BEETLES

of Eastern North America

Arthur V. Evans

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DEDICATION

This book is dedicated to CHARLES "CHUCK" LAWRENCE BELLAMY (1951–2013) and RICHARD LAWRENCE HOFFMAN (1928–2012) in recognition of their years of friendship, good cheer, support, and shared passion for all things beetle. I miss them both very much.

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PREFACE

When I moved from California to Virginia some 14 years ago, I found myself surrounded by a beetle fauna that was at once familiar, yet exotic. Familiar because, as a scarab beetle specialist, I had more than a working familiarity with the scarab fauna of eastern North America and its literature. Exotic because most of the beetles in other families were entirely new to me. I took the opportunity to extend my focus beyond scarabs to include all families of beetles that occurred in my newly adopted state. Through fieldwork, macro photography, literature searches, and the examination of museum collections, I soon discovered that Virginia's coastal, sandhill, piedmont, and montane plant communities served as habitats for a tremendous diversity of beetles that included those with decidedly boreal or austral distributions. In other words, studying the beetles of Virginia was like taking a crash course in the fauna of all of eastern North America.

Several books became my primary entrée to the beetles of the region, including *An Illustrated Descriptive Catalogue of the Coleoptera or Beetles (exclusive of the Rhynchophora) Known to Occur in Indiana* (Blatchley 1910) and *Rhynchophora or Weevils of North Eastern America* (Blatchley and Leng 1916). *A Manual of Common Beetles of Eastern North America* (Dillon and Dillon 1972) was also very helpful. *The Beetles of Northeastern North America* (Downie and Arnett 1996) provided numerous keys for identifying species. The two-volume *American Beetles* (Arnett and Thomas 2000, Arnett et al. 2002) provided a badly needed taxonomic update for the North American beetle fauna supported with well-illustrated keys and extremely useful bibliographies. Much of the published taxonomic, biological, ecological, and distributional information for the species that inhabit eastern North America is tucked away, however, among thousands of notes, articles, and monographs published in hundreds of departmental circulars, newsletters, peer-reviewed journals, regional guides, and various online resources.

Beetles likely make up nearly one-fifth of all plant and animal species found in eastern North America. Although beetles are frequently eye-catching because of their color, form, or habit, no one photographic guide covering species in all 115 families known in the region has been attempted until now. Most of the 1,409 species that appear in this work are quite conspicuous and found throughout the region, while a few are decidedly boreal or Floridian in distribution; however, it must be remembered that the species presented within these pages represent fewer than 10% of the entire eastern beetle fauna. As such, readers should not expect to find every species they encounter described among these pages; for example, typically rare forms excluded from this book may become locally common under extraordinary conditions. Still, readers using this book are likely to identify the majority of conspicuous beetles that cross their paths to the species level and should be able to reliably assign others to their appropriate genus or family.

The primary goal of this book is to present the beetles of eastern North America in an engaging format that is accessible to the amateur naturalist interested in beetles, yet authoritatively written to serve the needs of the professional biologist. I hope this richly illustrated book will increase the enjoyment of all interested in the natural world, serve as an introduction for students desiring to know more about beetles, and stimulate those who have already embraced the world's largest and most diverse group of animals as their life's work.

ACKNOWLEDGMENTS

First and foremost, I thank Robert Kirk, executive editor at Princeton University Press, for the opportunity to write this book. His support, guidance, and, most importantly, patience, were instrumental in the creation of this work. I also appreciate the dedication and expertise of Mark Bellis and Lorraine Doneker at Princeton University Press, copyeditor Lucinda Treadwell, and typesetter David Price-Goodfellow for their encouragement, advice, creativity, and expert copyediting.

