or rocks in stream riffles (or taken at lights) in central and southern Arizona.

In addition to this known distribution of *Dryops* in the United States, we may expect the genus to occur in southeastern California, in New Mexico, and in Texas along the Rio Grande (I have taken it just over the border in Mexico). Furthermore *Dryops viennensis* (Heer, 1841), an accidentally imported species from Europe, has become established in Quebec, and is to be expected in Maine.

Genus *Helichus* Erichson, 1847

Helichus basalis LeConte, 1852. Beneath rocks near the shore in streams from Georgia to Massachusetts and west to Texas, Kansas, and Ohio.

Helichus confluentus Hinton, 1935. On debris and beneath rocks usually in upland or mountain streams of western Texas, New Mexico, and Arizona, but with a disjunct population in the mountains of northern Georgia (Rabun Bald).

Helichus fastigiatus (Say, 1824). Under rocks in streams from Florida to Maine and Canada, west to Illinois, eastern Kansas and Oklahoma.

Helichus immsi Hinton, 1937. On debris and under rocks in streams from western Texas to California, often abundant.

Helichus lithophilus (Germar, 1824). Under stones or on submerged wood in streams from Florida to Canada and west to Wisconsin, Iowa, central Oklahoma and Texas.

Helichus productus LeConte, 1852. On debris and under rocks in valley and foothill streams of central and southern California.

Helichus striatus LeConte, 1852. On debris and under rocks in cool streams from South Carolina to Quebec, west to California and British Columbia.

Helichus striatus foveatus LeConte, 1852. On debris and under rocks in western streams up to elevations well above 8,000 feet, from Arizona and California to British Columbia.

Helichus suturalis LeConte, 1852. On debris and under rocks in all sorts of streams from warm, muddy, lowland rivers to mountain brooks well above 8,000 feet from central Oklahoma and Texas west to Utah and California and south to Guatemala; often abundant and frequently the only dryopoid in lowland southwestern streams.

Helichus triangularis Musgrave, 1935. On debris and under rocks in small mountain streams from the Chisos and Davis Mountains of Texas to the Chiricahua and Huachuca Mountains of Arizona.

Genus *Pelonomus* Erichson, 1847

Pelonomus obscurus LeConte, 1852. Not a "riffle" beetle. On aquatic plants and debris in swamps and ponds (though most often taken at lights) from Florida to Texas and north to Illinois.

Family LIMNICHIDAE (Thomson, 1860)

Subfamily Limnichinae

Genus *Limnichus* Latreille, 1829

Many species have been described, but none are known to be aquatic, although the adults may be found in damp places such as stream margins throughout much of the United States.

Genus *Lutrochus* Erichson, 1847

Lutrochus arizonicus Brown and Murvosh, 1970. Larvae in calcareous encrustation of submerged rocks, etc.; adults usually at or just above water line on the downstream side of rocks or wood projecting from the water in riffles of streams in central Arizona.

Lutrochus laticeps Casey, 1893. Larvae and adults as above in streams of high calcium content from Maryland to Michigan and eastern Oklahoma.

Lutrochus luteus LeConte, 1852. Larvae in calcareous encrustation or beneath submerged rocks; adults either at water line or on submerged rocks or wood in travertine or other streams with high calcium content from central Texas and Oklahoma to eastern New Mexico.

Genus *Physemus* LeConte, 1854

Physemus minutus LeConte, 1854. Not known to be aquatic, but adults may be found in damp places such as stream margins in southwestern states from Texas to California.

Subfamily Cephalobyrrhinae

Genus *Throscinus* LeConte, 1874

Not known to be aquatic; adults are intertidal (two species along the Gulf shore of Texas and one species on the shores of southern California).

Family PSEPHENIDAE (Lacordaire, 1854)

Subfamily Eubriinae

Genus *Acneus* Horn, 1880

(This genus merits study. Few larvae have been taken.)

Acneus oregonensis Fender, 1951. Larvae on or under submerged rocks, adults along swift, rocky streams from Oregon to Olympic Peninsula of Washington.

Acneus quadrimaculatus Horn, 1880. Larvae on or under submerged rocks in rapid sections of streams, but in pools of quiet water protected by boulders; adults on vegetation or rocks along swift, rocky streams in California and Oregon, at elevations up to about 4,000 feet.

Genus *Dicranopselaphus* Guerin-Meneville, 1861

Dicranopselaphus variegatus Horn, 1880. The larva probably occurs on or under submerged rocks or wood in streams; the adult near streams from New York, Maryland, and Pennsylvania to Illinois. Rare. (No one has reported the larva in the United States. It has probably been mistaken for that of *Ectopria*, or simply overlooked.)

Genus *Ectopria* LeConte, 1853

Ectopria nervosa (Melsheimer, 1844). Larvae on submerged rocks and wood in streams from Florida to Maine and Canada west to Iowa, Missouri, and Oklahoma; adults on vegetation along streams or taken at lights.

Subfamily Eubrianacinae

Genus *Eubrianax* Kiesenwetter, 1874

Eubrianax edwardsi (LeConte, 1874). Larvae on or under submerged rocks in California and Oregon streams up to about 6,000 feet; adults along stream banks.

Subfamily Psepheninae

Genus *Psephenus* Haldeman, 1853
(Additional species from Arizona are under study. Murvosh and I are describing two new species.)

Psephenus haldemani Horn, 1870. Larvae on or under submerged rocks in streams, adults on rocks or wood protruding from riffles, at or just above water line on downstream side; from California to British Columbia and northern Idaho at elevations up to about 4,000 feet.

Psephenus herricki (DeKay, 1844). Habitats as above; in streams from central Alabama and Georgia northeast to Maine and Canada and west to eastern Oklahoma, Kansas and Wisconsin, at elevations below 2,500 feet. Also on wave-washed shores with suitable rocks, as on the Bass Islands of Lake Erie.

Psephenus murvoshi Brown, 1970. Habitats as above, in streams of central Arizona at elevations below 5,000 feet.

Psephenus texanus Brown and Arrington, 1967. Habitats as above, in streams of central and southwestern Texas, at elevations below 2,000 feet. These streams are typically clear, with a high calcium content.

Family PTILODACTYLIDAE (Lacordaire, 1857)

Genus *Anchycteis* Horn, 1880

Anchycteis velutina Horn, 1880. Larvae in springs and rapid streams of northern California and adjacent Nevada; adults along or near streams.

Genus *Anchytarsus* Guerin-Meneville, 1843

Anchytarsus bicolor (Melsheimer, 1846). In or near streams from Georgia to New York, rare.

Genus *Stenocolus* LeConte, 1853

Stenocolus scutellaris LeConte, 1853. Along streams of central California at elevations up to 4,000 feet.

SECTION III

KEY TO AQUATIC GENERA AND SPECIES OF ADULT DRYOPOID BEETLES OF THE UNITED STATES

1 Compact, ovoid; head retracted within prothorax and invisible from dorsal view, antennae fitting into grooves of prosternum; tarsus with third segment lobed; claws not prominent; not genuinely aquatic (Fig. 16): CHELONARIIDAE, *Chelonarium lecontei*

Head usually visible from dorsal view, though it may be temporarily retracted within prothorax; third segment of tarsus not conspicuously lobed; tarsal claws prominent 2

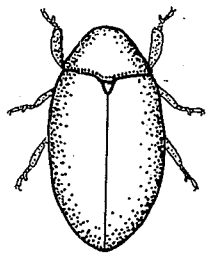


Fig. 16- *Chelonarium lecontei* adult, dorsal.

2(1) Typically hard-bodied; front coxae rounded or transverse 3

Typically soft-bodied; front coxae exserted and projecting and/or hind margin or pronotum crenulate 5

3(2) Typically very plump, convex, and ovoid; legs retractile; apical segment of tarsus shorter than remaining segments combined; middle coxae widely separated, hind coxae close together .....LIMNICHIDAE 105

Usually more elongate; legs not retractile; apical segment of tarsus usually as long as other four segments combined, with large claws; if middle coxae are widely separate, so are hind coxae 4

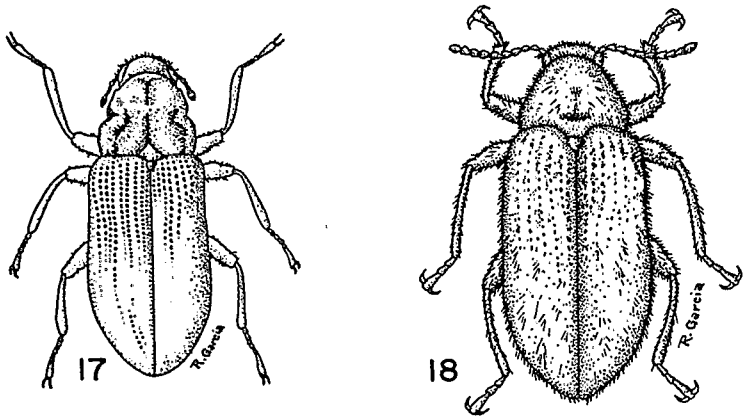
4(3) Anterior coxae typically globular and without exposed trochantin; antennae typically slender, not forming a pectinate or lamellate club; female genitalia symmetrical, with jointed, movable styli (Fig. 11); about 1-8 mm long, usually less than 4 mm ....ELMIDAE 6

Anterior coxae transverse and with exposed trochantin; antennae usually short, with apical segments pectinate or lamellate and forming a club; female genitalia without styli, usually asymmetrical and resembling two knife blades (Figs 101, 102), functioning as ovipositors; about 4-8 mm long .....DRYOPIDAE 94

5 (2) Rather broad and depressed; mandibles typically concealed; labrum usually not visible from in front ..PSEPHENIDAE... 110
Body relatively elongate; mandibles visible; labrum usually visible from in front.....PTILODACTYLIDAE 118

6 (4) Riparian, usually not under water; agile fliers; rather soft-bodied; pubescent, but without tomentum; procoxae transverse and with trochantin exposed.....LARINI..... 7
Aquatic; typically slow-moving, clinging to submerged objects; rarely flying except at night; hard-bodied; with tomentum on various ventral parts; procoxae rounded and trochantin concealed....., ELMINI..... 10

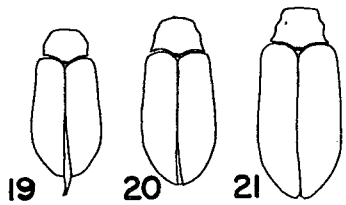
7 (6) Less than 4 mm long; antennae clubbed; pronotum with sublateral sulci (Fig. 17): *Phanocerus clavicornis*
More than 5 mm long; black, antennae not clubbed; pronotum without sublateral sulci (Fig. 18)..... *Lara*..... 8



Figs 17-18 Dorsal view of adult: 17- *Phanocerus clavicornis;* 18- *Lara avara.*

8 (7) From 5.5-6.5 mm long; pronotum with hind angles acute but scarcely more prominent than middle lobes; elytral pubescence uniform (Fig. 19): *Lara gehringi*
From 6.8-8.1 mm long; pronotum with hind angles acute and prominent; alternate elytral intervals with the pubescence decumbent, so that the elytra appear dark with sericeous lines..... 9

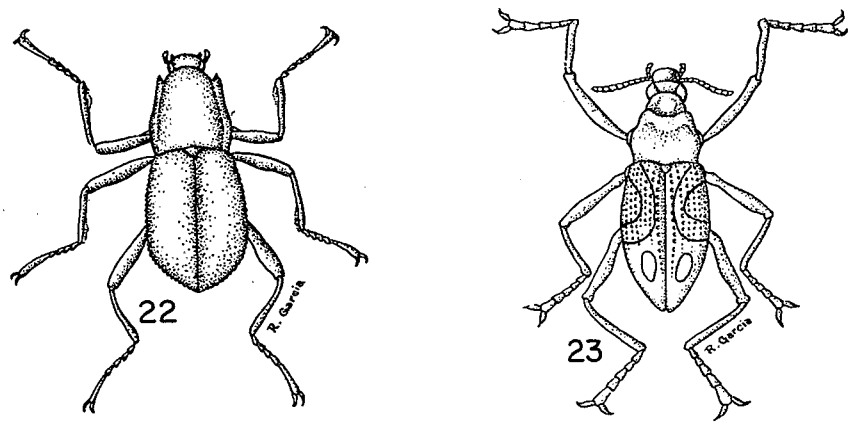
9 (8) Elytra 6.0-6.5 mm long; elytra wider in proportion to pronotum; pronotum with more prominent angles (Fig. 21): *Lara avara amplipennis*
Elytra about 5.2-5.5 mm long; elytra narrower in proportion to pronotum; pronotal angles less prominent (Fig. 20): *Lara avara avara*



Figs 19-21 Pronotum and elytra: 19- *Lara gehringi;* 20- *Lara avara avara;* 21- *Lara avara amplipennis* (all from Darlington, 1929)

10 (6) Hind coxae globular and about same size as other coxae; posterior margin of prosternal process almost as wide as head; on wood 11
Hind coxae transverse and larger than other coxae; posterior margin of prosternal process much narrower than width of head; often on rocks or in gravel 12

11 (10) Black; elytra with sublateral carinae; antennae with 7 segments, enlarged at apex; pronotum without transverse impressions; 2.5-3.5 mm long (Fig. 22): *Macronychus glabratus*
Conspicuously colored with black and yellow or orange; elytra and pronotum without sublateral carinae; antennae with 11 segments, filiform; pronotum with oblique transverse impressions at apical third; tarsal claw with a basal tooth; 2.1-2.6 mm long (Fig. 23): *Ancyronyx variegata*

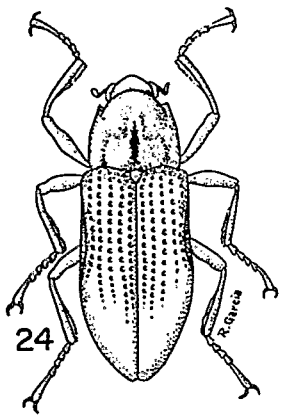


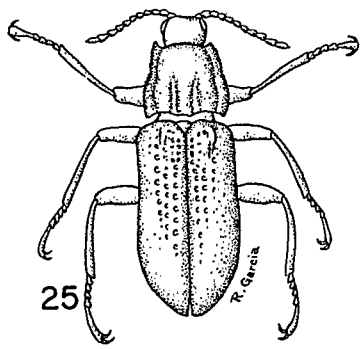
Figs 22-23 Dorsal view of adult: 22- *Macronychus glabratus;* 23- *Ancyronyx variegata.*

12 (10) Antennae with 8 segments, the apical one being enlarged; pronotum with median longitudinal groove; elytra with 3 sublateral carinae ..... *Zaitzevia* 13
Antennae with 10 or 11 segments, usually filiform 14

13 (12) In cold mountain streams; 2-2.5 mm long, 0.8-1 mm wide (Fig. 24): *Zaitzevia parvula*
In a warm spring near Bozeman, Montana; 2 mm long, 0.7 mm wide: *Zaitzevia thermae*

14 (12) Anterior tibia with fringe of tomentum (Fig. 2)..... 43
Anterior tibia without fringe of tomentum 15





Figs 24-25 Dorsal view of adult: 24- *Zaitzevia parvula;* 25- *Ordobrevia nubifera.*

15 (14) Elytron with an accessory stria (sutural stria confluent with second stria at about fifth puncture); granules of head and legs elongate; 2.2-2.4 mm (Fig. 25): *Ordobrevia nubifera*
Elytron without such an accessory stria; granules of head and legs round (Fig. 26) ..... *Stenelmis*..... 16
(This section is adapted from Sanderson (1938). In identification of species it will be helpful to know that in most males the inner surface of the middle tibia bears a swelling or row of spinules as shown in Fig. 26.)

