



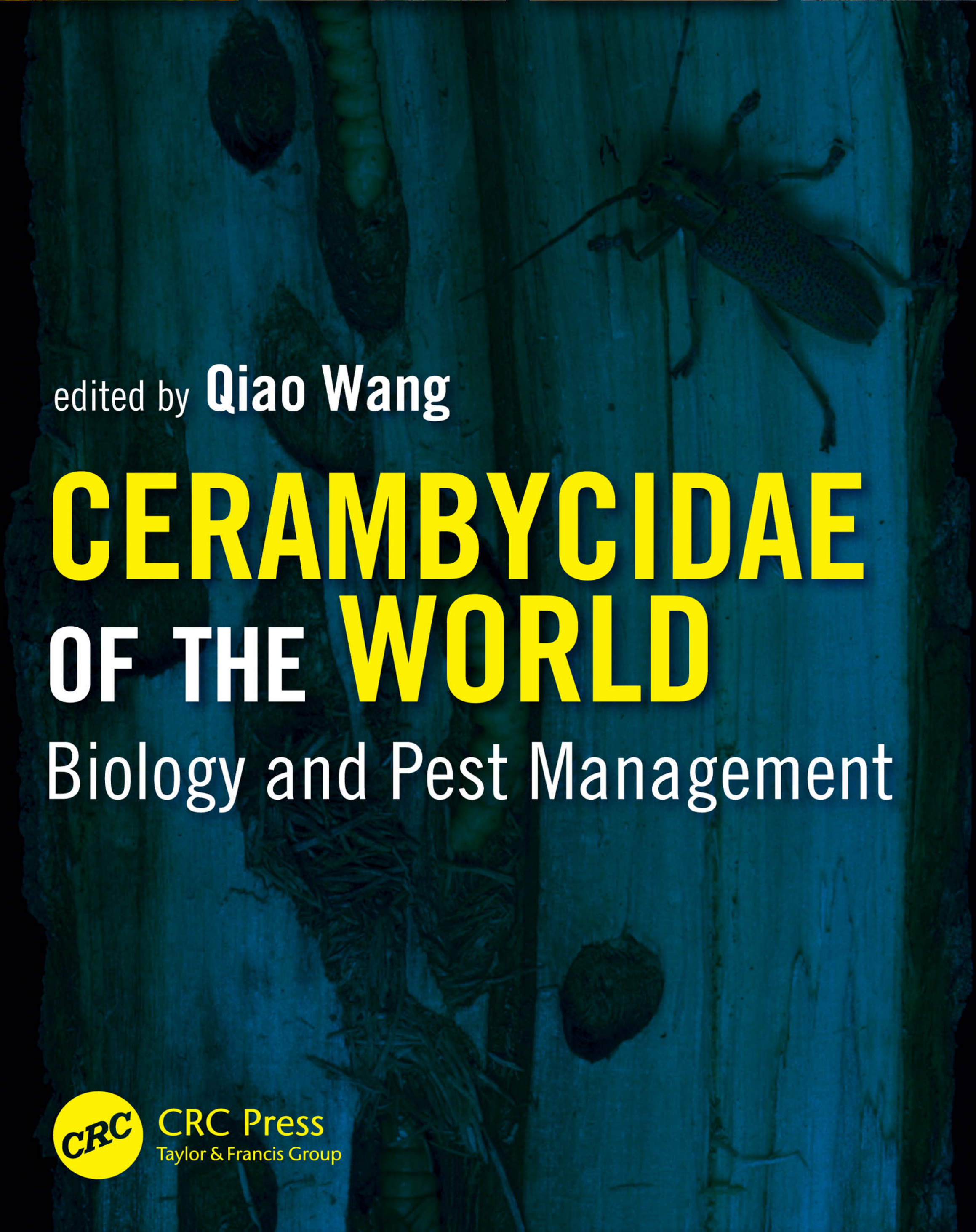

edited by **Qiao Wang**

CERAMBYCIDAE OF THE WORLD

Biology and Pest Management

CRC Press
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CERAMBYCIDAE OF THE WORLD

Biology and Pest Management

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CERAMBYCIDAE OF THE WORLD

Biology and Pest Management

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The editor dedicates this book to the late Professor Shu-nan Chiang (1914–2013),

a cerambycidist, who led him to the world of Cerambycidae.