A book of this size, depth, and quality would have been impossible to achieve were it not for the excellent images supplied by a talented and dedicated cadre of photographers. Their persistence in seeking out and capturing images of all kinds of beetles served as an inspiration to me as I compiled this work. I am particularly grateful for the efforts of Chris Wirth and Tom Murray, whose stunning work represents a significant portion of the images that appear on these pages. The contributions of the following photographers provided this book with the taxonomic breadth and depth required to establish its utility, and enhance its aesthetic appeal: Ken Allen, Dave Almquist, Jerry Armstrong, Lyn Atherton, Troy Bartlett, Christy Beal, Paul Bedell, Christoph Benisch, Thomas Bentley, Ashley Bradford, Donna Brunet, Val Bugh, Bob Carlson, Chris Carlton, Carmen Champagne, Jan Ciegler, Patrick Coin, Alan Cressler, Stephen Cresswell, Rob Curtis, Denis Doucet, Josef Dvořák, Charley Eiseman, Mardon Erbland, John Frisch, David Funk, Nicolas Gompel, Henri Goulet, Bob Gress, Joyce Gross, Guy Hanley, Randy Hardy, Phil Harpootlian, Jeff Hollenbeck, Scott Justis, James Kalisch, WonGun Kim, Thor Kristiansen, Jessica Lawrence, René Limoge, Ilona Loser, Stephen Luk, Ted MacRae, Crystal Maier, Daniel Marlos, Steve Marshall, Ole Martin, Charles Matson, John Maxwell, Sean McCann, Richard Migneault, Graham Montgomery, Roy Morris, Tim Moyer, Steve Nanz, Scott Nelson, Mark O'Brien, Jenn Orth, Johnny Ott, Nikola Rahme, Jon Rapp, Jennifer Read, David Reed, Lary Reeves, Charles Robertson, Matt Roth, Kurt Schaefer, Lynnette Schimming, Kyle Schnepp, Jimmy Sherwood, Tom Schultz, Roy Sewall, Ken Schneider, Marvin Smith, Gayle (deceased) and Jeanell Strickland, Tracy Sunvold, Mike Thomas, Alexey Tishechkin, Ed Trammel, Donna Watkins, Alex Wild, Jane Wyche, Dan Young, and Robert Lord Zimlich. I am forever grateful to all these superb photographers for their generosity and enthusiasm for this project.

Jennifer Read expertly prepared all 1,500+ images used in this work. She converted jpegs into tifs when needed and, when absolutely necessary, cropped, sharpened, adjusted exposures, repaired or replaced the occasional missing or damaged appendage, and removed dust and stray hairs so that each and every image in this book would look its absolute best. Jen also rendered the illustrations accompanying the key to families. Many thanks to Graham Wilson and Megan Rollins for their assistance in the initial phase of developing these illustrations.

I thank the following friends and colleagues for their assistance with specimen identifications, sorting out taxonomic issues, providing pertinent literature, collecting live specimens to photograph, supplying unpublished biological and geographic data, and reviewing portions of the manuscript: Albert Allen, Bob Anderson, Bob Androw, Chuck Bellamy (deceased), Vassili Belov, Larry Bezark, Yves Bousquet, Michael Brattain, Carlyle Brewster, Adam Brunke, Chris Carlton, Mike Caterino, Don Chandler, Anne Chazal, Jan Ciegler, Andy Cline, Maureen Dougherty, Hume Douglas, Terry Erwin, David Funk, François Genier, James Gibbs, Bruce Gill, Phil Harpootlian, Chris Hobson, Richard Hoffman (deceased), W.M. Hood, Mike Ivie, Paul Johnson, Kerry Katovich, Sergey Kazantsev, John Kingsolver, Nadine Kriska, John Lawrence, John Leavengood, Rich Leschen, Stephané Le Tirant, Steve Lingafelter, Darren Loomis, Chris Ludwig, Ted MacRae, Chris Majka, Blaine Matheson, Adriean Mayor, Chuck McClung, Will Merrit, Alfred Newton, Rolf Obeprieler, Charlie O'Brien, M.J. Paulsen, Stewart Peck, Keith Philips, Keith Pike, John Pinto, Darren Pollock, Jens Prena, Jennifer Read, Steve Roble, Bill Shepard, Floyd Shockley, Derek Sikes, Paul Skelley, Charlie Staines, Warren Steiner Jr., Margaret Thayer, Mike Thomas, Alexey Tishechkin, Natalia Vandenberg, Robert Vigneault, Graham Wilson, Rebecca Wilson, Norm Woodley, and Dan Young.

Finally, I thank my wife, Paula, whose love and support have made all my entomological pursuits in this century possible. Without her I would never have been able to undertake or complete this book.