16 (15) From thermal waters in southern Nevada; elytra immaculate (*S. c. calida*) or faintly trivittate (*S. c. moapa*); wings reduced and non-functional; body covered with dense, matted, greenish gray pile; antennae and palps testaceous; aedeagus quite similar to that of *S. fuscata;* 3-3.6 mm long, 1-1.25 mm wide: *Stenelmis calida*
From east of the Rocky Mountains 17

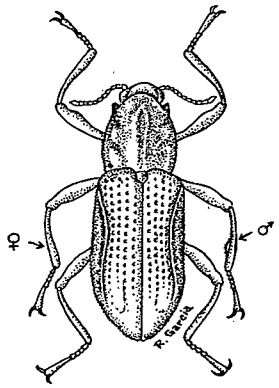
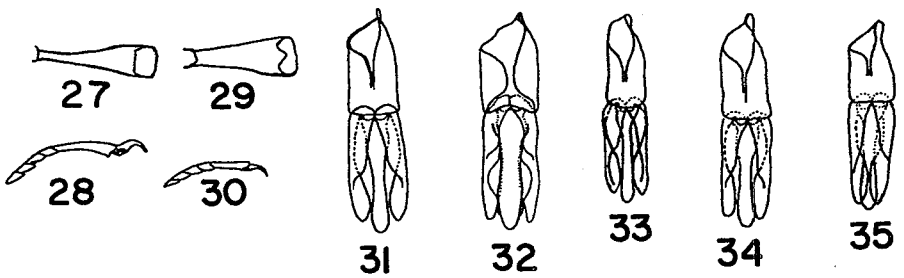


Fig. 26- *Stenelmis crenata* adult showing appearance of middle tibia of female on the left and of the male on the right (to illustrate means of distinguishing sexes if genitalia are not visible).

17 (16) Last tarsal segment distinctly longer than the other four combined, the last segment usually suddenly dilated beyond the middle (Fig. 27); tarsal claws relatively robust (Fig. 28) ..... *Humerosa-sinuata* group 28

Last tarsal segment not distinctly longer than the other four combined, the last segment not as noticeably dilated (Fig. 29); tarsal claws relatively slender (Fig. 30) ..... *Crenata* group 18



Figs 27-35 Tarsus of *Stenelmis* species: 27- Apical segment of *S. vittipennis;* 28- *S. markeli;* 29- Apical segment of *S. sandersoni;* 30- *S. lateralis.* Aedeagus (male genitalia) of *Stenelmis* species: 31- *S. sexlineata,* dorsal aspect; 32- *S. crenata;* 33- *S. exigua;* 34- *S. beameri;* 35- *S. lateralis* (all from Sanderson).

18 (17) Each elytron with 3 longitudinal vittae; 3.2-3.6 mm long, 1.25-1.4 mm wide (Fig. 31): *Stenelmis sexlineata*
Each elytron with no more than one vitta or elytron bimaculate 19

19 (18) Humeral spot or vitta embracing umbone of elytron 22
Humeral spot or vitta on inside of sixth interval 20

20 (19) Body very robust, and with the elytral spots or stripe wider, covering considerably more than the fifth interval; third interval sharply elevated at base; elytron with entire vitta or bimaculate; 3.0-3.35 mm long, 1.2-1.35 mm wide (Figs 26, 32): *Stenelmis crenata*
Body very elongate, with the elytral spots or stripe narrower, covering but little more than the fifth interval; third interval but slightly elevated at base and this elevation very short 21

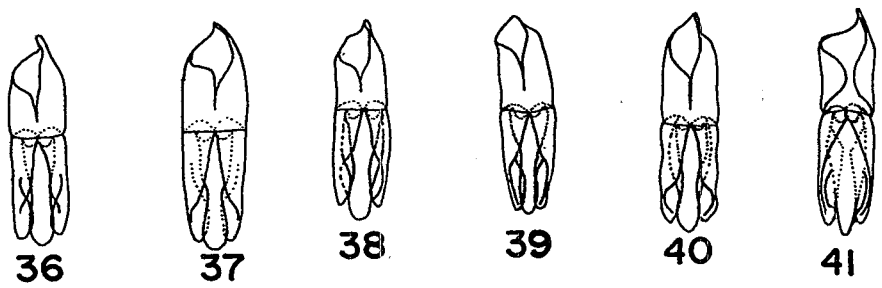
21 (20) Median lobe of aedeagus distinctly constricted at middle (Fig. 33); 2.85-2.9 mm long, 1-1.1 mm wide: *Stenelmis exigua*
Median lobe of aedeagus more nearly parallel (Fig. 34); 3.2-3.4 mm long, 1.2-1.25 mm wide: *Stenelmis beameri*

22 (19) Vitta very broad and covering nearly all of the space between the first and sixth intervals; 2.65-3 mm long, 0.95-1.1 mm wide (Fig. 35): *Stenelmis lateralis*
Vitta narrower and never extending medially beyond the second or third interval 23

23 (22) Size larger: 3.2-3.6 mm; lower margin of last tarsal segment with a conspicuous angular process (Fig. 29) 24
Size smaller: 2.6-3.25 mm; lower margin of last tarsal segment without such a process (Fig. 27) 25

24 (23) Apical abdominal emargination equal to width of last tarsal segment; tibiae testaceous only at base; elytron bimaculate; 3.3-3.6 mm long, 1.3-1.5 mm wide: *Stenelmis concinna*
Apical emargination very inconspicuous and much less than width of last tarsal segment; tibiae and apices of femora testaceous; bimaculate; 3.2-3.5 mm long, 1.25-1.5 mm wide (Fig. 37): *Stenelmis sandersoni*

25 (23) Basal tubercle of pronotum elongate and carinate 26
Basal tubercle of pronotum only slightly elongate and never carinate 27



Figs 36-41 Aedeagus of *Stenelmis* species: 36- *S. concinna;* 37- *S. sandersoni;* 38- *S. mera;* 39- *S. knobeli;* 40- *S. bicarinata;* 41- *S. douglasensis* (all from Sanderson).

26 (25) Legs testaceous; elytra twice as long as body width; elytron bimaculate; 2.8-3 mm long, 1-1.1 mm wide: *Stenelmis exilis*

Legs entirely or partially dark; elytra less than twice as long as wide; elytron vittate but with vitta clouded at middle; 2.6-2.85 mm long, 1-1.2 mm wide (Fig. 38): *Stenelmis mera*

27 (25) Each elytron distinctly bimaculate; 2.75-3 mm long, 1-1.05 mm wide (Fig. 39): *Stenelmis knobeli*

Each elytron with an entire vitta; 2.8-3.25 mm long, 1.1-1.25 mm wide (Fig. 40): *Stenelmis bicarinata*

28 (17) Femora distinctly granulate 30

Femora punctulate, not at all granulate 29

29 (28) Elytral vitta complete from base to apex; lateral processes on median lobe of aedeagus evenly rounded (Fig. 41); 3.35-3.6 mm long, 1.2-1.5 mm wide: *Stenelmis douglasensis*

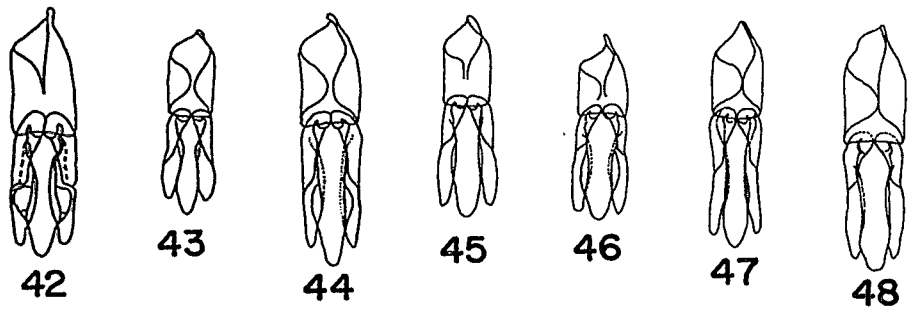
Elytron distinctly bimaculate; processes on median lobe of aedeagus subangulate anteriorly (Fig. 42); 3.25-3.6 mm long, 1.25-1.4 mm wide: *Stenelmis grossa*

30 (28) Elytra immaculate 31

Elytra maculate or vittate 33

31 (30) Smaller (less than 2.7 mm); median band of head as wide as two lateral ones combined; 2.3-2.7 mm long, 0.7-0.9 mm wide (Fig. 43): *Stenelmis parva*

Larger (over 2.7 mm long and 1 mm wide); median band of head but little wider than either lateral band 32



Figs 42-48 Aedeagus of *Stenelmis* species: 42- *S. grossa;* 43- *S. parva;* 44- *S. fuscata;* 45- *S. hungerfordi;* 46- *S. humerosa;* 47- *S. mirabilis;* 48- *S. antennalis* (all from Sanderson).

32 (31) Lateral processes on penis (median lobe of aedeagus) present and distinct (Fig. 44); 3.25-3.4 mm long, 1.15-1.25 mm wide: *Stenelmis fuscata*
Lateral processes of median lobe very inconspicuous (Fig. 45); 2.7-2.8 mm long, 1-1.1 mm wide: *Stenelmis hungerfordi*

33 (30) Humeral spot or vitta distinctly embracing umbone 34
Humeral spot or vitta on inside of sixth interval 35

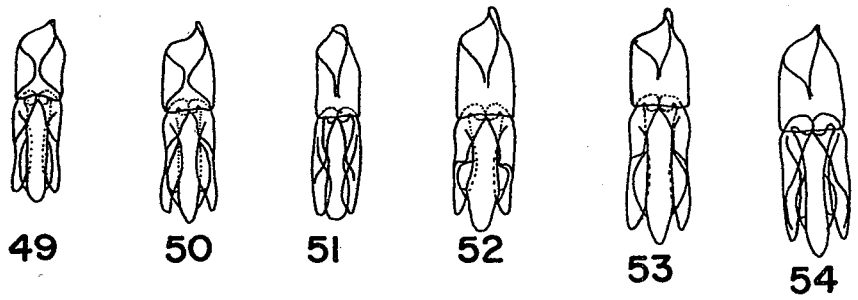
34 (33) Femora and tibiae entirely gray; elytral vitta usually entire, though somewhat clouded at middle; palpi testaceous; 2.3-2.7 mm long, 0.95-1.1 mm wide (Fig. 46): *Stenelmis humerosa*
Femora gray, tibiae testaceous; elytron distinctly bimaculate; palpi dark brown to black; 2.7-2.9 mm long,1.1-1.12 mm wide (Fig. 47): *Stenelmis mirabilis*

35 (33) Antennae and palpi testaceous 38
Antennae or palpi, or both, dark brown to black 36

36 (35) Palpi testaceous; last 6 or 7 segments of antenna shining black; elytron bimaculate; 2.5-2.7 mm long, 1 mm wide (Fig. 48): *Stenelmis antennalis*
Palpi usually dark brown to black, the antennae usually lighter 37

37 (36) Lateral processes about one third the width of median lobe (Fig. 49); elytron usually distinctly bimaculate, but occasionally vitta is entire; 2.4-2.65 mm long; 0.95-1.05 mm wide: *Stenelmis musgravei*

Lateral processes about two thirds the width of median lobe (Fig. 50); elytron distinctly bimaculate; 2.7-3.2 mm long, 1.1-1.25 mm wide: *Stenelmis quadrimaculata*



Figs 49-54 Aedeagus of *Stenelmis* species: 49- *S. musgravei;* 50- *S. quadrimaculata;* 51- *S. decorata;* 52- *S. vittipennis;* 53- *S. convexula;* 54- *S. markeli* (all from Sanderson).

38 (35) Sides of pronotum in anterior third divergent, the apical angles subtruncate instead of acute; elytron maculate, with vitta narrow and occupying little more than fifth interval; lateral processes of penis resembling those of *S. humerosa;* 3.2-3.45 mm long, 1.2-1.35 mm wide: *Stenelmis sinuata*

Sides of pronotum in anterior third parallel or convergent 39

39 (38) Lateral processes of median lobe of aedeagus present and conspicuous 41

Lateral processes of median lobe absent or very inconspicuous 40

40 (39) Elytral stripe entire; median lobe of aedeagus without lateral processes (Fig. 51); 2.87-3 mm long, 1.1-1.15 mm wide: *Stenelmis decorata*

Elytron immaculate or with small, faint humeral and apical spots; median lobe of aedeagus with narrow and inconspicuous lateral processes (Fig. 45); 2.7-2.8 mm long, 1-1.1 mm wide: *Stenelmis hungerfordi*

41 (39) Lateral processes of median lobe of aedeagus subangulate anteriorly (Fig. 52); elytron with vitta entire; 3-3.4 mm long, 1.1-1.35 mm wide: *Stenelmis vittipennis*

Processes of median lobe evenly rounded 42

42 (41) Lateral processes of penis as wide as parameres near apex (Fig. 53); body more convex; elytron usually with very faint humeral and apical spots; middle tibia of male without the enlargement or spiny ridge on inner side which is typical of most species of *Stenelmis;* 2.75-3.1 mm long, 1.1-1.12 mm wide: *Stenelmis convexula*

Lateral process of penis about half the width of paramere near apex (Fig. 54); body less convex; elytron with vitta entire, though slightly narrowed at middle; 3-3.25 mm long, 1.17-1.3 mm wide: *Stenelmis markeli*

43 (14) Lateral margin of fourth or fifth abdominal sternite produced as a prominent lobe or tooth which is bent upward to clasp the epipleuron; epipleuron widened to receive tooth, then usually narrowing abruptly toward apex 56

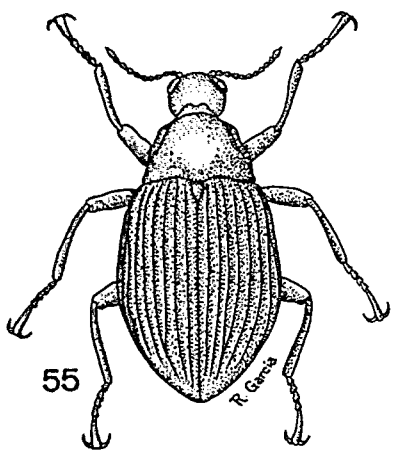
Lateral margin of abdominal sternites not produced into a prominent upturned tooth; epipleuron usually tapering uniformly toward apex 44

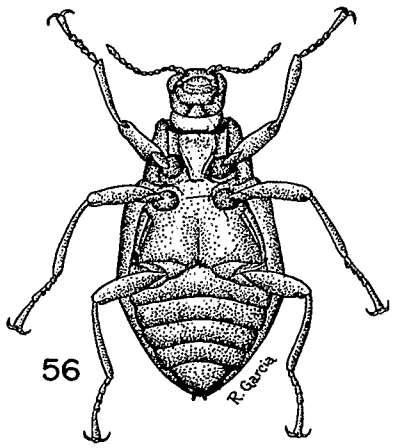
44 (43) Pronotum with sublateral carinae 45

Pronotum smooth, without sublateral carinae 49

45 (44) Prosternum projecting beneath head; epipleuron extending to middle of fifth abdominal segment; black; 2.5-2.6 mm long, 1.2-1.3 mm wide (Figs 55, 56): *Rhizelmis nigra*

Prosternum not projecting beneath head; epipleuron ending at base of fifth abdominal segment; less than 2.3 mm long 46





Figs 55-56 *Rhizelmis nigra* adult: 55- dorsal; 56- ventral.