Contents

Preface

There are more than 36,000 described species in the family Cerambycidae worldwide. Although only a small proportion of these species are pests in agriculture, forestry, or horticulture, their economic impact is enormous, costing billions of dollars in production losses, damage to landscapes, and management expenditures. A number of cerambycid species are important pests of various field, vine, and tree crops as well as forest and urban trees in their native regions. However, with the substantial increase of international trade in recent decades, many cerambycid species have become established outside their natural range of distribution, with the potential for causing enormous damage in these novel habitats. So far, no comprehensive work dealing with all aspects of cerambycid biology and management from a global viewpoint has been published.

This volume attempts to address that void by covering the entire spectrum from cerambycid classification, biology, ecology, plant disease transmission to biological, cultural, and chemical control tactics, to the world's major agricultural and tree pests, invasive pests, and biosecurity measures. It is intended to provide an entrance to the scientific literature on Cerambycidae for scientists in research institutions, primary industries, and universities, and an essential reference for quarantine officers in governmental departments charged with detection, exclusion, and control of cerambycids throughout the world. It is hoped that this book will serve as a valuable reference work for many years to come.

This book is divided into 13 chapters, each of which covers a particular topic consisting of our current knowledge and the gaps to be filled. Hundreds of examples, graphs, and photos are presented. The book begins with an introductory chapter dealing with morphology of adults and immature stages, the current classification system, the identification of adults and immatures to subfamily, and biology, global diversity, and distribution of subfamilies. Chapter 2 discusses the types of habitats commonly occupied by cerambycids; oviposition, fecundity, and egg development; voltinism, overwintering, quiescence, and diapause; adult dispersal and longevity; and population dynamics in relation to environmental conditions. Chapter 3 focuses on adult and larval feeding habits and wood digestion; flight, pollination, and plant disease transmission in relation to adult feeding; larval host plant range and conditions, parts and tissue utilized, and voltinism in relation to development and nutrition. Chapter 4 discusses adult phenology and diet in association with host and mate location, mating and oviposition behavior, larval development, and reproductive strategies. Historically, it was thought that cerambycids did not use semiochemicals to mediate reproductive behaviors, but research over the past 15 years suggests that this was erroneous, and that semiochemical use is very common if not ubiquitous within the family. Thus, Chapter 5 summarizes recent research on cerambycid pheromones and their chemistry, the role of plant volatiles as pheromone synergists, mechanisms for maintaining reproductive isolation, and applications of pheromones and kairomones in pest management and detection of invasive pest species. Chapter 6 describes the biology and control of cerambycids as vectors of pathogens (nematodes) of the pine wilt disease and plant–beetle–nematode interactions. Chapter 7 presents a thorough review of laboratory rearing and handling of both cerambycid adults and immature stages with artificial and natural diets. These are followed by three chapters on pest control tactics. Chapter 8 describes natural enemies in relation to cerambycid life history, taxonomic range of natural enemies, impact of natural enemies on cerambycid population dynamics, biological control approaches, and case studies. Using a number of examples, Chapter 9 covers cultural control measures, including mechanical and sanitary techniques, irrigation, plant density management, adjusting planting and harvest times, physical barriers, traps, crop rotation and intercropping, plant resistance, and pest management in relation to climate change. Chapter 10 discusses chemical control of cerambycid pests and provides a number of examples, covering the main classes of chemical insecticides and their field applications, including field sprays, bark treatment, trunk injection and insertion, and soil and root treatment. Chapter 11 presents 43 selected cerambycid species that illustrate the wide range of life history strategies found among cerambycids infesting forest and urban trees throughout the world; information is provided on the identification of adults, native and introduced geographic range, larval hosts, life history, economic impact, and control options. In Chapter 12, 90 cerambycid species of economic importance in field crops, tree crops, and vine crops from around the world are discussed along with their adult diagnoses, native and introduced geographic range, damage, biology, and management measures. Chapter 13 deals with invasive cerambycid pests and biosecurity measures, providing detailed information on interceptions and pathways of invasive pests, inspection and detection methods, pest risk assessments, eradication programs, and establishment and outbreaks of nonnative species.