I share the success of *Beetles of Eastern North America* with all the aforementioned individuals, but the responsibility for any and all of its shortcomings, misrepresentations, inaccuracies, and omissions is entirely my own.

HOW TO USE THIS BOOK

To get the most out of this book, read its introductory sections before venturing out into the field. Once you have become familiar with the bodies and lives of beetles, when to find them, where they live, and how to collect them, move on to the family diagnoses that punctuate the species accounts. Begin learning the physical features that characterize each family and distinguish them from similar families. Then peruse the individual accounts to get an idea of where and when to look for specific species. With this information at your disposal, you will be much better prepared to find and observe beetles and recognize the specific characteristics that will aid in their identification.

CLASSIFICATION

Numerous and substantial changes have been made in the classification of the Coleoptera since the appearance of the *American Beetles* volumes, and this process is ongoing. The families and species covered in this book mostly follow the order presented in *Family Group Names in Coleoptera (Insecta)* (Bouchard et al. 2011). In this book, the Cybocephalidae, treated elsewhere as a subfamily of the Nitidulidae, is treated as a family. The Ischaliidae, also recognized in this book, has been considered either its own family or a subfamily of the Anthicidae by previous authors. See the appendix, Classification of the Beetles of Eastern North America (p.501), for further details.

KEY TO FAMILIES

To assist with the correct placement of the most commonly encountered beetles in their proper family, a dichotomous key is presented (pp.53–7). This key consists of a series of "either–or" choices based on the quality of physical features possessed by a specimen. As with a road map, the reader is directed to a series of junctions called *couplets* that, through a process of elimination, will lead to a smaller and more manageable subset of the most commonly encountered families with which the beetle in question can be compared, checked against similar families, and, it is hoped, matched to a species photo and account.

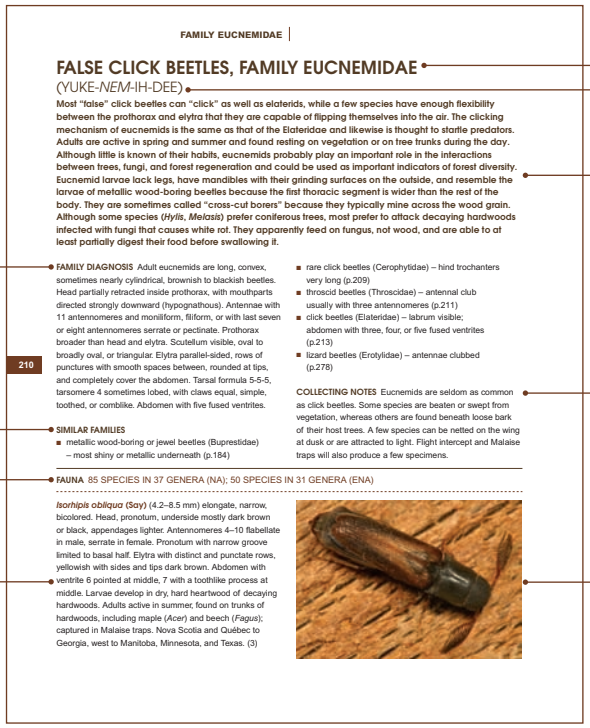
FAMILY DIAGNOSES

Each family diagnosis provides information on the accepted common family name, pronunciation of the scientific family name, a brief overview of the natural history of the species in the family, and family diagnosis based on morphological features, including length in millimeters, shape, color, and features of the head, thorax, abdomen, and appendages. This information is augmented by descriptions of select features of other families of beetles containing species superficially similar in appearance or habit. Finally, the numbers of species and genera of each family (if known) found in the Nearctic and eastern North America are presented to give readers an idea of the beetle diversity in the region and how it compares with the combined fauna of Canada and the United States. Some of these numbers are only estimates since many taxa are inadequately known.