46 (45) Pronotal carinae forked at base (Fig. 57) .. *Cleptelmis* ... 47
Pronotal carinae not forked 48

47 (46) Elytra immaculate and black (humeral angle may be paler); 1.7-2.3 mm long, 1-1.2 mm wide: *Cleptelmis addenda*
Elytra black with humeral and subapical red spot; 1.8-2.2 mm long, 1-1.2 mm wide (Fig. 57): *Cleptelmis ornata*

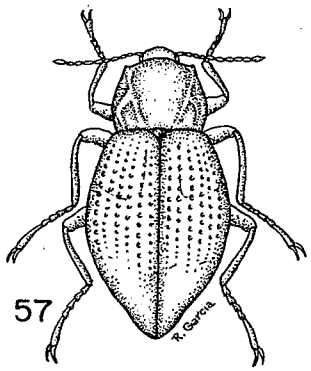
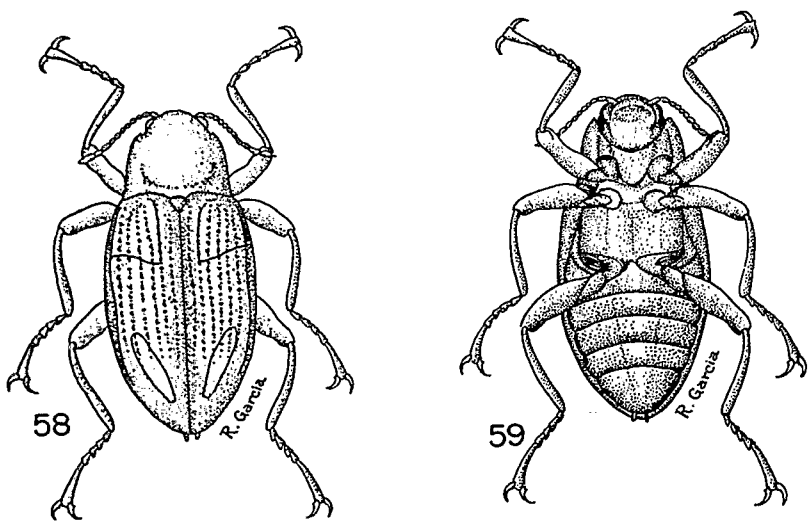


Fig. 57- *Cleptelmis ornata* adult, dorsal.

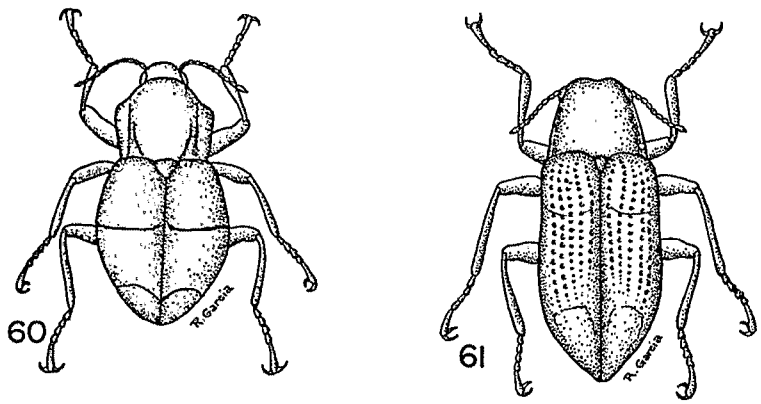
48 (46) Sides of pronotum converging from base; body rather spindle-shaped; black, each elytron with a broad humeral and an oblique, narrow subapical spot; tarsi and claws prominent; 2 mm long, 0.9 mm wide (Figs 58, 59): *Atractelmis wawona*
Sides of pronotum parallel or divergent at base, strongly convergent apically; hump-backed; black, elytra black to red, uniformly colored or with basal half red, with or without broad apical red spots; tarsi and claws not unusually prominent; 1.8-2.2 mm long, 1.1-1.2 mm wide (Fig. 60): *Ampumixis dispar*

49 (44) Maxillary palpi 3-segmented; markings, if present, transverse (Fig. 61)..... *Narpus* 50
Maxillary palpi 4-segmented; markings, if present, longitudinal (Fig. 62)..... *Dubiraphia* 52

50 (49) Slender, more than two and one half times as long as wide; 3-4 mm long, 1.1-1.4 mm wide; sides almost parallel; black: *Narpus angustus*
Relatively plump, less than two and one half times as long as wide; sides convex 51



Figs 58-59 *Atractelmis wawona* adult: 58- dorsal; 59- ventral.



Figs 60-61 Dorsal view of adult: 60- *Ampumixis dispar;* 61- *Narpus concolor.*

51 (50) Uniformly black with bronze luster; pronotal punctures at middle separate by little more than their own diameters; 3.4 mm long, 1.4 mm wide: *Narpus arizonicus*

Elytra black to red, usually with black band across middle; pronotal punctures at middle separated by twice their own diameters; 3.2-4.2 mm long, 1.4-1.9 mm wide (Fig. 61): *Narpus concolor*

52 (49) Large (2.6-3.3 mm long, 1-1.2 mm wide); eastern; elytron black, with broad testaceous vitta; pronotum darker testaceous: *Dubiraphia bivittata*

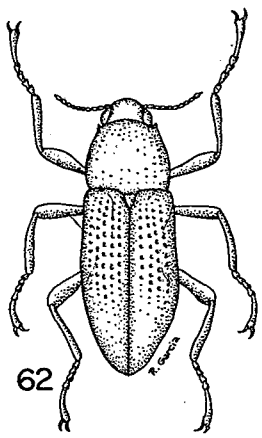
Smaller (1.7-2.5 mm long, 0.65-0.85 mm wide); eastern or western 53

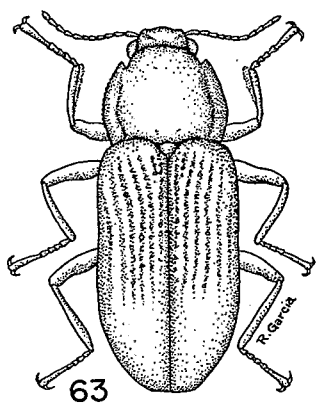
53 (52) West of the Rocky Mountains (continental divide) 54
East of the Rocky Mountains (continental divide) 55

54 (53) Elytron dark brown, with at most faint yellowish humeral or subapical spots; 1.8-2.5 mm long: *Dubiraphia brunnescens*
Elytron black with humeral and apical light yellow spots, sometimes united to form a vitta; 2.1-2.3 mm long: *Dubiraphia giulianii*

55 (53) Black, elytron with humeral and apical rufous or testaceous spots, which may be united to form a vitta; 1.7-2.5 mm long, 0.65-0.85 mm wide (Fig. 62): *Dubiraphia quadrinotata*
Brownish, elytron with a broad testaceous vitta; 1.8-2.5 mm long, 0.7-0.85 mm wide: *Dubiraphia vittata*

56 (43) Tooth which clasps epipleuron arising from lateral margin of fifth abdominal sternite 57
Tooth which clasps epipleuron arising from apical (posterior) lateral margin of fourth abdominal sternite 76





Figs 62-63 Dorsal view of adult: 62- *Dubiraphia quadrinotata;* 63- *Elsianus texanus.*

57 (56) Elytron at base with a short accessory stria between sutural and second major striae (Fig. 63); testis trilobate ..... *Elsianus* 58
Elytron without such an accessory stria, testis usually bilobate 60

58 (57) Small (3.1-3.8 mm long, 1.2-1.5 mm wide); black, with antennae and tarsi rufous, palp rufo-testaceous; penis extending beyond apices of parameres more than one third the length of parameres: *Elsianus shoemakei*

Larger (over 4 mm long); penis extending beyond apices of parameres less than one quarter the length of the parameres 59

59 (58) In Arizona; rufous to black; 4-5.2 mm long, 1.7-2.1 mm wide (it may be that more than a single species is represented by these measurements; very few specimens have been taken): *Elsianus moestus*

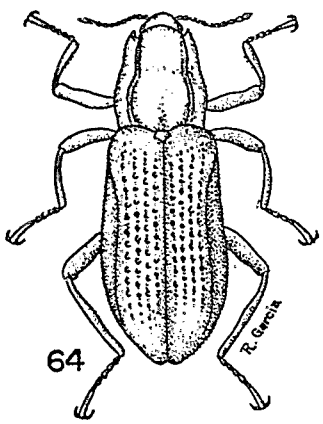
In Texas and eastern New Mexico; rufous to black; 4-5.4 mm long, 1.7-2 mm wide (Fig. 63) (further study may reveal this species to be synonymous with *E. moestus*): *Elsianus texanus*

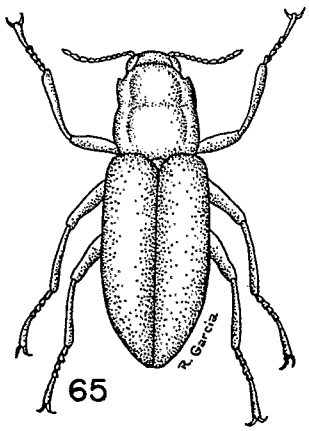
60 (57) Elytron with one sublateral carina; pronotum without oblique sculpturing 61

Elytron with two sublateral carinae (rarely only one in *Microcylloepus*, which has oblique sculpturing on posterior half of pronotum) 62

61 (60) Posterior half of pronotum divided by a conspicuous median longitudinal impression; pronotum with a transverse impression slightly anterior to middle; brown to black; 2.6-3.3 mm long, 1-1.2 mm wide (Fig. 64): *Neocylloepus boeseli*

Pronotum undivided except by transverse impression at anterior two-fifths; testaceous; 1.5-1.7 mm long, 0.5-0.6 mm wide (Fig. 65): *Neoelmis caesa*





Figs 64-65 Dorsal view of adult: 64- *Neocylloepus boeseli*; 65- *Neoelmis caesa*.

62 (60) Hypomeron of pronotum with a belt of tomentum extending from coxa to lateral margin; pronotum with a shallow median longitudinal impression but with no transverse impressions; testaceous to black; 1.7-2.1 mm long, 0.7-0.85 mm wide (Fig. 66):
Hexacylloepus ferrugineus

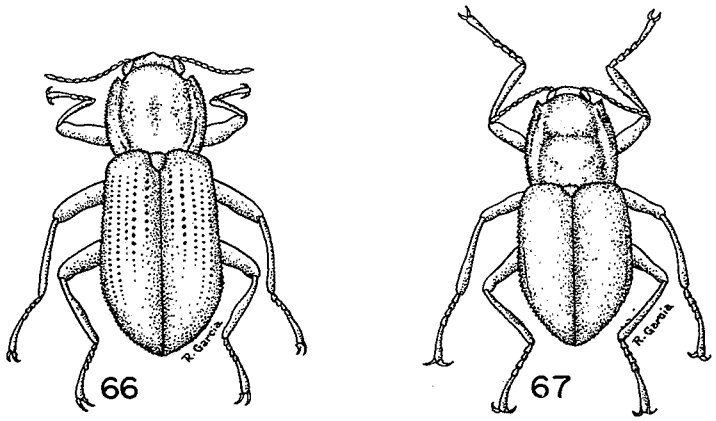
Hypomeron with or without tomentum, but if present it does not reach lateral margin 63

63 (62) Prosternal process broad and truncate; pronotum without median longitudinal impression, usually with transverse impression at middle; pronotal hypomeron with tomentum near coxa; body usually plump; mandible with a lateral lobe (Fig. 5) ..... *Heterelmis* 64

Prosternal process relatively narrow, elongate with apex tapering or rounded; pronotum with median longitudinal impression; hypomeron without tomentum; body not plump 66

64 (63) Basal segment of each tarsus with two closely appressed, short, stout spines on inner apex; reddish brown to black; pronotum with little or no transverse impression at middle; 2.5-3.3 mm long, 1.1-1.5 mm wide:
Heterelmis obesa

Basal segment of tarsus without such spines on inner apex; pronotum with transverse impression at middle; less than 2.5 mm long 65



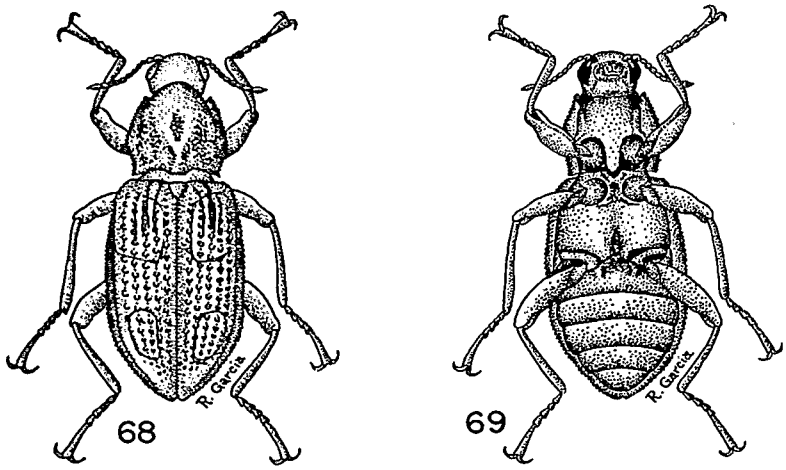
Figs 66-67 Dorsal view of adult: 66- *Hexacylloepus ferrugineus;* 67- *Heterelmis vulnerata.*

65 (64) Medial surface of parameres of aedeagus bearing a row of delicate hairs; brown to black; 1.9-2.2 mm long, 1-1.1 mm wide:
Heterelmis glabra

Medial surface of parameres devoid of hairs; brown to black; 1.8-2.35 mm long, 0.9-1.15 mm wide (Fig. 67):
Heterelmis vulnerata

66 (63) Pronotum with a transverse impression at anterior two-fifths; mandible with a lateral lobe as in Fig. 5; epipleuron without tomentum; small, less than 2.3 mm long (Fig. 70) ..... *Microcylloepus* 68
Pronotum without such a transverse impression; mandible without a lateral lobe; epipleuron with tomentum; larger, at least 2.3 mm long (Fig. 68).... *Cylloepus*.... 67

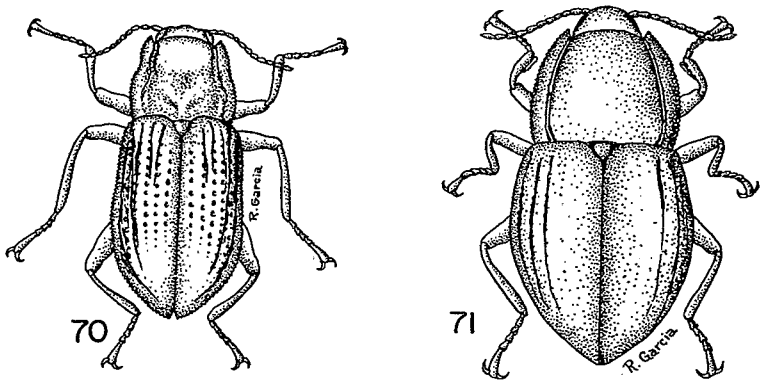
67 (66) Pronotum wider than long; fifth elytral interval not carinate; metasternum with a short carina at middle near posterior margin; black, elytron usually with two large reddish spots; 2.3-3 mm long; 1.2 mm wide (Figs 68, 69): *Cylloepus parkeri*
Pronotum slightly longer than wide; fifth elytral interval partly carinate; metasternum depressed but without a posterior median carina; reddish brown to black; 3.5-4.3 mm long, 1.5-1.65 mm wide: *Cylloepus abnormis*



Figs 68-69 *Cylloepus parkeri* adult: 68- dorsal; 69- ventral.

68 (66) Pronotum longer than wide; wing usually reduced, shorter than elytron; from warm springs 69
Pronotum usually wider than long; wing functional, when extended longer than elytron; 1.65-2.2 mm long, 0.68-0.9 mm wide (Fig. 70)... *Microcylloepus pusillus*... 72

69 (68) Elytron with 1 sublateral carina; elytra only slightly wider than pronotum; sculpturing of pronotum reduced; black; 1.4-1.7 mm long, 0.5 mm wide; from warm spring in northwestern Nevada: *Microcylloepus thermarum*
Elytron with 2 sublateral carinae; elytra distinctly wider than pronotum; reddish to black 70



Figs 70-71 Dorsal view of adult: 70- *Microcylloepus pusillus*; 71-*Oulimnius latiusculus*.