Because of the nature of multiauthored contributions, it has not been possible to keep strict uniformity in all chapters. The editor has tried, however, to adopt a uniform nomenclature for all cerambycid species throughout the book. This has not been easy because the taxonomy of the Cerambycidae is still in flux, and the recent synonymizations of several species are reflected in a few chapters. Although chapters are logically linked, each represents an independent topic. Therefore, to keep the integrity of each chapter, there is some overlap in subject matter in a few chapters.

The editor is indebted to many people for their advice during the preparation of this book, in particular to Dr. J. Sulzycki, Dr. M. C. Thomas, Dr. T. A. Miller, J. J. Jurgensen, Jennifer Blaise, and to all of the book's contributors. This volume could not have been completed without the generosity of numerous photographers, reviewers, and copyright holders, whose help is gratefully acknowledged in individual chapters. I thank all of my family for their love and support, which have kept me going.

Qiao Wang
Massey University

More than 200 full color illustrations, which will be useful for identification purposes, are available from the CRC Press website under the Downloads tab: https://www.crcpress.com/Cerambycidae-of-the-World-Biology-and-Pest-Management/Wang/p/book/9781482219906

Editor

Qiao Wang, PhD, is a professor of entomology at the Institute of Agriculture and Environment, Massey University, Palmerston North, New Zealand. He earned his MSc under Professor Shu-nan Chiang from Southwest Agricultural University, Chongqing, China, PhD under Professors Ian W.B. Thornton and Tim R. New from La Trobe University, Melbourne, Australia, and postdoctoral experience under Professor Jocelyn G. Millar from the University of California, Riverside, before joining Massey University. He has studied cerambycid beetles since 1982. His research team currently focuses on plant protection, insect behavior, biological control, and evolutionary biology. Dr. Wang's experience in Australia, China, New Zealand, and the United States is reflected in his more than 300 publications; work with more than 70 postgraduate, postdoctoral, and visiting scientists from around the world; service on editorial boards of a number of international journals and international expert panels; and chairmanship of international conference sessions. Dr. Wang was awarded the 2012 Distinguished Scientist Award by the Entomological Society of America for his outstanding contributions to entomological science during his career.

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1

General Morphology, Classification, and Biology of Cerambycidae

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CONTENTS

1.1 Introduction

Cerambycidae Latreille, 1802, commonly known as longicorns, longhorns, longicorn beetles, longhorned beetles, longhorned borers, round-headed borers, timber beetles, or sawyer beetles, are among the most diverse and economically important families of Coleoptera. Taxonomic interest in the family has been fairly consistent for the past century, but the description of new taxa has accelerated in recent decades. The number of described cerambycid species in the world is about 36,300 in more than 5,300 genera (Tavakilian 2015). The adult body length ranges from less than 2 mm in *Cyrtinus pygmaeus* (Haldeman) (Linsley 1961) to greater than 170 mm in *Titanus giganteus* (L.) (Williams 2001). Cerambycids are widely distributed around the world—from sea level to 4,200 m above—wherever their host plants are found. Distribution and generic diversity of the world's cerambycid subfamilies and tribes are shown in Table 1.1.

The longicorn adults are free-living beetles that may or may not need to feed. They can live for a few days to a few months depending on whether they feed (Hanks 1999; Wang 2008). Cerambycids usually reproduce sexually but, in very rare cases—such as in some species of *Kurarus* Gressitt (Cerambycinae) (Goh 1977) and *Cortodera* Mulsant (Lepturinae) (Švácha and Lawrence 2014), they can reproduce parthenogenetically. Švácha and Lawrence (2014) suggested that at least in *Cortodera*, parthenogenesis probably is of recent origin because the female has a distinct spermatheca with a spermathecal gland. Mate location depends on the occurrence and status of larval hosts, adult food sources, and/or pheromones. Hanks (1999) predicted that the absence of feeding in the adult stage of many species is associated with the production of long-range pheromones, but the current knowledge shows that the use of volatile pheromones is widespread in cerambycids (see Chapter 5). The females lay their eggs on or near their hosts. The larvae of most cerambycid species feed on woody plants, but some select herbaceous hosts. The vast majority of species at the larval stage are living and feeding inside the plants although small minorities are free-living in soil and feed on plant roots.