SPECIES ACCOUNTS

The species accounts provide the accepted common name (if any), scientific name, length in millimeters, overall form, and color of living beetles. The bright colors (pink, red, orange, yellow, green) of some living beetles frequently fade after death, while metallic colors and iridescence are usually permanent, except in some tortoise beetles (Chrysomelidae). Read the species accounts carefully to discern species-specific features that may not be evident in the photo. As good as the photographs are in this book, they sometimes do not adequately highlight the subtle characters necessary for accurate species identification. Snap judgments based solely on overall appearance and color often result in misidentifications. Information on distinguishing males and females is presented for many species in which the sexes markedly differ from one another externally. Brief notes on seasonality, habitat, food preferences (for adults and occasionally larvae), and distribution are also provided. The origin of species not native to North America, either purposely or accidentally introduced, is indicated when appropriate. Every effort has been made to ferret out published distributional records and augment them with unpublished data gleaned from local lists, records provided by avocational coleopterists, and specimens in select museums. Still, the actual distributions

A representative page showing the main elements of the family diagnoses and species accounts (see p.9).



of many species described in this guide are very likely broader than indicated in this book. At the end of most accounts is the total number of species in the genus known east of the Mississippi river.

SPECIES IDENTIFICATION

The identification of beetles can be challenging. Many conspicuous species are easily identified by direct comparison with a photograph, but most beetles are small and the characters necessary for species identification simply are not going to be available for examination without the specimen in hand. This is why it is best to capture and properly prepare a short series of specimens and have them available for detailed microscopic examination. Although 10× or 20× hand lenses are very useful for this purpose, a stereoscopic dissecting microscope with good lighting is ideal. Using a hand lens or microscope to examine specimens takes a bit of practice at first, but once you have mastered these indispensible tools, you will never again waste time by straining your unaided eyes to count tarsomeres and antennomeres or examine genitalia.

Many beetles can be positively identified to species only through examination of the male reproductive organs and comparison with detailed illustrations, photos, or previously identified specimens that were determined by experts. Although providing detailed drawings of thousands of beetle genitalia is well beyond the scope of this book, it is useful to get into the habit of extracting the male genitalia while the specimen is still fresh and pliable so they can be easily examined by a specialist or compared to literature that depicts the genital structures of closely related species. You can extract the genitalia from the posterior opening of the abdomen by gently pulling them out with fine-tipped forceps or with the aid of a fish-hooked insect pin. Extracting genitalia from dried specimens requires that the specimens first be softened in a relaxing chamber, or placed in boiling water with a few drops of dish soap added as a wetting agent. Once the genitalia are extracted, you can leave them attached to the tip of the abdomen by their own tissue, where they will dry in place, or remove them entirely and glue to an insect mounting point, and pin the point just below the pinned specimen for later examination. Some beetles, especially very small species, require specialized techniques for extracting and preserving their genitalia. Consult the pertinent literature or a specialist before undertaking the dissection of these specimens.

Readers requiring accurate species identification, especially for control of horticultural, agricultural, and forest pests, are encouraged to consult coleopterists affiliated with cooperative extension offices or the entomology department of a museum or university for verification.

INTRODUCTION TO BEETLES

BEETLE ANATOMY

Although colors and patterns are sometimes useful, beetles are classified and more reliably identified on the basis of their anatomical features. Therefore, a basic understanding of beetle anatomy (Fig. 1) is essential for better understanding of not only their evolutionary relationships, but also the terminology used in the family diagnoses and species accounts that appear in this book.