70 (69) From warm springs in Montana (near Bozeman); black; 2 mm long, 0.68-0.7 mm wide: *Microcylloepus browni*
From warm springs in southeastern Nevada; reddish black, 1.7-1.9 mm long, 0.7-0.8 mm wide. *Microcylloepus moapus*. 71

71 (70) Wing greatly reduced, not exceeding one-third of abdominal length: *Microcylloepus moapus moapus*
Wing less reduced, slightly over half of abdominal length: *Microcylloepus moapus fraxinus*

72 (68) Elytron reddish to black, without distinct markings 73
Elytron with vitta or spots 74

73 (72) In western states: *Microcylloepus pusillus similis*
In southeastern Gulf coastal plain: *Microcylloepus pusillus lodingi*

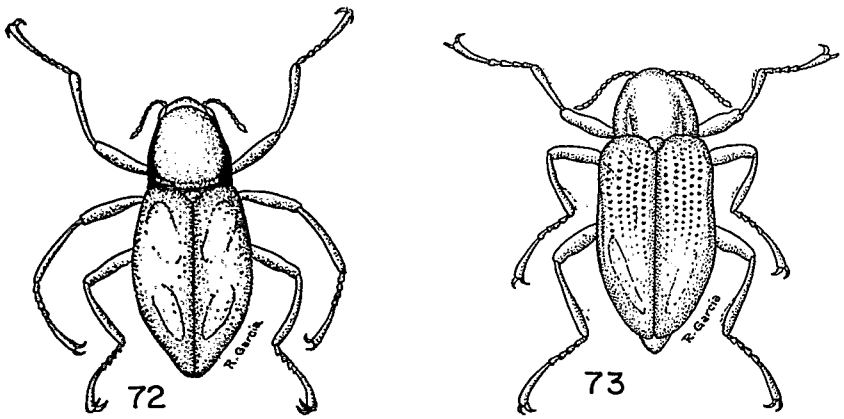
74 (72) Elytron with a vitta: *Microcylloepus pusillus aptus*
Elytron with spots 75

75 (74) Elytron with humeral and apical spots: *Microcylloepus pusillus pusillus*
Elytron with only humeral spot: *Microcylloepus pusillus perditus*

76 (56) Pronotum with sublateral carina extending from base to anterior margin; elytron with 3 sublateral carinae; brown to black; 1.25-1.6 mm long, 0.65-0.8 mm wide (Fig. 71): *Oulimnius latiusculus*
Pronotum with sublateral carina absent or not extending beyond about middle; elytron without sublateral carinae; larger species, longer than 1.6 mm 77

77 (76) Pronotum smooth, without or with only a trace of carinae; body elongate and spindle-shaped; black, elytron with two oblique yellowish spots; legs long, claws prominent and recurved; 2-2.6 mm long, 0.95-1.1 mm wide (Fig. 72): *Gonielmis dietrichi*

Pronotum with short sublateral carinae 78



Figs 72-73 Dorsal view of adult: 72- *Gonielmis dietrichi;* 73- *Promoresia elegans.*

78 (77) Body rather elongate; tarsi and claws long and prominent; lateral and posterior margins of pronotum smooth; eastern (Fig. 73)..... *Promoresia* 79

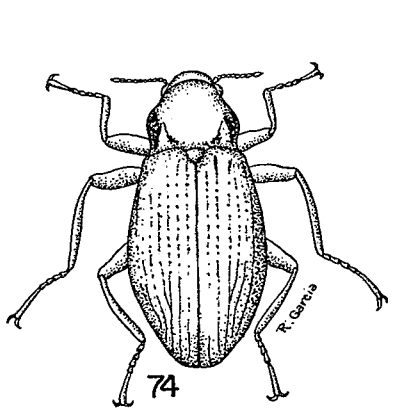
Body plump; tarsi and claws not conspicuously enlarged; lateral margin of pronotum usually slightly serrate, posterior margin usually with many small, closely-placed teeth 80

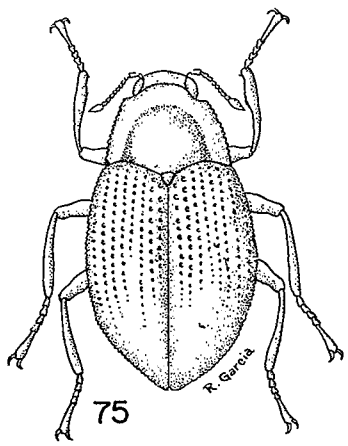
79 (78) Black, elytron bimaculate, both spots very elongate and oblique, the anterior spot extending from the humerus posteromedially to second stria and terminating acutely near middle of elytron, the posterior spot extending from near middle of elytron (lateral to apex of anterior spot) posteromedially almost to sutural interval and apex of elytron; 2.1-2.4 mm long, 0.9-1 mm wide (Fig. 73): *Promoresia elegans*

Black, elytron bimaculate, the anterior spot broadly rounded, extending posteriorly no more than one third of elytral length; subapical spot elongate and oblique, but shorter than in previous species; 2-2.4 mm long, 0.9-1.1 mm wide: *Promoresia tardella*

80 (78) Convex, giving a rather hump-backed appearance, with sutural intervals slightly raised; with third or fourth elytral stria converging and merging with second or third stria at about apical third; major striae entire, extending to apex of elytron; antennae with 10 or 11 segments, last 3 somewhat enlarged; apex of fifth abdominal sternite usually somewhat truncate or emarginate; tarsal claws relatively slender; in western mountains (Fig. 74)..... *Heterlimnius* 81

Less convex; sutural interval usually not raised; elytral striae not ordinarily merging as described above, either being entire or becoming obsolete in posterior portion of elytron; antennae with 11 segments, the last 3 less enlarged; apex of fifth abdominal sternite usually evenly rounded; claws somewhat larger and more curved (Fig. 75) .... *Optioservus* ..... [This section is largely based upon Collier (1969).].... 82





Figs 74-75 Dorsal view of adult: 74- *Heterlimnius corpulentus;* 75- *Optioservus ovalis.*

81 (80) Antenna with 11 segments; pronotum black; elytron reddish to black, often reddish or yellowish in basal half shading to brown or black and with a diffuse lighter spot apically; 2-2.5 mm long, 1.1-1.3 mm wi e (Fig. 76): *Heterlimnius koebelei*

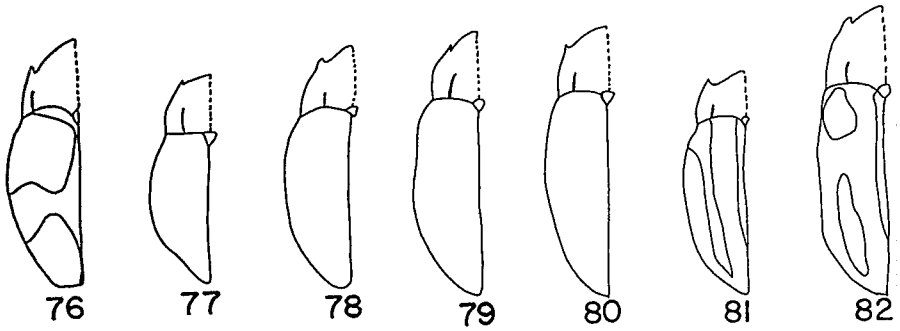
Antenna with 10 segments; pronotum black; elytron brown to black, often reddish at base and in a rather faint apical spot; 2.4-2.9 mm long, 1.25-1.45 mm wide (Fig. 74): *Heterlimnius corpulentus*

82 (80) Elytra immaculate, with no vittae or spots 83

Elytra with vittae and/or spots 86

83 (82) Small, 2-2.1 mm long, 1 mm wide; slightly humped in side view; brown to black; eastern (Fig. 77): *Optioservus cryophilus*

Larger, at least 2.2 mm long; not noticeably humped in side view 84



Figs 76-82 Outline of adult pronotum and elytron: 76- *Heterlimnius koebelei;* 77- *Optioservus cryophilus;* 78- *O. immunis;* 79- *O. divergens;* 80- *O. pecosensis;* 81- *O. trivittatus;* 82- *O. sandersoni* (all from Collier).

84 (83) Eastern; strial punctures on elytra deep; 2.2-2.4 mm long, 1.2-1.3 mm wide; brown to black (Fig. 78): *Optioservus immunis*

Western 85

85 (84) Penis tapering gradually to a subacute apex; elytral striae lightly punctured; brown to black, with elytra at times lighter than head and thorax; 2.2-2.5 mm long, 1-1.1 mm wide (Fig.79): *Optioservus divergens*

Penis more finger-shaped, tapering abruptly to a rounded apex; strial punctures deeper; uniformly shiny black; 2.4-2.6 mm long, 1-1.2 mm wide (Fig. 80): *Optioservus pecosensis*

86 (82) Elytron with sutural vitta extending to apical third 87

Elytron without sutural vitta 89

87 (86) Elytron also with yellow vitta from humerus almost to apex (Fig. 81), 1.65-2.1 mm long, 0.9-1.1 mm wide: *Optioservus trivittatus*

Without humeral vitta 88

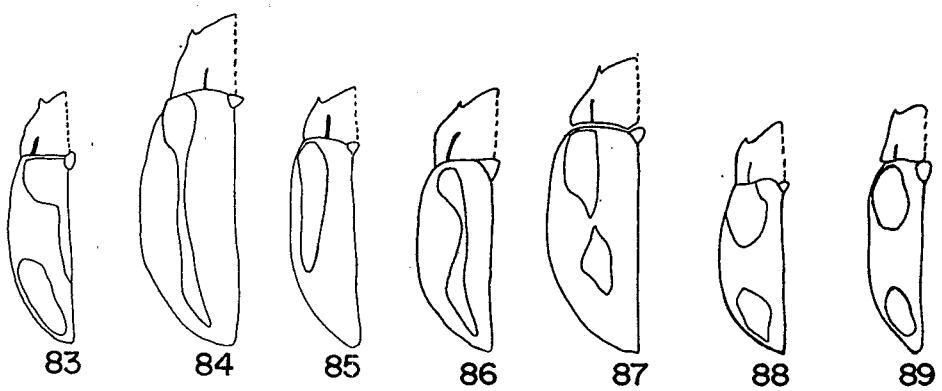
88 (87) Sutural vitta narrow; humeral spot discrete; apical spot long and narrow, subvittate (Fig. 82); 2.6 mm long, 1.3 mm wide: *Optioservus sandersoni*

Sutural vitta broadened anteriorly and combined with humeral spot, apical spot elongate (Fig. 83); 2.3 mm long, 1.2 mm wide: *Optioservus ozarkensis*

89 (86) Elytron bimaculate 92
Elytron with an elongate humeral spot or with a vitta extending from humerus almost to apex 90

90 (89) Large, 2.8-3.1 mm long, 1.4-1.5 mm wide; elytral vitta extending almost to apex, at times bright yellow; pronotal carinae rather short and feeble (Fig. 84): *Optioservus fastiditus*
Smaller, less than 2.7 mm long; pronotal carinae well developed and extending at least to basal third.... 91

91 (90) In far west; elytron with elongate humeral spot or short vitta (Fig. 85); elytra with grizzled appearance due to long golden hairs; 2.1-2.5 mm long, 0.9-1.4 mm wide: *Optioservus canus*
Eastern; elytron with vitta from humerus almost to apex (Fig. 86); not grizzled; 2.3-2.6 mm long, 1.2-1.3 mm wide: *Optioservus ampliatus*

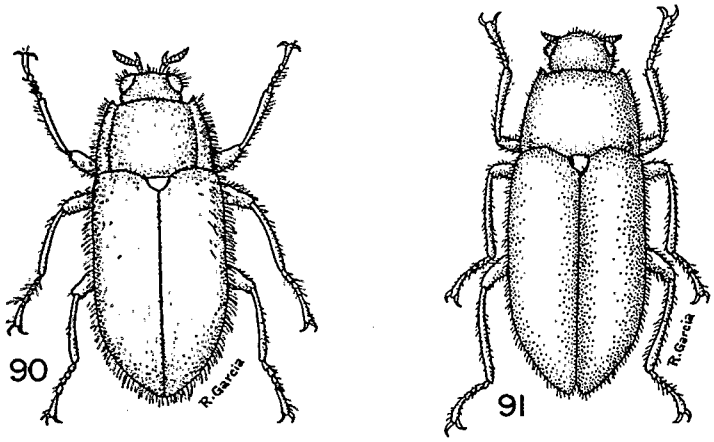


Figs 83-89 Outline of adult pronotum and elytron of *Optioservus* species: 83- *O. ozarkensis;* 84- *O. fastiditus;* 85- *O. canus;* 86- *O. ampliatus;* 87- *O. ovalis;* 88- *O. quadrimaculatus;* 89- *O. seriatus* (all from Collier).

92 (89) Eastern; elytral spots almost forming a vitta in some specimens (Figs 75, 87); 2.4-2.6 mm long, 1.2-1.4 mm wide: *Optioservus ovalis*
Western; elytral spots widely separated 93

93 (92) Relatively broad, elytra noticeably wider than pronotum; humeral spot larger, usually reaching second stria (Fig. 88); 1.8-2.2 mm long, 1-1.1 mm wide: *Optioservus quadrimaculatus*
More elongate, elytra scarcely wider than pronotum; humeral spot narrower, usually not reaching medially beyond third stria (Fig. 89); 1.8-2.2 mm long, 0.8-0.9 mm wide: *Optioservus seriatus*

94 (4) Pronotum on each side with a conspicuous, complete sublateral longitudinal sulcus; pubescent; brown; about 4.5 mm long, 1.75 mm wide (Fig. 90):*Dryops arizonensis*
Pronotum without such a sublateral sulcus 95



Figs 90-91 Dorsal view of adult: 90- *Dryops arizonensis;* 91- *Pelonomus obscurus.*

95 (4) Second segment of antenna not enlarged; antennae pubescent, as are head and body; bases of antennae very close together; both third and fourth segments of maxillary palp very elongate; without tomentum; reddish to dark brown; 4.8-6.5 mm long, 2-2.5 mm wide (Fig. 91): *Pelonomus obscurus*
First, and, even more, second segment of antenna enlarged and heavily sclerotized, forming a shield beneath which remaining segments may be retracted and protected; bases of antennae widely separated; parts of body and legs with tomentum (Fig. 92) .... *Helichus*....
[This section of the key is largely based upon Musgrave (1935).] 96

96 (95) Pubescence of last abdominal sternite different from that of preceding sternites, the last sternite often appearing bare 99
All abdominal sternites similarly and densely pubescent (tomentose) 97

97 (96) Male genitalia (Figs 93, 94) flattened dorsoventrally; in lateral aspect paramere not enlarged apically; in dorsal aspect penis acutely pointed at apex; female genitalia (Fig. 95) relatively streamlined; black; 5.2-7.25 mm long, 2.15-3 mm wide: *Helichus confluentus*
Male genitalia not flattened; paramere enlarged at apex; penis not acutely pointed; female genitalia with tip of ovipositor (hemisternite) turned up more abruptly..... 98

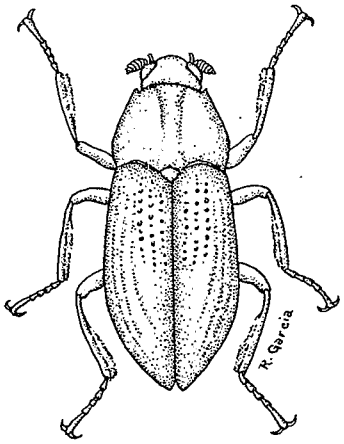
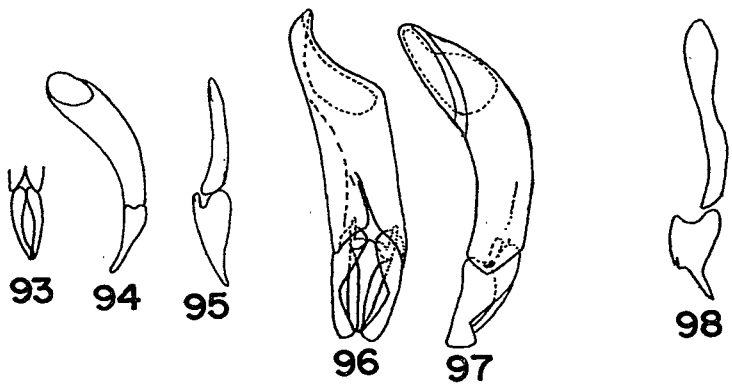


Fig. 92- *Helichus lithophilus* adult, dorsal.