Many cerambycid larvae are dead plant feeders and play a major role in recycling dead plants; others attack living plants of different health states, ranging from stressed to healthy plants. To date, there are about 200 cerambycid species worldwide that have some economic impact on agriculture, forestry, and horticulture, causing billions of dollars of damage in production losses, environmental disasters, and management costs. They may damage plants by direct feeding and/or transmission of plant diseases.

TABLE 1.1

Distribution and Generic Diversity of Cerambycid Subfamilies and Tribes

Subfamilies and Tribes	Biogeographic Regions	No. Genera
Cerambycinae Latreille, 1802	**All biogeographic regions**	**1,757**
Acangassuini Galileo & Martins, 2001	Neotropical	1
Achrysonini Lacordaire, 1868	All biogeographic regions	20
Agallissini Le Conte, 1873	Neotropical	3
Alanizini Di Iorio, 2003	Neotropical	1
Anaglyptini Lacordaire, 1868	All biogeographic regions	12
Aphanasiini Lacordaire, 1868	Afrotropical and Australian	6
Aphneopini Lacordaire, 1868	Australian	5
Auxesini Lepesme & Breuning, 1952	Afrotropical	8
Basipterini Fragoso, Monné & Campos Seabra, 1987	Neotropical	2
Bimiini Lacordaire, 1868	Australian and Neotropical	7
Bothriospilini Lane, 1950	Neotropical	11
Brachypteromatini Sama, 2008	Palaearctic	1
Callichromatini Swainson, 1840	All biogeographic regions	178
Callidiini Kirby, 1837	All biogeographic regions	38
Callidiopini Lacordaire, 1868	All biogeographic regions	62
Cerambycini Latreille, 1802	All biogeographic regions	99
Certallini Fairmaire, 1864	Palaearctic, Afrotropical, and Australian	9
Chlidonini Waterhouse, 1879	Afrotropical (Madagascar)	2
Cleomenini Lacordaire, 1868	Afrotropical and Oriental	23
Clytini Mulsant, 1839	All biogeographic regions	83
Compsocerini Thomson, 1864	All biogeographic regions	33
Coptommatini Lacordaire, 1869	Australian	1
Curiini LeConte, 1873	Neotropical	1
Deilini Fairmaire, 1864	Palaearctic and Australian	3
Dejanirini Lacordaire, 1868	Oriental	2
Diorini Lane, 1950	Neotropical	1
Distichocerini Pascoe, 1867	Australian	2
Dodecosini Aurivillius, 1912	Neotropical	4
Dryobiini Arnett, 1962	Nearctic and Neotropical	3
Eburiini Blanchard, 1845	Neotropical	23
Ectenessini Martins, 1998	Neotropical	12
Elaphidiini Thomson, 1864	Nearctic and Neotropical	91
Eligmodermini Lacordaire, 1868	Neotropical	5
Erlandiini Aurivillius, 1912	Neotropical	1
Eroschemini Lacordaire, 1868	Australian	2
Eumichthini Linsley, 1940	Nearctic	2
Gahaniini Quentin & Villiers, 1969	Afrotropical	1
Glaucytini Lacordaire, 1868	Oriental and Australian	18
Graciliini Mulsant, 1839	All biogeographic regions	22
Hesperophanini Mulsant, 1839	All biogeographic regions	85
Hesthesini Pascoe, 1867	Australian	1
Heteropsini Lacordaire, 1868	Neotropical and Australian	29
Hexoplini Martins, 2006	Neotropical	22
Holopleurini Chemsak & Linsley, 1974	Nearctic	1
Hyboderini Linsley, 1940	Nearctic and Neotropical	4
Hylotrupini Zagajkevich, 1991	Palaearctic	1
Ideratini Martins & Napp, 2009	Neotropical	1

(Continued)