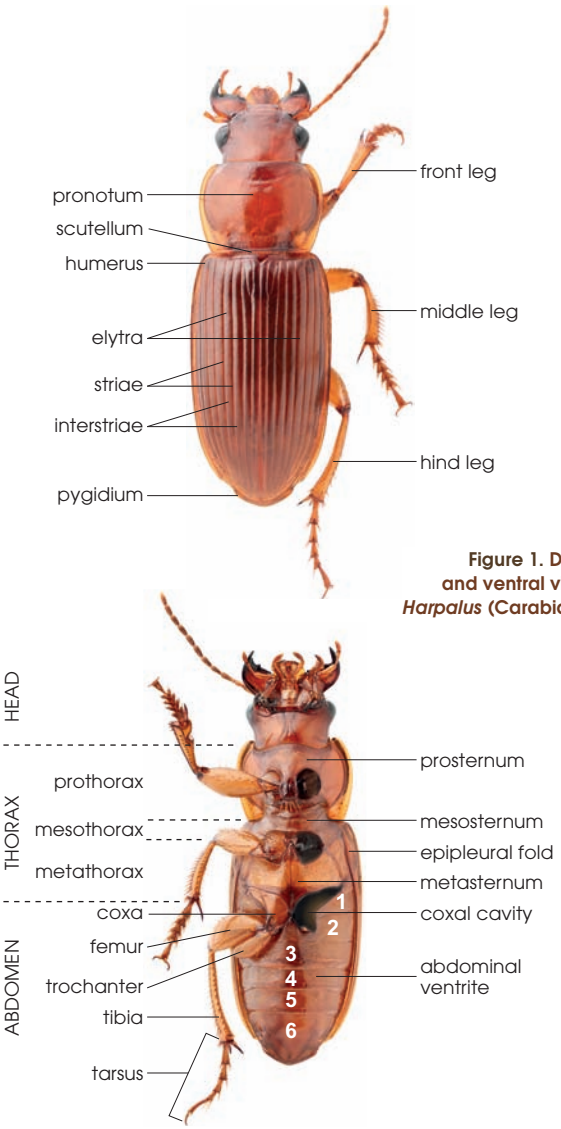


Figure 1. Dorsal and ventral views, *Harpalus* (Carabidae).

EXOSKELETON

Adult beetles are covered and protected by a highly modified *exoskeleton* that functions as both skeleton and skin. Internally, the exoskeleton serves as a foundation for powerful muscles and organ systems, while externally providing a platform for important sensory structures connecting them to their surrounding environment. The exoskeleton is light yet durable and composed of a multilayered structure comprising the polysaccharide *chitin* and the protein *sclerotin*.

The exoskeleton is subdivided into *segments*, some of which are composed of smaller plates, or *sclerites*. The segments are joined into functional units that form appendages (mouthparts, antennae, legs) and three body regions (head, thorax, abdomen). Segments are joined together by membranes of pure chitin or separated by narrow furrows called *sutures*. The division of the exoskeleton into body regions and sclerites affords flexibility to beetle bodies, much the way the joints and plates of armor allowed knights to maneuver in battle.

BODY SHAPE

The basic body shape (Figs. 2a–n) of a beetle when viewed from above is sometimes variously described as elongate, oval, triangular, or antlike, among others. Parallel-sided refers to the straight and parallel sides of the elytra, the wing covers of a beetle. Terms like *convex*, *hemispherical*, flat, and flattened are useful too for describing the upper or *dorsal* surface, a description best determined when viewed from the side. Lady beetles (Coccinellidae) and some leaf beetles (Chrysomelidae) are sometimes referred to as “hemispherical” because their dorsal surface is very convex while the *ventral* surface or underside is relatively flat. *Cylindrical* is usually applied to elongate, parallel-sided species with convex dorsal and ventral surfaces and suggests that they would appear almost circular in cross section.

SURFACE SCULPTURING

The nature of the body surface on beetles, or surface sculpturing, is very useful in species identification. Surfaces can be shiny like patent leather or dulled (*aluteceous*)