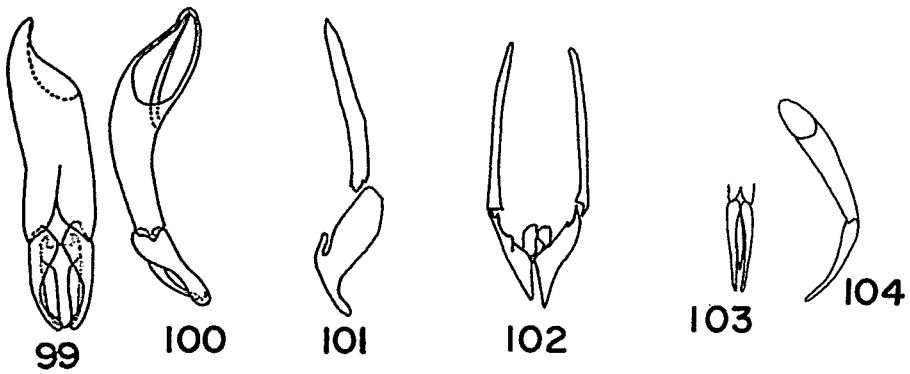
Figs 93-98 *Helichus confluentus*: 93- aedeagus, dorsal aspect; 94- aedeagus, lateral aspect, left side (from Musgrave); 95- female genitalia, lateral aspect, left side. *H. immsi*: 96- aedeagus, dorsal aspect; 97- aedeagus, left lateral aspect; 98- female genitalia, left lateral aspect (all from Hinton).

98 (97) Paramere of male in lateral aspect with apex abruptly enlarged (Figs 96, 97); ovipositor of female shorter and broader (Fig. 98); black; 5.9-8 mm long, 2.4-3.3 mm wide: *Helichus immsi*

Paramere in lateral aspect with apex gradually enlarged, aedeagus less robust (Figs 99, 100); ovipositor longer, narrower, and with a more digitate ventral process (Figs 101, 102); black; about 6-8 mm long, 2.5-3.2 mm wide: *Helichus productus*

99 (96) Uniformly covered with fine, silky pubescence; male genitalia very elongate and slender (Figs 103, 104); brown to black; 4.4-5.8 mm long, 2-2.5 mm wide: *Helichus lithophilus*

Not uniformly covered with fine, silky pubescence 100



Figs 99-104 *Helichus productus*: 99- aedeagus, dorsal aspect; 100- aedeagus, right lateral aspect; 101- female genitalia, left lateral aspect; 102- female genitalia, dorsal aspect (all from Hinton). Aedeagus of *H. lithophilus*: 103- dorsal aspect; 104- left lateral aspect (all from Musgrave).

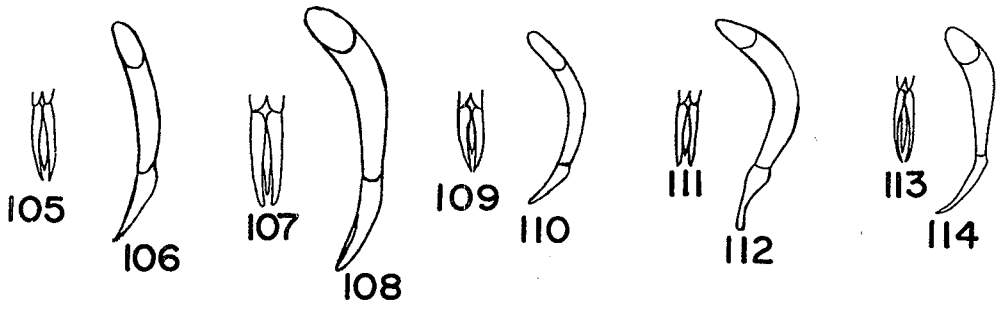
100 (99) Thorax abruptly depressed behind middle; a space in front of the scutellum glabrous or almost glabrous..... 101

Thorax gradually depressed; without glabrous space in front of scutellum 102

101 (100) Glabrous space of thorax shining; first stria of elytra almost impunctate, or at most with small punctures not reaching base; male genitalia long and narrow, acutely tipped (Figs 105, 106); brown to black; 4.3-5.5 mm long, 2-2.5 mm wide: *Helichus basalis*

Glabrous space of thorax alutaceous; punctures of first stria larger and often reaching to base of elytron; male with a tooth-like process on antero-medial surface of hind coxa; male genitalia with stouter basal piece, parameres blunt-tipped (Figs 107, 108); brown to black, with bronzed pubescence; about 4.5-5.5 mm long; 2.2-2.5 mm wide: *Helichus fastigiatus*

102 (100) Thorax with fovea on each side behind middle; parameres of male neither decurved nor recurved near apex (Figs 109, 110); brown to black; 4.5-6.3 mm long, 2-3 mm wide ..... *Helichus striatus* 103
Thorax without foveae 104



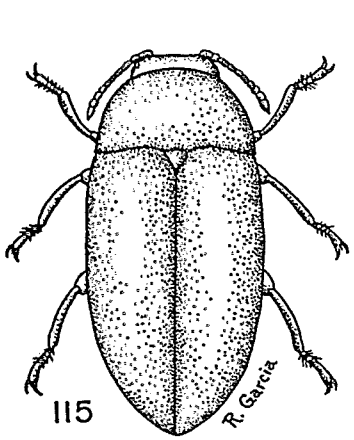
Figs 105-114 Aedeagus of *Helichus* species: 105- *H. basalis*, dorsal aspect; 106- *H. basalis*, left lateral aspect; 107- *H. fastigiatus*, dorsal aspect; 108- *H. fastigiatus*, left lateral aspect; 109- *H. striatus*, dorsal aspect; 110- *H. striatus*, left lateral aspect; 111- *H. triangularis*, dorsal aspect; 112- *H. triangularis*, left lateral aspect; 113- *H. suturalis*, dorsal aspect; 114- *H. suturalis*, left lateral aspect (all from Musgrave).

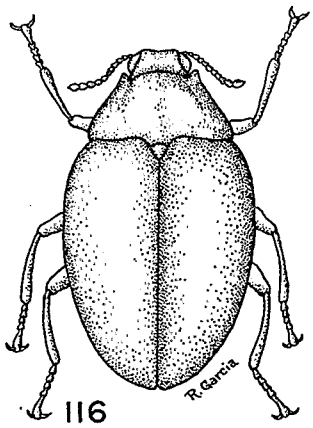
103 (102) Elytron with alternate intervals more convex or raised: *Helichus striatus striatus*
Elytron with intervals uniformly convex: *Helichus striatus foveatus*

104 (102) Elytron uniformly and granularly pubescent; parameres of male slightly recurved (turned upward) near apex and not acutely pointed at tips; basal piece conspicuously curved (Figs 111, 112); gray or brown to black; 5-6.1 mm long, 2.25-2.6 mm wide: *Helichus triangularis*
Elytron with sutural interval less pubescent; parameres more elongate, decurved toward apex, acutely pointed as seen in dorsal aspect; basal piece not conspicuously curved (Figs 113, 114); reddish brown to black, quite variable in size and general aspect, about 3.6-5.3 mm long, 1.7-2.3 mm wide (much smaller than listed here in parts of Mexico and central America): *Helichus suturalis*

105 (3) Pronotal hypomeron with a transverse or oblique ridge; body plump and convex; near streams... LIMNICHINAE ... 106
Hypomeron without a ridge; body more elongate; on ocean mudflats or beaches (Fig. 115) ... CEPHALOBYRRHINAE ..... *Throscinus* .....(species not included in key since they seem unrelated to water quality)

106 (105) Antennae distinctly clubbed; pronotum with smooth anterolateral cavities for reception of antennae; ovoid and compact; shiny reddish to black; 0.8-1 mm long, 0.65-7 mm wide: *Physemus minutus*
Antennae not clubbed; pronotum without cavities for reception of antennae; usually well over 1 mm long ... 107





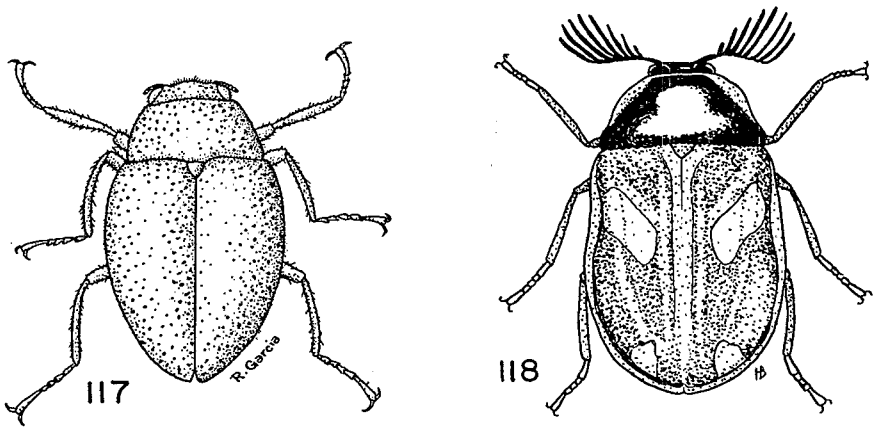
Figs 115-116 Dorsal view of adult: 115- *Throscinus schwartzi;* 116- *Limnichus* sp.

107 (106) Small (1.2-2.3 mm long); antenna slender, with 10 segments; first abdominal sternite with grooves for reception of folded hind legs (Fig. 116): *Limnichus* (Although 28 species have been described from the United States, none are known to be aquatic either as larvae or adults, so no attempt is made here to provide a key to them.)
Larger (2.5-4.2 mm long); antenna with 11 segments, the first two enlarged and the remaining nine subpectinate; first abdominal sternite without grooves for the reception of folded legs (Fig. 117).*Lutrochus*..108

108 (107) Apical segment of maxillary palp subequal in width to apical segment of labial palp; densely pubescent with a yellowish cast, but dark brown where cuticle is exposed; 3-4.2 mm long, 1.75-2.3 mm wide: *Lutrochus arizonicus*
Apical segment of maxillary palp not over three quarters as wide as that of labial palp 109

109 (108) Margin of clypeus emarginate; pubescence of dorsum thinner; eastern; 2.8-3.8 mm long, 1.5-2.1 mm wide: *Lutrochus laticeps*

Margin of clypeus straight; dorsal pubescence dense and yellowish; southwestern; 2.5-3.5 mm long, 1.5-2.1 mm wide (Fig. 117): *Lutrochus luteus*



Figs 117-118 Dorsal view of adult: 117- *Lutrochus luteus;* 118- *Acneus quadrimaculatus* male.

110 (5) Posterior margin of pronotum crenulate or finely beaded; males with at least the anterior claw on each foot forked at apex (this requires high magnification and the proper angle to observe); adults not aquatic ..... EUBRIINAE 111

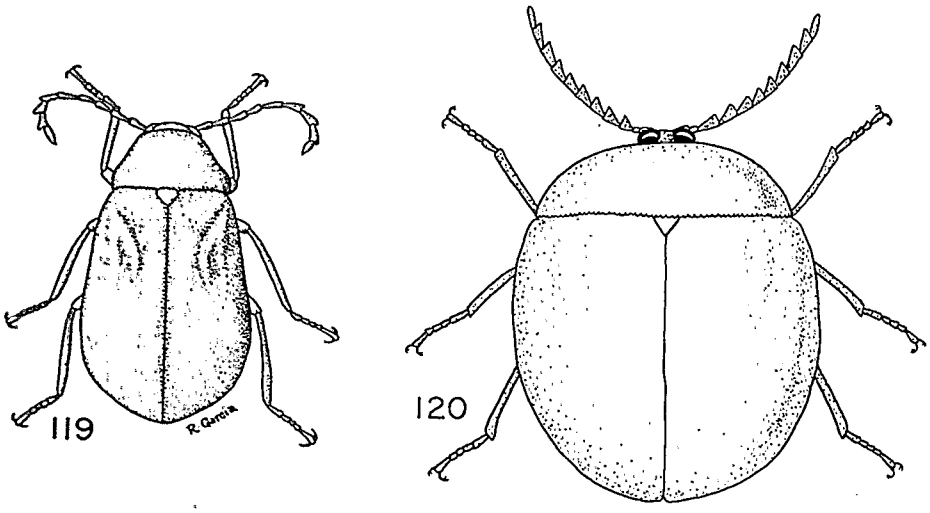
Posterior margin of pronotum smooth 114

111 (110) Prosternum narrow, depressed between coxae; antenna with third joint at least as long as either the first two or next three combined; male with flabellate antennae (Fig. 118); female larger than male and with serrate antennae; tarsal claws of female not toothed at base..... *Acneus* 112

Prosternum of moderate width, not depressed between coxae; tarsal claws of both sexes with a basal tooth; antenna of male not flabellate 113

112 (111) Elytron pale, with 7 blackish spots; mesosternal process widely concave; male 3.5 mm long: *Acneus oregonensis*

Elytron dark brown or black with 2 pale spots which do not reach the elytral suture; these spots may be joined by a pale marginal loop; sutural interval may be lighter; 3.5-4.5 mm long, 2.1-2.8 mm wide (Fig. 118): *Acneus quadrimaculatus*



Figs 119-120 Dorsal view: 119- *Ectopria nervosa* female; 120- *Dicranopselaphus* sp. male.