TABLE 1.1 ***(Continued)***

Distribution and Generic Diversity of Cerambycid Subfamilies and Tribes

Subfamilies and Tribes	Biogeographic Regions	No. Genera
Lissonotini Swainson, 1840	Neotropical	1
Luscosmodicini Martins, 2003	Neotropical	1
Lygrini Sama, 2008	Afrotropical	1
Macronini Lacordaire, 1868	Australian	4
Megacoelini Quentin & Villiers, 1969	Afrotropical	2
Methiini Thomson, 1860	Oriental, Afrotropical, and Neotropical	19
Molorchini Gistel, 1848	All biogeographic regions	26
Mythodini Lacordaire, 1868	Oriental	4
Necydalopsini Lacordaire, 1868	Neotropical	12
Neocorini Martins, 2005	Neotropical	7
Neoibidionini Monné, 2012	Neotropical	55
Neostenini Lacordaire, 1868	Australian	4
Obriini Pascoe, 1871	All biogeographic regions	43
Ochyrini Pascoe, 1871	Australian	1
Oedenoderini Aurivillius, 1912	Afrotropical	1
Oemini Lacordaire, 1868	All biogeographic regions	101
Opsimini LeConte, 1873	Nearctic and Palaearctic	3
Oxycoleini Martins & Galileo, 2003	Neotropical	2
Paraholopterini Martins, 1997	Neotropical	1
Phalotini Lacordaire, 1868	Australian	4
Phlyctaenodini Lacordaire, 1868	Australian and Neotropical	17
Phoracanthini Newman, 1840	Australian	22
Phyllarthriini Lepesme & Breuning, 1956	Afrotropical	4
Piesarthriini McKeown, 1947	Australian	4
Piezocerini Lacordaire, 1868	Neotropical	19
Platyarthrini Bates, 1870	Neotropical	1
Plectogasterini Quentin & Villiers, 1969	Afrotropical	8
Plectromerini Nearns & Braham, 2008	Neotropical	1
Pleiarthrocerini Lane, 1950	Neotropical	1
Plesioclytini Wappes & Skelley, 2015	Nearctic	1
Proholopterini Monné, 2012	Neotropical	3
Protaxini Gahan, 1906	Oriental	1
Prothemini Lacordaire, 1868	Oriental	3
Psebiini Lacordaire, 1868	Afrotropical and Neotropical	24
Pseudocephalini Aurivillius, 1912	Australian and Neotropical	4
Pseudolepturini Thomson, 1861	Oriental	6
Psilomorphini Lacordaire, 1868	Australian	3
Pteroplatini Thomson, 1861	Afrotropical and Neotropical	10
Rhagiomorphini Newman, 1841	Australian	4
Rhinotragini Thomson, 1861	Neotropical	82
Rhopalophorini Blanchard, 1845	Nearctic, Neotropical, and Australian	29
Sestyrini Lacordaire, 1868	Oriental	2
Smodicini Lacordaire, 1868	Afrotropical, Nearctic, and Neotropical	8
Spintheriini Lacordaire, 1869	Australian	2
Stenhomalini Miroshnikov, 1989	Oriental	2
Stenoderini Pascoe, 1867	Australian and Oriental	10
Stenopterini Gistel, 1848	Palaearctic and Oriental	14
Strongylurini Lacordaire, 1868	Australian	6

(Continued)