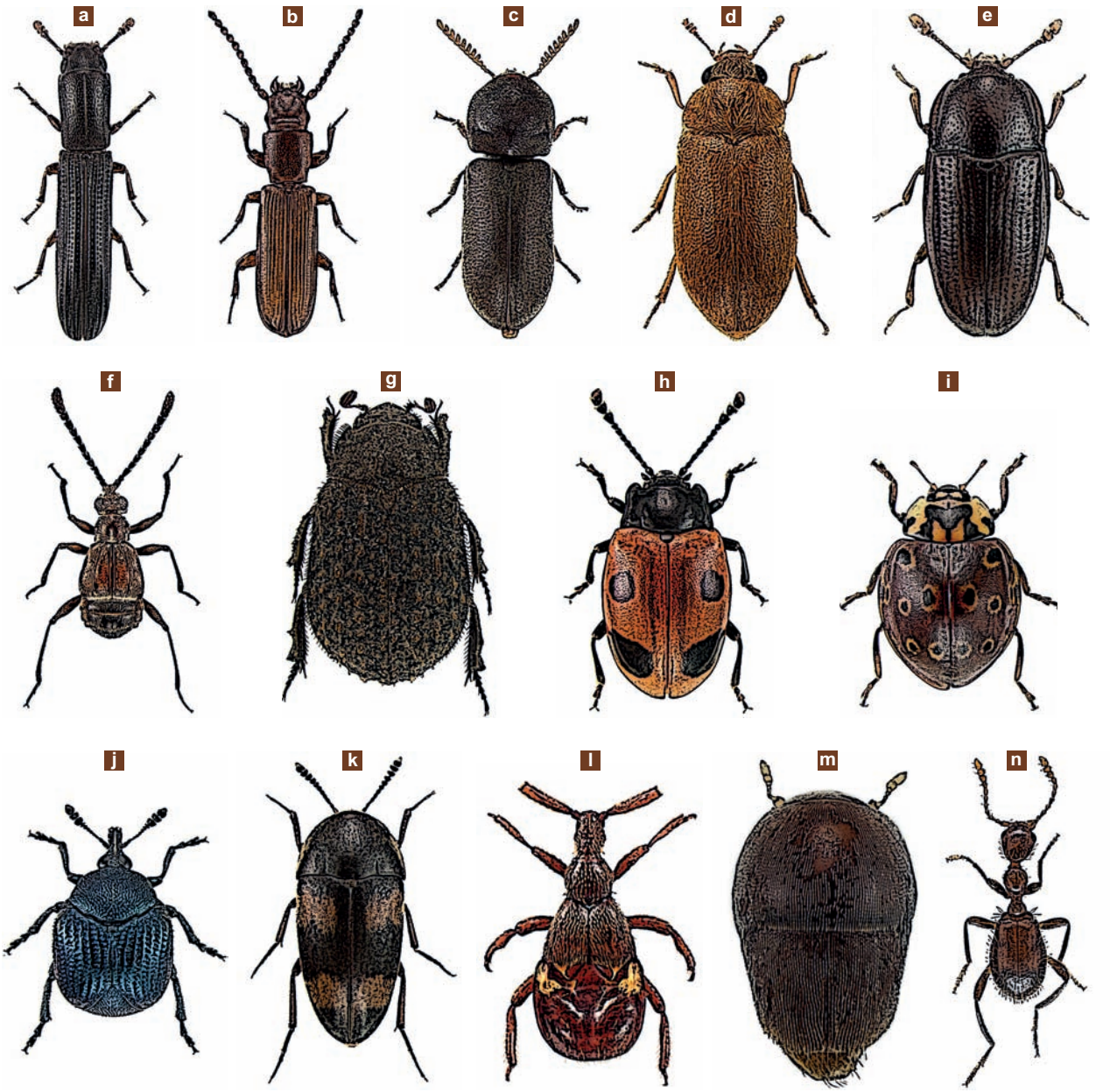


Figure 2. Body shapes.
a. elongate, *Colydium* (Zopheridae); b. elongate, *Catogenus* (Passandridae); c. elliptical, *Ptilinus* (Ptinidae); d. elongate-oval, *Byturus* (Byturidae); e. elongate-oval, *Philothermus* (Cerylonidae); f. elongate-oval, *Ctenisodes* (Staphylinidae); g. oval, *Trox* (Trogidae); h. oval, *Endomychus* (Endomychidae); i. broadly oval, *Anatis* (Coccinellidae); j. broadly oval, *Pterocolus* (Attelabidae); k. obovate, *Holostrophus* (Tetratomidae); l. triangular, *Adranes* (Staphylinidae); m. limuloid, *Sepdophilus* (Staphylinidae); n. antlike, *Acanthinus* (Anthicidae).

by a minute network of fine cracks resembling those of human skin. The surfaces of the head and legs, especially in burrowing species, are sometimes dulled by normal abrasion as the beetle burrows through soil or wood. Sometimes the surface is *glaucous*, or coated with a grayish or bluish coating of waterproof wax secreted by epidermal glands underlying the exoskeleton. This coating is easily rubbed off or dissolved in chemical preservatives and is usually evident only in freshly emerged individuals.