113 (111) Tarsi slender, fourth joint smaller than third and not prolonged beneath fifth; form, color, and pattern variable, but females larger than males and with antenna filiform to feebly serrate whereas antenna of male is serrate to subpectinate; brown to black, often with yellow or orange on much of pronotum; 3-5 mm long, about 2-3 mm wide (Fig. 119): *Ectopria nervosa*

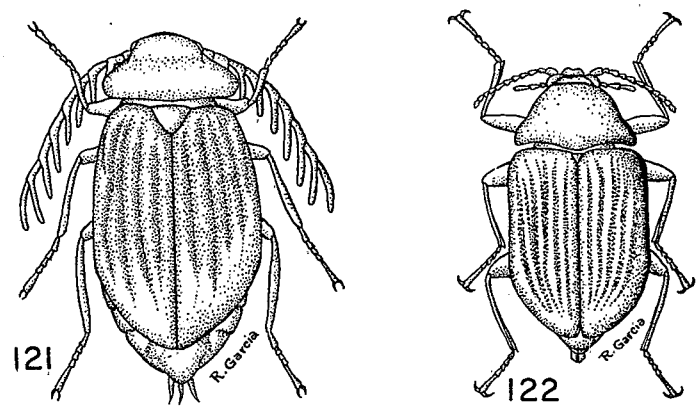
Tarsi slightly dilated, second, third, and fourth joints feebly emarginate, the fourth slightly prolonged beneath the fifth; antenna of male serrate to feebly pectinate; brownish, thorax darker, elytra clouded and with pale, anastomosing lines; male about 3 mm long (Fig. 120): *Dicranopselaphus variegatus*

114 (110) Head usually hidden beneath broadly expanded pronotum; base of claws with a membranous appendage nearly reaching to tip of claw; antenna of male pectinate (Fig. 121), that of female serrate; testaceous to black; 3-4.5 mm long, 2-2.5 mm wide: *Eubrianax edwardsi*

Head visible from above; base of claws without membranous appendage; antenna of female moniliform, that of male subserrate to serrate; brown to black (Fig. 122) ..... *Psephenus* 115

115 (114) Anterior margin of head distinctly bisinuate (medially emarginate); ventral sclerite of penis almost as wide as long, emarginate at base (Fig. 123); about 4-5.5 mm long, 1.7-3.2 mm wide (Fig. 122): *Psephenus texanus*

Anterior margin of head usually arcuate; ventral sclerite of penis at least twice as long as wide 116



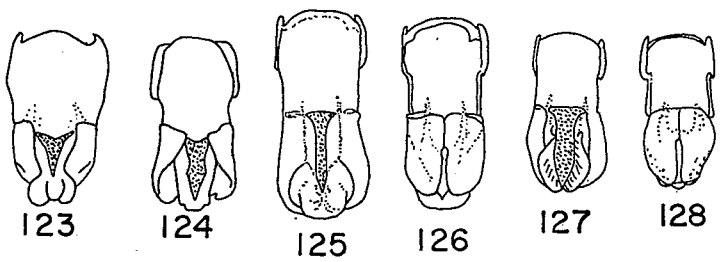
Figs 121-122 Dorsal view of male: 121- *Eubrianax edwardsi;* 122- *Psephenus texanus.*

116 (115) Maxillary palp about half as long as antenna; ventral sclerite of penis emarginate at base (Fig. 124); about 4-5.3 mm long, 1.7-3.1 mm wide: *Psephenus herricki*

Maxillary palp about two-thirds to three-fourths as long as antenna; ventral sclerite of penis arcuate at base 117

117 (116) Coloration uniformly dark; maxillary palp about two-thirds as long as antenna; tarsal claws toothed at base; aedeagus with ventral sclerite of penis slender, parameres subparallel in dorsal aspect (Figs 125, 126); about 3.5-5 mm long, 1.6-3 mm wide: *Psephenus haldemani*

Head and pronotum black, elytra brown, epipleura, bases of legs and other parts testaceous; maxillary palp about three-quarters as long as antenna; tarsal claws not appreciably toothed at base; aedeagus with ventral sclerite of penis relatively broad, parameres with lateral margins tapering distally from near middle (Figs 127, 128); male about 3.2 mm long, 1.6 mm wide: *Psephenus murvoshi*



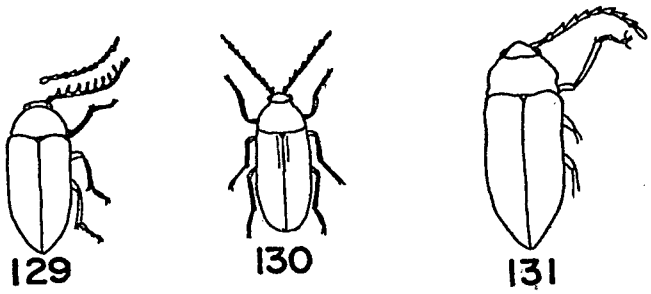
Figs 123-128 Aedeagus of *Psephenus* species: 123- *P. texanus,* ventral aspect with sclerite stippled; 124- *P. herricki,* ventral aspect with sclerite stippled; 125- *P. haldemani,* ventral aspect with sclerite stippled; 126- *P. haldemani,* dorsal aspect; 127- *P. murvoshi,* ventral aspect with sclerite stippled; 128- *P. murvoshi,* dorsal aspect.

118 (5) Mandibles prominent, acutely margined above (margin may be obscured by pubescence), rectangularly flexed at tip; head not retracted, moderately deflexed; pronotum acutely margined; black with cinerous pubescence; 14-22 mm long (Fig. 131):
Stenocolus scutellaris

Mandibles not prominent, arcuate at tip, not acutely margined above; head strongly deflexed 119

119 (118) Antennae serrate in female, pectinate in male; middle coxae twice as widely separated as anterior coxae; margin of pronotum obtusely rounded; prosternum short in front of coxae; black; 10 mm long (Fig. 129):
Anchycteis velutina

Antennae slender; middle coxae no more widely separated than anterior coxae; pronotum obtusely margined; prosternum moderately long before coxae; elongate oval; black; 5-6 mm long (rare) (Fig. 130):
Anchytarsus bicolor



Figs 129-131 Dorsal view of adult: 129- *Anchycteis velutina* male, plus antenna of female (from Horn); 130- *Anchytarsus substriatus* female (from Champion); 131- *Stenocolus scutellaris* (from Horn).

SECTION IV

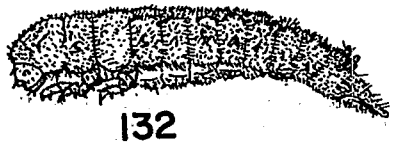
KEY TO GENERA OF AQUATIC AND SEMI-AQUATIC DRYOPOID BEETLE LARVAE OF THE UNITED STATES

1 Broadly ovoid in shape and very much flattened; lateral margins of each segment greatly expanded, the head completely concealed from a dorsal view by the expanded anterior pronotal margin (water pennies)... PSEPHENIDAE ... 33
Less broad and flat, usually slender with a round or triangular cross section; head exposed from dorsal view 2

2 (1) Ninth abdominal segment with a movable ventral operculum closing a caudal chamber (Fig. 13)..... 3
Ninth abdominal segment without an operculum..PTILODACTYLIDAE.. 7

3 (2) Body cylindrical, with abdominal sternites and pleurites greatly reduced, the tergites almost forming complete rings on first 5 segments and forming complete ones on segments 6-9; without retractile gills; abdominal spiracles lateral on segments 1-7 and dorsal on segment 8 (Unlikely to be found in our streams.).... DRYOPIDAE 5
Body usually not cylindrical; abdominal sternites not greatly reduced on anterior segments; with retractile filamentous caudal gills emerging from caudal chamber 4

4 (3) Operculum with a pair of internally attached hooks (Fig. 13)... 9
Operculum without hooks, but with a flat, movable, dorsal sclerite attached to each lateral margin; thoracic segments and first 8 abdominal segments each with a dorsolateral flattened projection bearing many hairy filaments (Fig. 132): CHELONARIIDAE: *Chelonarium*



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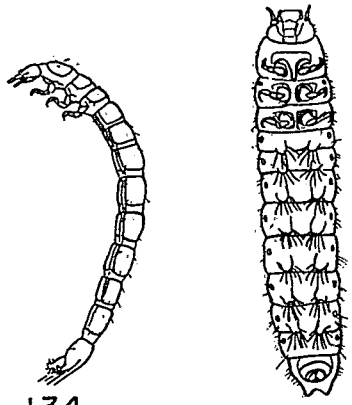
133

Figs 132-133 Left lateral aspect of larva: 132- *Chelonarium* sp. (from Boving & Craighead); 133- *Dryops* sp. (from Bertrand).

5 (3) Operculum with 2 toothlike tubercles on posterior margin; sides of tergites transversely grooved; ninth abdominal segment flattened dorsally and emarginate at apex: *Helichus*
Operculum without tubercles; tergites not transversely grooved; ninth abdominal segment convex dorsally 6

6 (5) Tergites with anterior margins smooth; gular sutures present (Fig. 133): *Dryops*
Tergites (except pronotum) with numerous longitudinal carinae arising near each anterior margin; gular sutures obliterated, with 2 pairs of setae near where sutures would be: *Pelonomus*

7 (2) Abdominal segments 1-7 each with 2 ventral tufts of filamentous gills; submentum not divided; ninth abdominal segment without prehensile appendages bearing hooks (Fig. 135): *Stenocolus*
Abdominal segments 1-7 without gill tufts; submentum divided longitudinally into 3 parts; anal region of ninth abdominal segment with 2 curved prehensile appendages covered with short spines 8

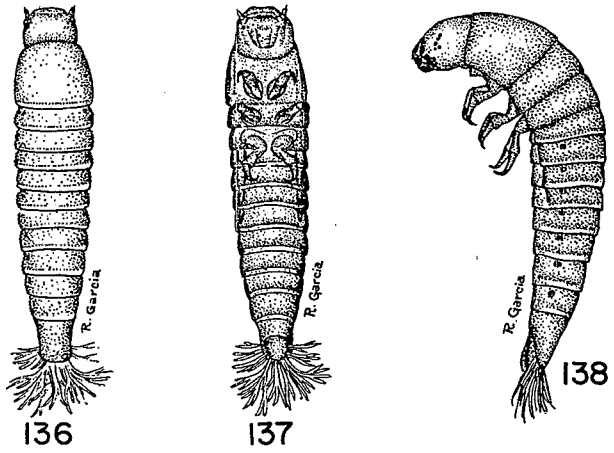


Figs 134-135 Larva: 134- *Anchytarsus bicolor*, left lateral aspect (from Bertrand); 135- *Stenocolus scutellaris*?, ventral aspect (from Boving & Craighead).

8 (7) Ninth abdominal segment with numerous fingerlike anal gills; apex without projection (Fig. 134) *Anchytarsus*
Ninth abdominal segment with 3 median anal gills and 1 gill lateral to each prehensile appendage; dorsal, flattened apex of ninth segment with small raised projection: *Anchycteis*

9 (4) Abdomen with pleurites on at least the first 6 segments; ventral surface of thorax sclerotized, usually with sternites; thoracic pleurites often divided into 2 or 3 parts; apex of ninth abdominal segment typically emarginate ..... ELMIDAE 10

Abdomen with pleurites present on only first 4 segments; with erect hairs along medial margin of each narrow, undivided thoracic pleurite; thoracic sternites membranous or absent; apex of ninth abdominal segment evenly rounded; each eyespot with 5 ocelli and with another ventral ocellus below base of antenna; body robust; head almost as wide as thorax, but usually retracted within it (Figs 136, 137, 138):
LIMNICHIDAE: *Lutrochus*
(Larvae of the other genera are unknown; they are probably not aquatic.)

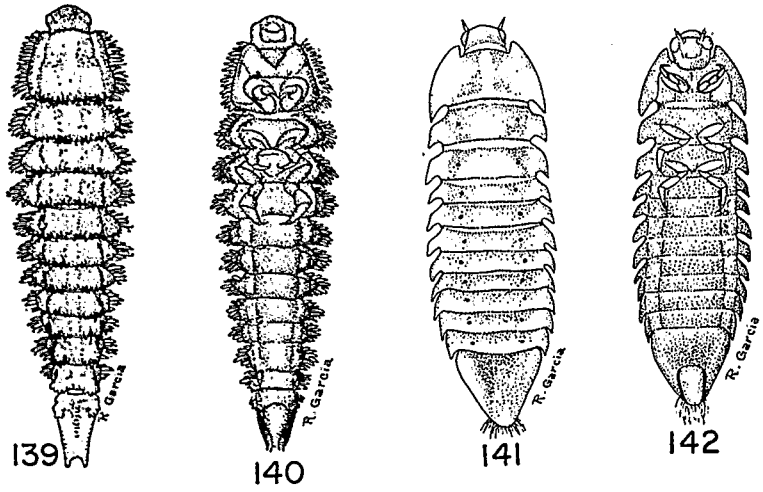


Figs 136-138 Larva of *Lutrochus luteus*: 136- dorsal aspect; 137- ventral aspect; 138- lateral aspect.

10 (9) Abdomen with pleura on first 8 segments 11
Abdomen with pleura on first 6 or 7 segments...ELMINI 16

11 (10) Body rather broad, lateral margins expanded....LARINI 12
Body slender, elongate, cylindrical or hemicylindrical ..... ELMINI, in part 13

12 (11) With coarse, prominent spines along lateral margins; dorsal surface ridged on each side; last segment rather square-sided and flat dorsally; procoxal cavities open behind; up to 16 mm long (Figs 139, 140): *Lara*
Without marginal spines; body quite flattened and with rather smooth surface; testaceous to brown, somewhat translucent; procoxal cavities closed behind (Figs 141, 142): *Phanocerus*



Figs 139-142 Larva of *Lara avara*: 139- dorsal aspect; 140- ventral aspect. Larva of *Phanocerus clavicornis*: 141- dorsal aspect; 142- ventral aspect.

13 (11) Last abdominal segment very long and slender (at least 4 times as long as wide); operculum confined to posterior third of segment (Figs 143, 144): *Dubiraphia*

Last abdominal segment not conspicuously long or slender (less than 4 times as long as wide); operculum not confined to apical third 14

14 (13) Head tuberculate, with suberect spines; anterior margin of head without a prominent frontal tooth on each side; body subcylindrical, yellowish; often more than 8 mm long (Figs 145, 146): *Narpus*

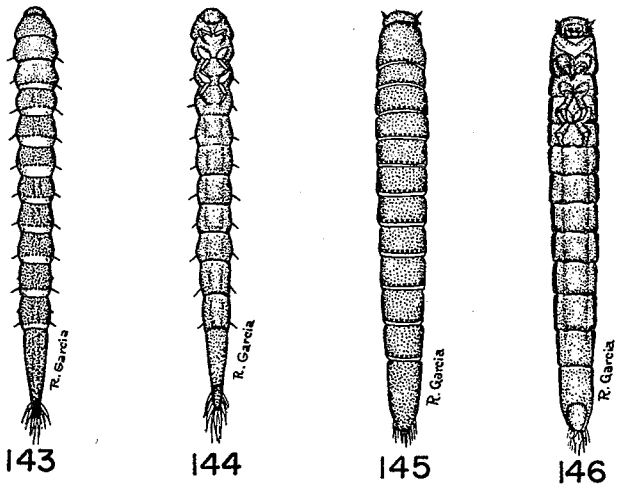
Head without suberect spines, anterior margin with a prominent frontal tooth on each side (Fig. 13) 15

15 (14) Body cylindrical; pleural sutures extend to basal half of ninth abdominal segment; procoxal cavities closed behind (Fig. 147); larger, often longer than 6.5 mm (Fig. 148): *Cylloepus*

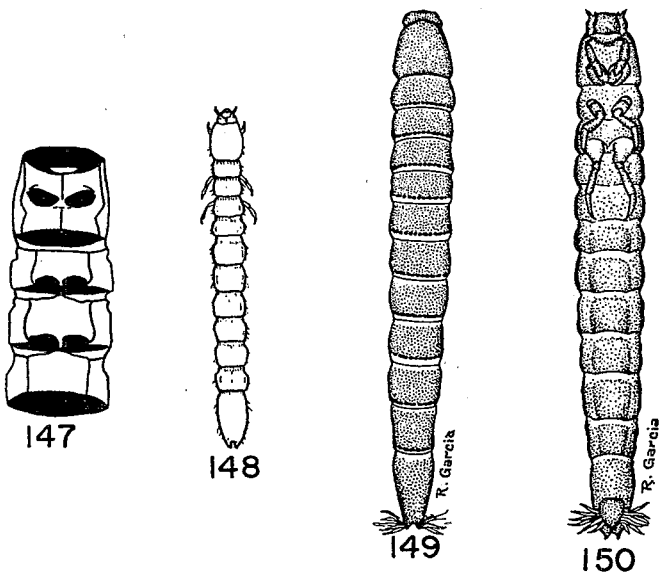
Body hemicylindrical; pleural sutures not extending onto ninth abdominal segment; procoxal cavities open behind; smaller, less than 6.5 mm (Figs 149, 150): *Rhizelmis*

16 (10) Prothorax with a posterior sternum (Fig. 13), so procoxal cavities are closed behind 17

Prothorax without posterior sternum; procoxal cavities open behind 25



Figs 143-146 Larva of *Dubiraphia* sp.: 143- dorsal aspect; 144- ventral aspect. Larva of *Narpus concolor*: 145- dorsal aspect; 146- ventral aspect.