TABLE 1.1 ***(Continued)***

Distribution and Generic Diversity of Cerambycid Subfamilies and Tribes

Subfamilies and Tribes	Biogeographic Regions	No. Genera
Tessarommatini Lacordaire, 1868	Australian	1
Thraniini Gahan, 1906	Oriental	3
Thyrsiini Marinoni & Napp, 1984	Neotropical	1
Tillomorphini Lacordaire, 1868	Nearctic, Neotropical, Oriental, and Australian	31
Torneutini Thomson, 1861	Neotropical	16
Trachyderini Dupont, 1836	All biogeographic regions	154
Tragocerini Pascoe, 1867	Australian	1
Trichomesiini Aurivillius, 1912	Australian	1
Trigonarthrini Villiers, 1984	Afrotropical	2
Tropocalymmatini Lacordaire, 1868	Australian	1
Typhocesini Lacordaire, 1868	Australian	4
Unxiini Napp, 2007	Neotropical	8
Uracanthini Blanchard, 1853	Australian	6
Vesperellini Sama, 2008	Palaearctic	1
Xystrocerini Blanchard, 1845	Afrotropical and Australian	2
Dorcasominae Lacordaire, 1868	**Afrotropical, Oriental, and Palaearctic**	**95**
Apatophyseini Lacordaire, 1869	Afrotropical, Oriental, and Palaearctic	90
Dorcasomini Lacordaire, 1868	Afrotropical, Oriental, and Palaearctic	5
Lamiinae Latreille, 1825	**All biogeographic regions**	**2,964**
Acanthocinini Blanchard, 1845	All biogeographic regions	386
Acanthoderini Thomson, 1860	All biogeographic regions	66
Acmocerini Thomson, 1864	Afrotropical	6
Acridocephalini Dillon & Dillon, 1959	Afrotropical	1
Acrocinini Swainson, 1840	Neotropical	1
Aderpasini Breuning & Teocchi, 1978	Afrotropical	1
Aerenicini Lacordaire, 1872	Neotropical	26
Agapanthiini Mulsant, 1839	All biogeographic regions	84
Amphoecini Breuning, 1951	Australian	2
Ancitini Aurivillius, 1917	Australian	1
Ancylonotini Lacordaire, 1869	Afrotropical, Oriental, and Palaearctic	36
Anisocerini Thomson, 1860	Neotropical	26
Apomecynini Thomson, 1860	All biogeographic regions	240
Astathini Thomson, 1864	Australian, Afrotropical, Oriental, and Palaearctic	23
Batocerini Thomson, 1864	Australian, Oriental, and Palaearctic	10
Calliini Thomson, 1864	Neotropical	40
Ceroplesini Thomson, 1860	Afrotropical, Oriental, and Palaearctic	88
Cloniocerini Lacordaire, 1872	Afrotropical	1
Colobotheini Thomson, 1860	Neotropical	12
Compsosomatini Thomson, 1867	Neotropical	13
Cyrtinini Thomson, 1864	Australian and Neotropical	16
Desmiphorini Thomson, 1860	All biogeographic regions	319
Dorcadionini Swainson, 1840	Palaearctic and Oriental	14
Dorcaschematini Thomson, 1860	Oriental and Australian	9
Elytracanthinini Bousquet, 2009	Neotropical	1
Enicodini Thomson, 1864	Australian and Oriental	27
Eupromerini Galileo & Martins, 1995	Neotropical	5
Forsteriini Tippmann, 1960	Neotropical	16
Gnomini Thomson, 1860	Australian, Oriental, and Palaearctic	4

(Continued)

TABLE 1.1 ***(Continued)***

Distribution and Generic Diversity of Cerambycid Subfamilies and Tribes

Subfamilies and Tribes	Biogeographic Regions	No. Genera
Gyaritini Breuning, 1950	Australian and Oriental	14
Heliolini Breuning, 1951	Australian	1
Hemilophini Thomson, 1868	Neotropical and Nearctic	127
Homonoeini Thomson, 1864	Australian, Oriental, and Palaearctic	22
Hyborhabdini Aurivillius, 1911	Oriental	1
Lamiini Latreille, 1825	Afrotropical, Australian, Oriental, and Palaearctic	48
Laticraniini Lane, 1959	Neotropical	2
Mauesiini Lane, 1956	Neotropical	4
Megabasini Thomson, 1860	Neotropical	1
Mesosini Mulsant, 1839	All biogeographic regions	99
Microcymaturini Breuning & Teocchi, 1985	Afrotropical	3
Moneilemini Thomson, 1864	Nearctic and Neotropical	1
Monochamini Gistel, 1848	All biogeographic regions	263
Morimonellini Lobanov, Danilevsky & Murzin, 1981	Palaearctic	1
Morimopsini Lacordaire, 1869	All regions except Nearctic	47
Nyctimeniini Gressitt, 1951	Australian and Oriental	1
Obereini Thomson, 1864	All regions except Neotropical	3
OcularIini Breuning, 1950	Afrotropical	2
Onciderini Thomson, 1860	Neotropical and Nearctic	81
Oncideropsidini Aurivillius, 1922	Oriental	1
Onocephalini Thomson, 1860	Neotropical	3
Onychogleneini Aurivillius, 1923	Oriental	1
Parmenini Mulsant, 1839	All biogeographic regions	87
Petrognathini Blanchard, 1845	Afrotropical and Oriental	10
Phacellini Lacordaire, 1872	Neotropical	7
Phantasini Kolbe, 1897	Afrotropical	3
Phrynetini Thomson, 1864	Afrotropical, Oriental, and Palaearctic	14
Phymasternini Teocchi, 1989	Afrotropical	1
Phytoeciini Mulsant, 1839	All biogeographic regions	32
Pogonocherini Mulsant, 1839	All biogeographic regions	33
Polyrhaphidini Thomson, 1860	Afrotropical and Neotropical	2
Pretiliini Martins & Galileo, 1990	Neotropical	1
Proctocerini Aurivillius, 1922	Afrotropical	1
Prosopocerini Thomson, 1864	Afrotropical	18
Pteropliini Thomson, 1860	All biogeographic regions	256
Saperdini Mulsant, 1839	All regions except Neotropical	154
Stenobiini Breuning, 1950	Afrotropical	7
Sternotomini Thomson, 1860	Afrotropical	20
Tapeinini Thomson, 1857	Neotropical and Oriental	2
Tetraopini Thomson, 1860	Nearctic and Neotropical	3
Tetraulaxini Breuning & Teocchi, 1977	Afrotropical	2
Tetropini Portevin, 1927	Palaearctic	2
Theocrini Lacordaire, 1872	Afrotropical	8
Tmesisternini Blanchard, 1853	Australian and Oriental	12
Tragocephalini Thomson, 1857	Afrotropical	63
Xenicotelini Matsushita, 1933	Oriental	1
Xenofreini Aurivillius, 1923	Neotropical	3
Xenoleini Lacordaire, 1872	Australian, Oriental, and Palaearctic	3