Shiny or not, many beetle bodies are typically covered to varying degrees with small pits called *punctures*. Punctures range from very small (*finely punctate*) to large (*coarsely punctate*) and may be shallow or deep. The density or distance of punctures from one another is often reported in

terms of the degree of separation in relation to the puncture's diameter. Contiguous or nearly contiguous punctures are those with rims that touch one another, or nearly so. In *rugopunctate* surfaces, the punctures are so tightly spaced, the surface appears rough. Punctures sometimes bear a single hairlike *seta* (pl. *setae*). Setae are fine or bristly, stand straight up (*erect*), or lie nearly flat on the surface (*recumbent*). Flattened setae, or *scales*, range in outline from nearly round, to *oval* (egg-shaped), *obovate* (pear-shaped), *lanceolate* (spear-shaped) to linear (long and slender). Densely setose or scaled surfaces may be partially or completely obscured from view, while the complete absence of setae or scales altogether is referred to as *glabrous*.

An *impunctate* surface lacks punctures altogether, while *rugose* (rough) surfaces have raised areas that are formed by small wrinkles, distinct ridges, bumps, or fingerprint-like whorls. *Granulate* surfaces consist of many small, distinct, and rounded bumps, like the pebbled surface of a basketball.

HEAD AND ITS APPENDAGES

The capsule-shaped *head* (Fig. 3) is attached to the thorax by a flexible, membranous neck that is sometimes visible from above (e.g., Meloidae) but usually hidden, along with part of the head, within the first thoracic segment, or *prothorax.* In the fireflies (Lampyridae), some hooded beetles (Corylophidae), and other beetle families, the head is completely hidden from above by a hoodlike extension of the dorsal sclerite of the prothorax, or *pronotum*.

The compound eyes are usually conspicuous and composed of dozens or hundreds of individual facets or lenses. Awash in light, the lenses of day-active (*diurnal*) beetles are relatively small and flat, while nocturnal species have more convex lenses that gather all available light. Flightless, cave-dwelling, and subterranean species often have small compound eyes with only a few lenses or may lack eyes altogether. Compound eyes are typically round, or oval to kidney-shaped in outline. The front margins of kidney-shaped eyes are weakly to strongly notched, or *emarginate*; the antennae of some species may originate within or near the emargination. The eyes are sometimes partially divided in front by a narrow ridge of cuticle called the *canthus*. In whirligigs (Gyrinidae) and some throscids (Throscidae) and longhorns (Cerambycidae), the canthus completely divides the eye. Some skin beetles (Dermestidae) and omaline rove beetles (Staphylinidae) also possess a simple eye, or *ocellus*, comprising a single lens located on the front of the head between the compound eyes.

The males of several eastern species (e.g., Geotrupidae, Scarabaeidae, and Tenebrionidae) have horns on their heads modified into spikes, scooped blades, or paired knobs that are used in mostly "bloodless" battles with other males of the same species over resources that will attract females. The variation of horn size in males of the same species is of particular interest to scientists who study mate selection. Environmental factors, especially larval nutrition, often play a more important role in horn development than genetic factors. Although outgunned in battle, lesser endowed males are still fully capable of mating with females and fertilizing their eggs when the opportunity arises.

The mouthparts of all beetles follow the same basic plan: an upper lip (*labrum*), two pairs of chewing appendages (*mandibles*, *maxillae*), and a lower lip (*labium*). Although the mandibles of beetles are variously modified to cut and tear flesh (e.g., Carabidae), grind leaves (e.g., Chrysomelidae), or strain fluids (some Scarabaeidae), they also serve other purposes. The outsized mandibles of some male stag beetles (Lucanidae) are not used for feeding at all, but rather for battling other males over females. The tile-horned prionus, *Prionus imbricornis* (Cerambycidae) uses its imposing mandibles to tunnel out of wood as well as for weapons of defense. Male tiger beetles (Carabidae) use their mandibles to firmly grasp the female during copulation. Attached to the maxilla and labium are delicate, flexible, fingerlike structures, or *palps*, that assist beetles in the manipulation of food. The long and conspicuous maxillary palps of water scavengers (Hydrophilidae) are easily mistaken for antennae. Each palp is divided into articles or