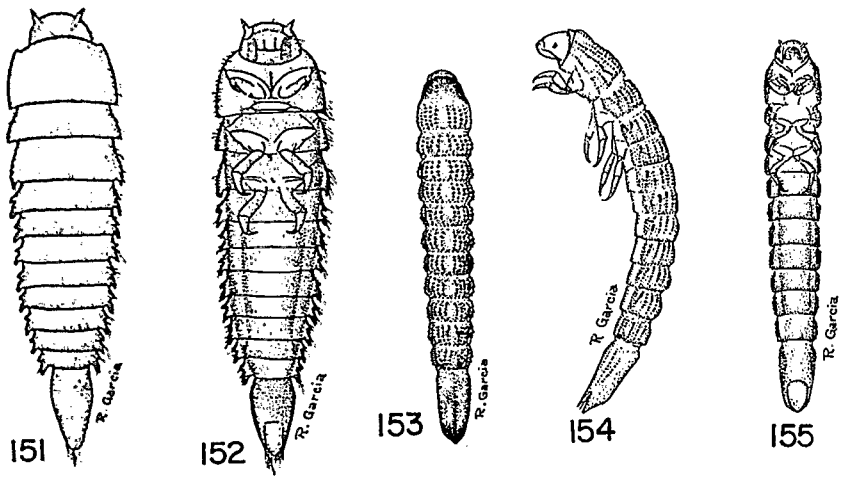
Figs 147-150 Larva: 147- *Cylloepus* sp., ventral aspect of thoracic and first abdominal segment (from Hinton); 148- *C. montanus*, dorsal aspect (from Bertrand). Larva of *Rhizelmis nigra*: 149- dorsal aspect; 150- ventral aspect.

17 (16) Posterolateral margins of abdominal segments 1-8 produced into spine-like processes; body rather robust (Figs 151, 152): *Ancyronyx*

Margins of abdominal segments not thus produced; body elongate 18

18 (17) Dorsum of all but last segment bearing spatulate tubercles or short spines arranged in about 10 conspicuous longitudinal or diagonal rows; last segment with a mid-dorsal longitudinal ridge and lateral margins bearing spatulate tubercles (Figs 153, 154, 155): *Heterelmis*

Dorsum without such spiny tubercles, although there may be rows of small, flat tubercles 19



Figs 151-155 Larva of *Ancyronyx variegata*: 151- dorsal aspect; 152- ventral aspect. Larva of *Heterelmis vulnerata*: 153- dorsal aspect; 154- lateral aspect; 155- ventral aspect.

19 (18) Anterior margin of head on each side with a distinct frontal tooth (Fig. 13)..... 22

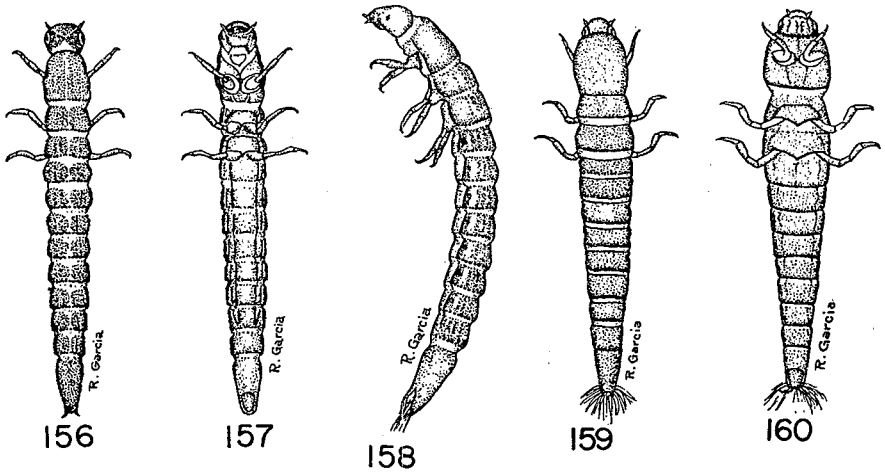
Anterior margin of head without distinct frontal tooth 20

20 (19) Dorsum with relatively conspicuous, flattened tubercles often arranged in longitudinal rows; abdominal tergites often with mid-dorsal pale spots; last segment with a weak mid-dorsal longitudinal ridge 21

Tubercles of dorsum inconspicuous, not arranged in longitudinal rows; without mid-dorsal pale spots; last segment convex dorsally, without median ridge (Figs 159, 160): *Neoelmis*

21 (20) Last abdominal segment conspicuously long and slender (3 times longer than wide); mid-dorsal spots widest near middle of each segment; dorsal tubercles not arranged in parallel longitudinal rows: *Hexacylloepus*

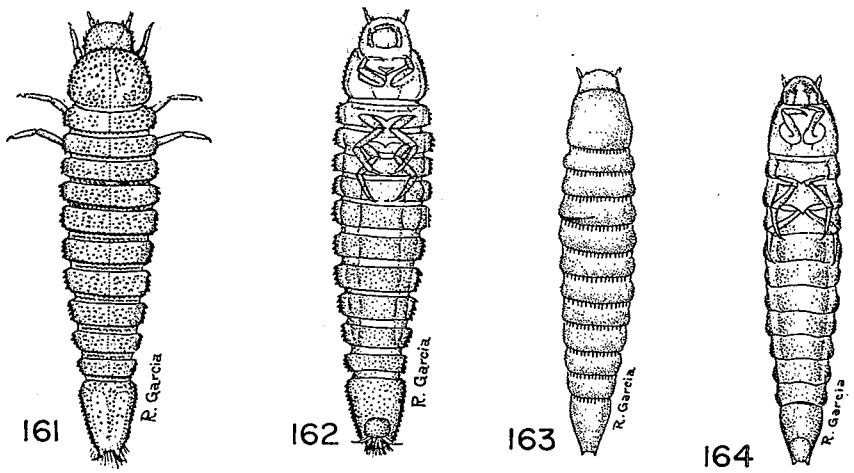
Last segment not unusually long or slender; mid-dorsal spots widest near posterior of segments; dorsal tubercles partially arranged in parallel longitudinal rows (Figs 156-158): *Microcylloepus*



Figs 156-160 Larva of *Microcylloepus pusillus*: 156- dorsal aspect; 157- ventral aspect; 158- lateral aspect. Larva of *Neoelmis* sp.: 159- dorsal aspect; 160- ventral aspect.

22 (19) Tergite of last abdominal segment with prominent median and sublateral longitudinal carinate ridges (in cross section, the segment would be pentagonal) (Figs 161, 162): *Neocylloepus*

Dorsum of last abdominal segment not carinate or prominently ridged 23



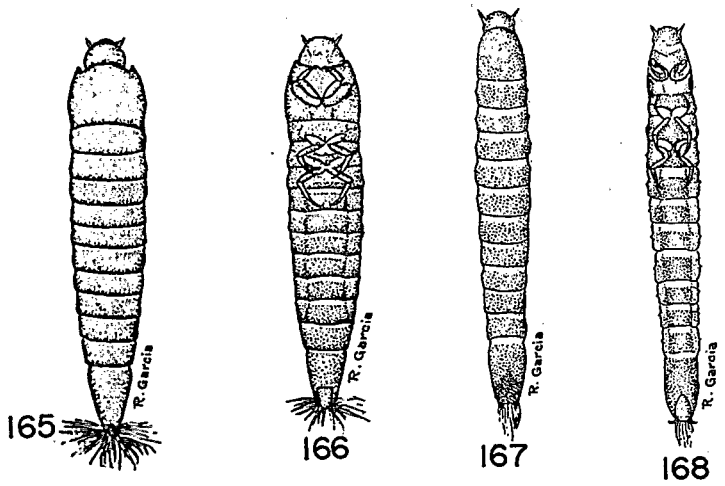
Figs 161-164 Larva of *Neocylloepus boeseli*: 161- dorsal aspect; 162- ventral aspect. Larva of *Ordobrevia nubifera*: 163- dorsal aspect; 164- ventral aspect.

23 (22) Second segment of antenna more than twice as long as first; prosternum with anterior suture obliterated; no suture extending from procoxal cavity to lateral margin of pronotum (Figs 163, 164): *Ordobrevia*

Second segment of antenna less than twice as long as first; prosternum with anterior median suture; suture from procoxal cavity to lateral margin may or may not be visible. 24

24 (23) Suture from procoxal cavity to lateral margin distinct; large and rather flattened, commonly well over 1 mm wide; our species usually relatively smooth, black, and rather shiny (Figs 165, 166): *Elsianus*

Suture from procoxal cavity to lateral margin indistinct or absent; body more convex and elongate, smaller, not more than about 1 mm wide; cuticle more granular in appearance, from pale tan to dark brown, not shiny (Figs 167, 168): *Stenelmis*



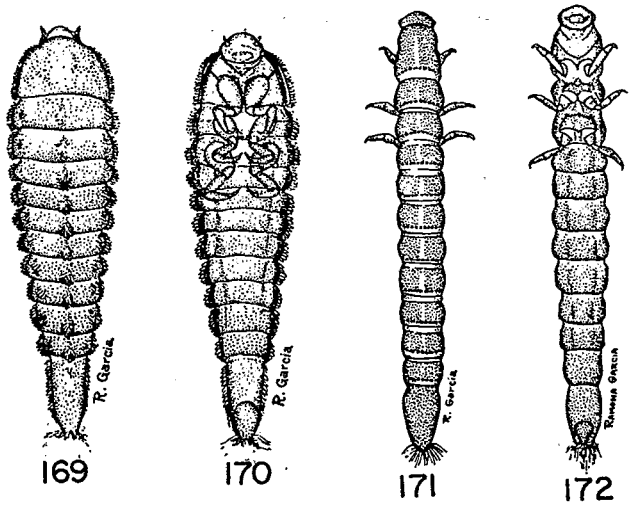
Figs 165-168 Larva of *Elsianus texanus*: 165- dorsal aspect; 166- ventral aspect. Larva of *Stenelmis* sp.: 167- dorsal aspect; 168- ventral aspect.

25 (16) Postpleurite composed of 1 part (Fig. 13)..... 26
Postpleurite composed of 2 parts (Fig. 177) 27

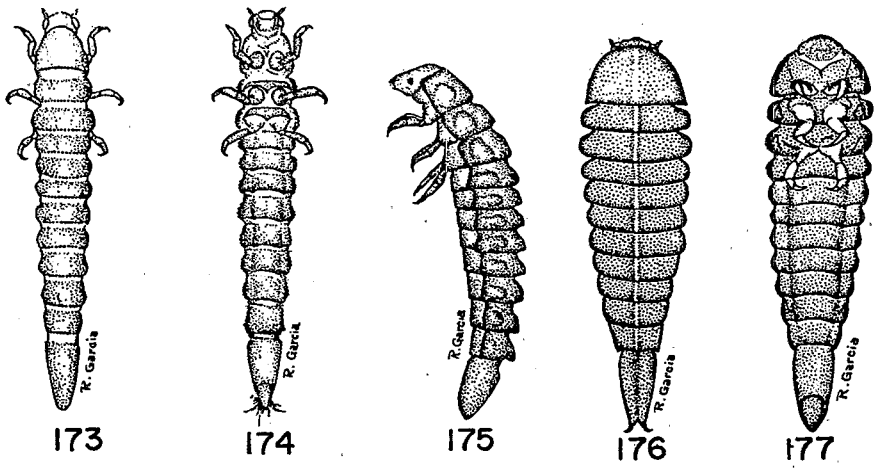
26 (25) Body robust, broad, subtriangular in cross section; with spatulate spines along lateral margins and mid-dorsal line (Figs 169, 170): *Ampumixis*

Body long and slender, hemicylindrical; without prominent clusters of spines (Figs 171, 172): *Cleptelmis*

27 (25) Mesopleuron composed of 1 part (Fig. 177) 28
Mesopleuron composed of 2 parts (Fig. 179) 29



Figs 169-172 Larva of *Ampumixis dispar* : 169- dorsal aspect; 170- ventral aspect. Larva of *Cleptelmis* sp.: 171- dorsal aspect; 172- ventral aspect.



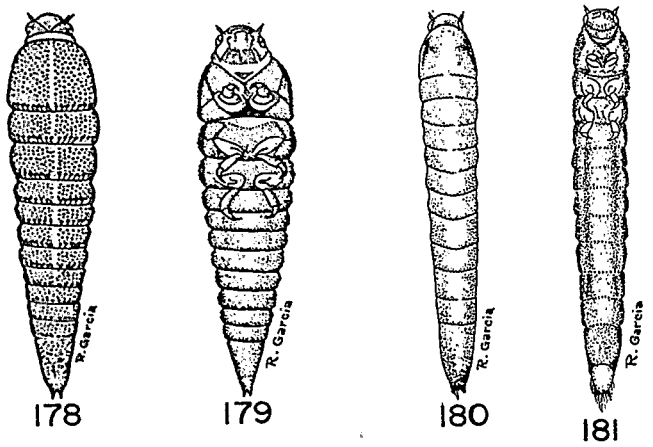
Figs 173-177 Larva of *Promoresia tardella*: 173- dorsal aspect; 174- ventral aspect; 175- lateral aspect. Larva of *Optioservus* sp.: 176- dorsal aspect; 177- ventral aspect.

28 (27) Dorsum of each segment with median and sub-lateral humps (Figs 173, 174, 175): *Promoresia*
(last segment strongly humped in *P. elegans*, feebly humped in *P. tardella*)
Dorsum without such humps (Figs 176, 177): *Optioservus*

29 (27) Abdominal segments 1-6 with pleura; last segment with 2 long, acute, narrowly separated apical processes (Figs 178, 179): *Macronychus*
Abdominal segments 1-7 with pleura 30

30 (29) Body long, slender, and hemicylindrical; apex of last segment rather deeply emarginate, the angles produced and acute (Figs 180, 181) *Zaitzevia*

Body usually less elongate, subtriangular in cross section; apex of last segment shallowly emarginate, angles less acute 31



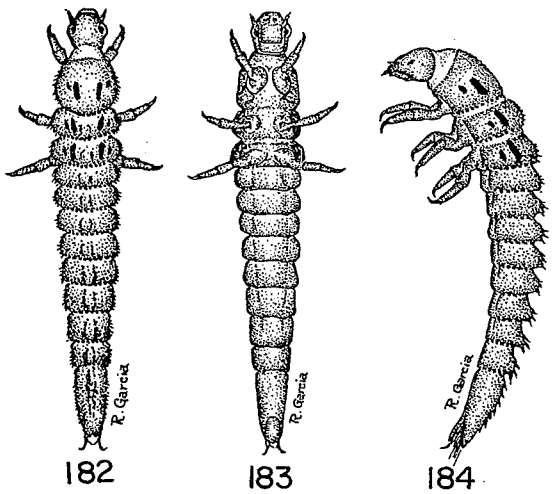
Figs 178-181 Larva of *Macronychus glabratus*: 178- dorsal aspect; 179- ventral aspect. Larva of *Zaitzevia parvula*: 180- dorsal aspect; 181- ventral aspect.