(Continued)

TABLE 1.1 ***(Continued)***

Distribution and Generic Diversity of Cerambycid Subfamilies and Tribes

Subfamilies and Tribes	Biogeographic Regions	No. Genera
Xylorhizini Lacordaire, 1872	Afrotropical, Australian, Oriental, and Palaearctic	10
Zygocerini Thomson, 1864	Australian and Oriental	9
Lepturinae Latreille, 1802	**All biogeographic regions**	**210**
Desmocerini Blanchard, 1845	Nearctic	1
Encyclopini LeConte, 1873	Nearctic and Palaearctic	2
Lepturini Latreille, 1802	All biogeographic regions	140
Oxymirini Danilevsky, 1997	Palaearctic	1
Rhagiini Kirby, 1837	All biogeographic regions	53
Rhamnusiini Sama, 2009	Palaearctic and Oriental	2
Sachalinobiini Danilevsky, 2010	Nearctic and Palaearctic	1
Teledapini Pascoe, 1871	Oriental	3
Xylosteini Reitter, 1913	Palaearctic and Oriental	7
Necydalinae Latreille, 1825	**Nearctic, Palaearctic, and Oriental**	**2**
Necydalini Latreille, 1825	Nearctic, Palaearctic, and Oriental	2
Parandrinae Blanchard, 1845	**All biogeographic regions**	**19**
Erichsoniini Thomson, 1861	Neotropical	1
Parandrini Blanchard, 1845	All biogeographic regions	18
Prioninae Latreille, 1802	**All biogeographic regions**	**302**
Acanthophorini Thomson, 1864	Afrotropical	7
Aegosomatini Thomson, 1861	Afrotropical, Oriental, and Australian	20
Anacolini Thomson, 1857	Afrotropical, Oriental, and Neotropical	33
Cacoscelini Thomson, 1861	Afrotropical and Australian	5
Callipogonini Thomson, 1861	Afrotropical, Palaearctic, and Neotropical	17
Calocomini Galileo & Martins, 1993	Neotropical	1
Cantharocnemini Thomson, 1861	Afrotropical and Australian	6
Closterini, Lacordaire, 1868	Afrotropical, Australian, and Oriental	8
Ergatini Fairmaire, 1864	Afrotropical, Palaearctic, and Nearctic	5
Eurypodini Gahan, 1906	Palaearctic and Oriental	4
Hopliderini Thomson, 1864	Afrotropical	5
Macrodontiini Thomson, 1861	Neotropical	5
Macrotomini Thomson, 1861	All biogeographic regions	78
Mallaspini Thomson, 1861	Neotropical	10
Mallodonini Thomson, 1861	Afrotropical, Oriental, Nearctic, and Neotropical	10
Meroscelisini Thomson, 1861	Afrotropical, Australian, and Neotropical	21
Prionini Latreille, 1802	All biogeographic regions	50
Remphanini Lacordaire, 1868	Oriental	6
Solenopterini Lacordaire, 1868	Neotropical	7
Tereticini Lameere, 1913	Afrotropical and Australian	3
Vesperoctenini Vives, 2005	Neotropical	1
Spondylidinae Audinet-Serville, 1832	**All biogeographic regions**	**32**
Anisarthrini Mamaev & Danilevsky, 1973	Palaearctic	4
Asemini Thomson, 1861	All biogeographic regions	12
Atimiini LeConte, 1873	Nearctic, Neotropical, and Palaearctic	3
Saphanini Gistel 1848	Afrotropical and Nearctic	10
Spondylidini Audinet-Serville, 1832	Neotropical, Nearctic, and Palaearctic	3

With the increase of international trade in recent years, many cerambycid species have been intercepted; some have become established outside their natural distribution range, causing serious problems globally (Haack et al. 2010; see Chapter 13).