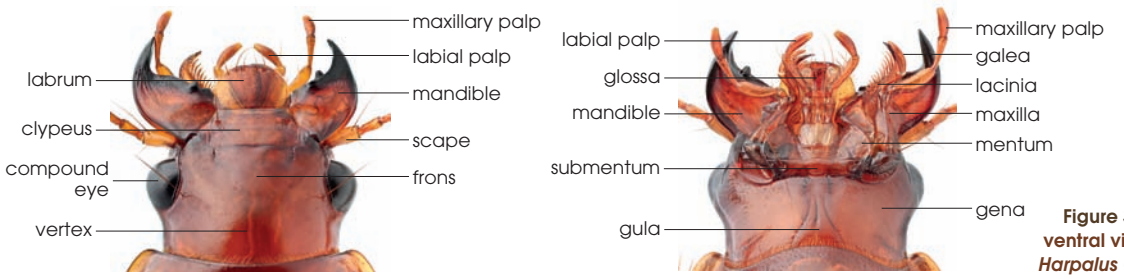


Figure 3. Dorsal and ventral views of head, *Harpalus* (Carabidae).

sections called *palpomeres*. Protecting the mouthparts from above in most beetles is a broad plate of cuticle formed by the leading edge of the head, or *clypeus*. Below the head at the base of the labium in most beetles are two sclerites: *mentum* and *gula*.

The mouthparts of predatory and some wood-boring beetles are typically *prognathous* (Fig. 4), directed forward and parallel to the long axis of the body. *Hypognathous* mouthparts (Fig. 5) are directed downward and typical of most plant-feeding beetles, including chafers

Figure 4. Prognathous mouthparts, *Hesperandra* (Cerambycidae).

Figure 5. Hypognathous mouthparts, *Chrysochus* (Chrysomelidae).

Figure 6. Rostrum, *Curculio* (Curculionidae).

(Scarabaeidae), some longhorn beetles (Cerambycidae), leaf beetles (Chrysomelidae), and weevils (Curculionidae). The hypognathous mouthparts of some net-winged beetles (Lycidae) and narrow-waisted beetles (Salpingidae), and many weevils and their relatives (Curculionidae, Nemonychidae, Brentidae, Anthribidae) are drawn out into a short, broad beak, or an elongate *rostrum* (Fig. 6).

The *antennae* are beetles' primary organs of smell and touch and usually attached to the sides of the head, often between the eyes and the bases of the mandibles. Although the antennae exhibit an incredible diversity of sizes and shapes, they all consist of three basic parts: *scape*, *pedicel*, and *flagellum* (Fig. 7). The usual number of antennal articles is 11, but 10 or fewer are common in some groups, while 12 or more occur only rarely. Insect morphologists note that only the scape and pedicel have their own internal musculature and are the only true antennal segments, while the remaining articles of the flagellum lack intrinsic musculature and are called *flagellomeres*. Distinguishing segments and flagellomeres to communicate information about the number of antennal articles and the like is unwieldy at best. For the sake of morphological correctness and clarity, all visible antennal articles are referred to as *antennomeres*. The scape is antennomere 1 and the pedicel is antennomere 2. Antennomeres 3–11 refer to the articles of the flagellum.

The antennae are generally shorter than the body and somewhat similar in both sexes; however, male pine sawyers in the genus *Monochamus* (Cerambycidae) have long, threadlike antennae up to three times the length of the body, while those of the female are only slightly longer than the body. In other species, the ornate antennal modifications possessed by male *Polyphylla* (Scarabaeidae), *Phengodes* (Phengodidae), *Sandalus* (Rhipiceridae), and wedge-shaped beetles (Ripiphoridae) are packed with sensory pits capable of tracking pheromones released by distant or secretive females.

The principal forms of beetle antennae (Figs. 8a–l) include the following:

- *filiform*, or threadlike, with antennomeres uniformly cylindrical, or nearly so
- *moniliform*, or beadlike, with round antennomeres of uniform size
- *serrate*, or saw-toothed, with flattened, triangular antennomeres
- *pectinate*, or comblike, with short antennomeres each bearing a prolonged extension
- *bipectinate*, or comblike, with short antennomeres each bearing two prolonged extensions