31 (30) Abdominal segments with mid-dorsal humps which are especially prominent toward the rear, each hump bearing conspicuous scale-like hairs (Fig. 184); dorsum of each thoracic segment with 2 longitudinal dark spots on each side (Figs 182-184): *Gonielmis*

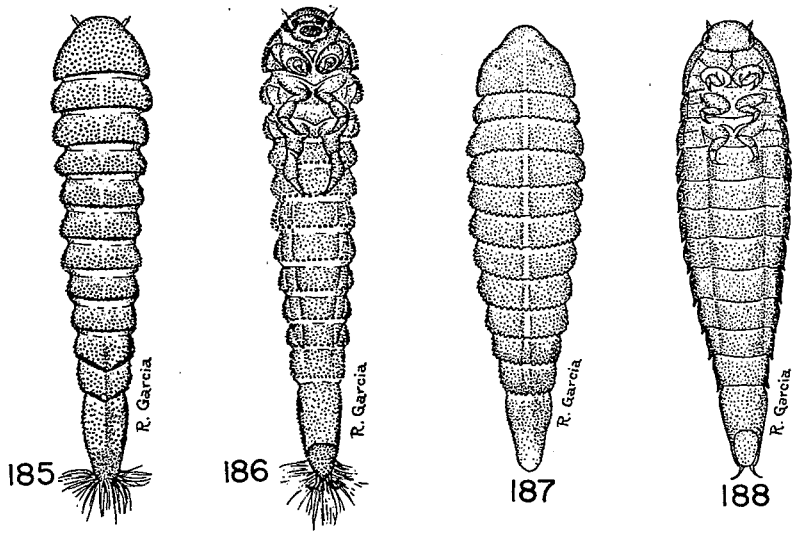
Abdominal segments without mid-dorsal humps; thorax without dark markings 32

32 (31) Western; tubercles of dorsum relatively dense, separated by less than their own widths, crowded along posterior margins of segments; mesothorax with anterior portion of pleuron much smaller than posterior portion; mature larva 4-5 mm long (Figs 185, 186): *Heterlimnius*

Eastern; tubercles of dorsum sparse, separated by more than their own widths except along mid-dorsal line, marginal tubercles separated by their own widths; mesothorax with anterior portion of pleuron subequal to posterior portion; mature larva not over 3 mm long (Figs 187, 188): *Oulimnius*



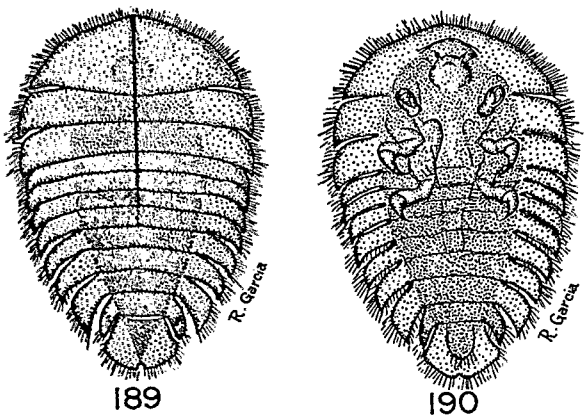
Figs 182-184 Larva of *Gonielmis dietrichi*: 182- dorsal aspect; 183- ventral aspect; 184- lateral aspect.



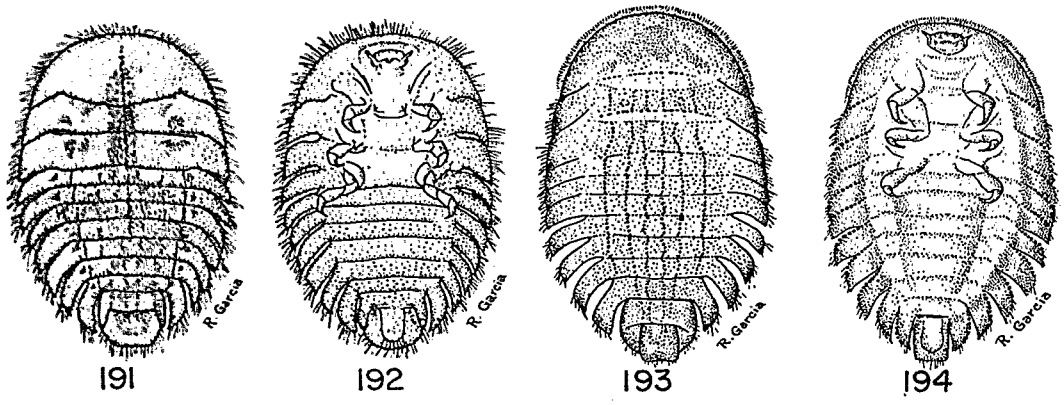
Figs 185-188 Larva of *Heterlimnius corpulentus*: 185- dorsal aspect; 186- ventral aspect. Larva of *Oulimnius latiusculus*: 187- dorsal aspect; 188- ventral aspect.

33 (1) Ninth abdominal segment with a ventral operculum closing a caudal chamber containing 3 tufts of retractile filamentous gills; without gills on other parts of abdomen; expanded lateral portions of abdominal segments separated ..... EUBRIINAE 34

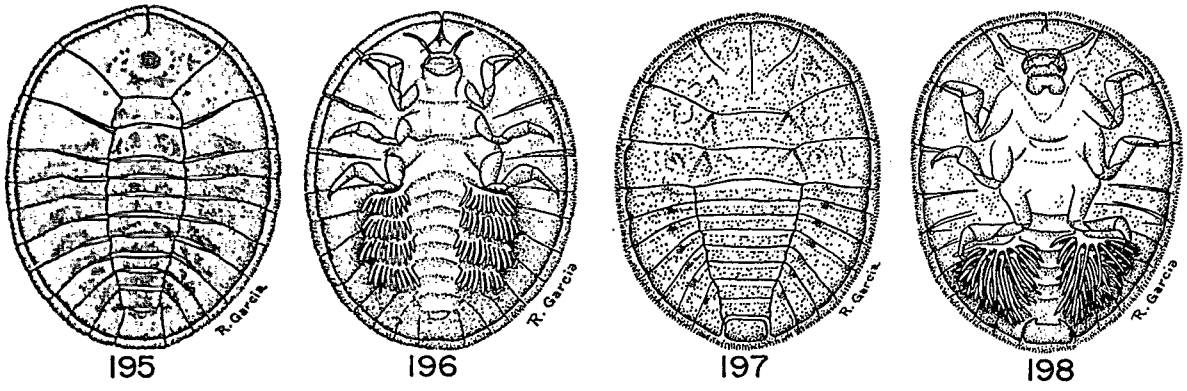
Ninth abdominal segment without ventral operculum; with pairs of ventral tufts of filamentous gills on 4 or 5 abdominal segments; expanded lateral portions of abdominal segments fitting tightly together at margin..... 36



Figs 189-190 Larva of *Acneus quadrimaculatus*: 189- dorsal aspect; 190- ventral aspect.



Figs 191-194 Larva of *Dicranopselaphus* sp.: 191- dorsal aspect; 192- ventral aspect. Larva of *Ectopria nervosa*: 193- dorsal aspect; 194- ventral aspect.



Figs 195-198 Larva of *Eubrianax edwardsi*: 195- dorsal aspect; 196- ventral aspect. Larva of *Psephenus texanus*: 197- dorsal aspect; 198- ventral aspect.

34 (33) Apex of ninth abdominal segment narrowly emarginate (i.e., with a distinct notch) (Figs 189, 190): *Acneus*
Apex of ninth segment truncate or broadly arcuate 35

35 (34) Ninth abdominal segment not rectangular, the sides expanding from base toward broadly arcuate apex; lateral expansions of eighth segment short, not forming part of lateral margin of body outline (Figs 191, 192): *Dicranopselaphus*
Ninth abdominal segment almost rectangular; lateral expansions of eighth segment forming part of margin of body outline (Figs 193, 194): *Ectopria*

36 (33) Eighth abdominal segment with lateral expansions; abdomen with 4 pairs of gills (Figs 195, 196): *Eubrianax*
Eighth abdominal segment without lateral expansions; abdomen with 5 pairs of gills (Figs 197, 198): *Psephenus*

SECTION V

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SECTION VI

GLOSSARY

accessory stria -- a short stria which usually fuses with another stria near the base of the elytron (Figs 25, 63).

aedeagus -- male genitalia (Fig. 10).

alutaceous -- covered with minute cracks or wrinkles, like the human skin.

angle -- corner (e.g., apical angle of pronotum of humeral angle or elytron as in Fig. 1).

apex (adj., *apical*) -- that part of a joint or segment farthest from the base by which it is attached; the apex of the thorax is anterior, that of the abdomen posterior.

arcuate -- arched, bow-like, rounded.

basal piece -- that part of the aedeagus to which the penis and parameres are attached (Fig. 10).

base (adj., *basal*) -- that part of a joint nearest to the main body; the base of the thorax is the posterior or hind portion, that of the abdomen being the anterior or front portion.

bimaculate -- bearing two spots (maculae).

carina -- an elevated ridge or keel (Figs 1, 4).

carinate -- exhibiting one or more carinae.

cinereous -- ashy gray in color.

clypeus -- that part of the head below the frons to which the labrum is attached (Figs 2, 3).

coxa -- the basal segment or joint of the leg (Fig. 2).

crenate -- scalloped with small, blunt, rounded teeth (Fig. 1).

crenulate -- with small, evenly rounded scallops.

decumbent -- bending downward (as decumbent hairs in contrast with erect ones).

decurved -- bowed or curved downward.

disc or *disk* -- the central upper surface (Fig. 1).

dorsum -- the dorsal or upper surface; opposite of venter.

elytra (plural of *elytron*) -- the leathery or sclerotized anterior wings which, at rest, cover the hind or flight wings, meeting in a straight line down the middle of the dorsum.

elytral interval -- the region between two adjacent elytral striae; the intervals are counted from the center,the first being the sutural interval (Fig.1) or that between the midline and the first stria.

elytral suture -- the mid-dorsal line where the elytra meet in repose.

emarginate -- notched, indented, hollowed out, curved inward.

epipleuron -- the deflexed or bent-under portion of the elytron just below the edge (Figs 2-4).

exserted coxa -- a protruding coxa; one that juts outward.

femur (plural, *femora*) -- that segment of the leg between the trochanter and the tibia (Fig. 2), sometimes the only part of the leg visible from above.

filiform -- thread-like; slender and of equal diameter; the joints of a filiform antenna are relatively uniform and shaped like elongate beads.

flabellate -- fan-shaped (Fig. 118).

fovea -- a pit or deep depression.

fuscous -- dark brown; reddish black.

genitalia -- the genital organs collectively (Figs 10, 11).

glabrous -- smooth and bare.

gular suture -- line of division between the gula (Fig. 7) and the gena lateral to it.

hemisternite -- basal portion (coxite) of female genitalia (Fig. 11), sometimes adapted for oviposition.

humerus -- the basal exterior angle of the elytron (Figs 1, 2).

hydrofuge pubescence -- tomentum; water-repellent fuzz.

hypomeron -- the deflexed or bent-under portion of the pronotum beneath the lateral margin or edge (Figs 2, 3); elytral hypomeron = epipleuron.

immaculate -- without spots or blotches.

labial palp -- jointed lateral appendage of the labium (Figs 2, 7, 15).

labium -- lower lip formed from fused second maxillae (Figs 2, 7, 13, 15).

labrum -- upper lip, attached basally to clypeus and covering bases of mandibles (Figs 2, 3).

lamellate antenna -- one with a number of terminal segments that are flattened and usually appressible like the pages of a book (Fig. 92).

lotic -- with moving water, either wave-washed or flowing.

maculate -- with spots (maculae).

mandible -- lateral jaw (Figs 2, 3, 5).

maxilla -- lateral mouth part between mandible and labium (Figs 6, 13, 14).

maxillary palp -- jointed appendage of maxilla (Figs 2, 3, 6, 14); often the most conspicuous mouthpart on the intact specimen.

mesopleuron -- pleuron of mesothorax.

mesosternum -- sternum of mesothorax (Figs 2, 13).

mesothorax -- middle segment of thorax; to it are attached the second or middle pair of legs and, in adults, the elytra.

metapleuron -- pleuron of metathorax.

metasternum -- sternum of metathorax (Figs 2, 13).

metathorax -- third segment of thorax; to it are attached the third or hind pair of legs and, in adults, the flight wings.

moniliform antenna -- one with joints or segments like rather uniform globular beads.

ocellus (plural, *ocelli*) -- a simple eye or eyespot.

ochreous or *ochraceous* -- brownish yellow.

operculum -- trapdoor-like ventral cover of gill chamber on last abdominal segment of larva (Fig. 13).

ovipositor -- sclerotized parts of female genitalia (usually hemisternites) adapted for insertion of eggs into the substrate (e.g., in *Helichus*, Figs 95, 101, 102).

paramere -- lateral lobe of male genitalia, attached to basal piece and enclosing penis (Fig. 10).

pectinate antenna -- one in which a number of segments are enlarged into long tooth-like projections so that the antenna resembles a comb or a garden rake (Fig. 121).

penis -- median lobe of male genitalia, attached to basal piece and flanked or enclosed by the paired parameres (Fig. 10).

pile -- pubescence; fuzz; short, dense hairs.

plastron -- gaseous film maintained under water by means of small, close-set, hydrofuge hairs covering parts of the body surface.

pleurite -- a sclerite covering part or all of a pleuron (Fig. 13).

pleuron (plural, *pleura*) -- the lateral region of a body segment between tergum and sternum.

postpleurite -- the pleurite of the prothorax behind the coxa (Fig. 13).

procoxa -- the coxa of a front leg (Fig. 3).

pronotum -- the dorsal portion of tergum of the prothorax (Figs 1, 3, 12).

propleuron -- the pleuron of the prothorax.

prosternal process -- posterior median projection of the prosternum between the procoxae (Fig. 2).

prosternum -- sternum of the prothorax (Figs 2, 3, 13).

prothorax -- first segment of thorax, to which head is attached and into which the head may be partially or entirely withdrawn; this segment also bears the front pair of legs.

pubescence -- fuzz; hairs.

puncta, punctation -- small punctures or pits in the surface; rows of such punctures form the striae of the elytra.

recurved -- bent or curved upward.

riparian -- shore-dwelling; occurring at or near the margin of the water.

rufous -- reddish.

sclerite -- a hardened piece or section of the exoskeleton.

sclerotized -- hardened.

scutellum -- the wedge-shaped median dorsal sclerite between the basal portions of the elytra (Fig. 1).

sericeous -- silky; downy.

serrate -- saw-toothed (e.g., serrate elytral margin as in Fig. 1 or serrate antenna as in Fig. 120).

sternite -- a sclerite of the sternum (Figs 1-4, 13).

sternum -- the ventral part of a body segment.

stria -- a row of punctures forming a longitudinal line (Fig. 1).

stylus -- sensory projection of the female genitalia attached to hemisternite (Fig. 11).

sub- (prefix) -- almost; nearly; slightly; close to; just below. (e.g., subequal; subquadrate.)

sublateral carina -- a lateral longitudinal carina parallelling the lateral margin (Figs 1, 3).

submentum -- the basal sclerite of the labium by which the labium is attached to the gula of the head (Fig. 7).

sulcus (plural, *sulci*) -- a groove or furrow.

sutural interval -- the first or median elytral interval (Fig. 1).

sutural vitta -- a vitta or stripe bordering the elytral suture (Figs 81, 82).

suture -- a seam or impressed line between two contiguous sclerites; the median line of juncture of the elytra (Figs 12, 13).

tarsus -- the foot; the distal part of the leg attached at the apex of the tibia, consisting typically of five joints or segments and bearing the tarsal claws (Fig. 2).

tergite -- a sclerite of the tergum (the dorsal part of a segment) (Figs 1, 12, 13).

testaceous -- yellow; brownish yellow.

thorax -- the body region between the head and the abdomen; the thorax bears the legs and, in adults, the wings.

tibia -- the joint or segment of the leg between the femur and the tarsus (Fig. 2).

tomentum -- a dense patch of hairs, either prominent, as on the tibia (Fig. 2), or closely appressed to the surface and providing a plastron on various body sclerites.

transverse coxa -- an elongate coxa extending transversely like the hind coxa of Fig. 2.

travertine -- a rather porous calcareous stone which forms on the substrate in falls and rapids of streams with a very high calcium content.

trochantin -- a small piece or joint on the outer side of the coxa (well separated from the trochanter) which may be exposed or may be hidden beneath the pronotum or prosternum.

truncate -- cut off squarely or abruptly at the tip.

tubercle -- a small button-like or pimple-like projection of the exoskeleton.

tuberculate -- bearing tubercles.

umbone -- an embossed, elevated knob on the humeral angle of an elytron (Fig. 1).

venter -- the ventral surface or under side of the body.

vitta -- a longitudinal stripe, usually relatively broad.

vittate -- striped; bearing vittae.

SECTION VII

INDEX OF SCIENTIFIC NAMES

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