Linsley (1961, 1962a) and Wang (2008) summarize the general morphology and biology of the Cerambycidae. More recently, Švácha and Lawrence (2014) have made a very detailed treatment of the morphology and a general account of the ecology of the Cerambycidae. Ślipiński and Escalona (2013) gave a good introduction to the morphology and ecology of Australian cerambycids. In this chapter, we summarize the current knowledge about this family, including the definition and morphology, and a brief introduction to the taxonomy, distribution, and general biology at the subfamily level. We aim to provide readers with a fundamental knowledge of cerambycids as well as a guide for those who may wish to consult specific chapters in this book where detailed treatments of Cerambycid biology and pest management are discussed.

1.2 Definition and Morphology of the Family Cerambycidae

1.2.1 Definition

Traditionally, the family Cerambycidae had wider scope, including nine subfamilies: Anoplodermatinae, Aseminae, Cerambycinae, Lamiinae, Lepturinae, Parandrinae, Philinae, Prioninae, and Spondylidinae (Napp 1994). In the current classification system (Bouchard et al. 2011; Monné 2012; Švácha and Lawrence 2014), Oxypeltinae, Vesperinae, and Disteniinae are considered independent families. We use the new system in this book and discuss eight subfamilies: Cerambycinae, Dorcasominae, Lamiinae, Lepturinae, Necydalinae, Parandrinae, Prioninae, and Spondylidinae. Table 1.1 summarizes the distribution and generic diversity of cerambycid subfamilies and tribes.

1.2.2 General Morphology

The general morphology of Cerambycidae is extracted from Ślipiński and Escalona (2013) and Švácha and Lawrence (2014).

1.2.2.1 Adult

1.2.2.1.1 Diagnosis

General external morphology of cerambycid adults is illustrated in Figures 1.1 and 1.2. Antennae usually filiform, elongate, and 11-segmented, rarely serrate and >12-segmented, usually inserted on pronounced tubercles; eyes usually emarginate; prothorax without pleural sutures; tibia with two distinct tibial spurs; tarsi usually pseudotetramerous with fourth tarsomere usually minute and concealed by third tarsomere; elytra usually covering abdomen; hind wings with a spur on radio-medial crossvein; abdomen usually with five visible sternites, fifth sternite entire.

1.2.2.1.2 Description

1.2.2.1.2.1 Head The head is prognathous and more or less horizontal in the Parandrinae (Figures 1.3 and 1.4). It is produced anteriorly to form a short to moderately long muzzle in some Lepturinae (Figures 1.5 and 1.6), Dorcasominae, and Cerambycinae, inclined anteriorly in the Spondylidinae, and is vertical or retracted, with the genal line directed posteriorly, in the Lamiinae (Figure 1.7). The eyes are entire in the Parandrinae (Figure 1.3), most Lepturinae, and some Prioninae; feebly emarginate in the Spondylidinae (Figure 1.8) and most Prioninae (Figure 1.9); emarginate to entire in the Dorcasominae; and usually are deeply emarginate and reniform in the Cerambycinae (Figure 1.10) and Lamiinae (Figure 1.7); although occasionally they are divided—as in *Tetraopes* Schönherr—or lacking the upper lobe—as in *Tillomorpha* Blanchard. The facets of the eyes are large and coarse in the Parandrinae, most Prioninae, and some Asemini and Cerambycinae; usually, they are finer in the Lepturinae, Lamiinae, and more specialized Cerambycinae.

The antennae usually have 11 antennomeres (Figures 1.1 and 1.2) that are inserted near the base of the mandibles in the Parandrinae (Figure 1.3), Prioninae (Figure 1.9), and in some Spondylidinae;

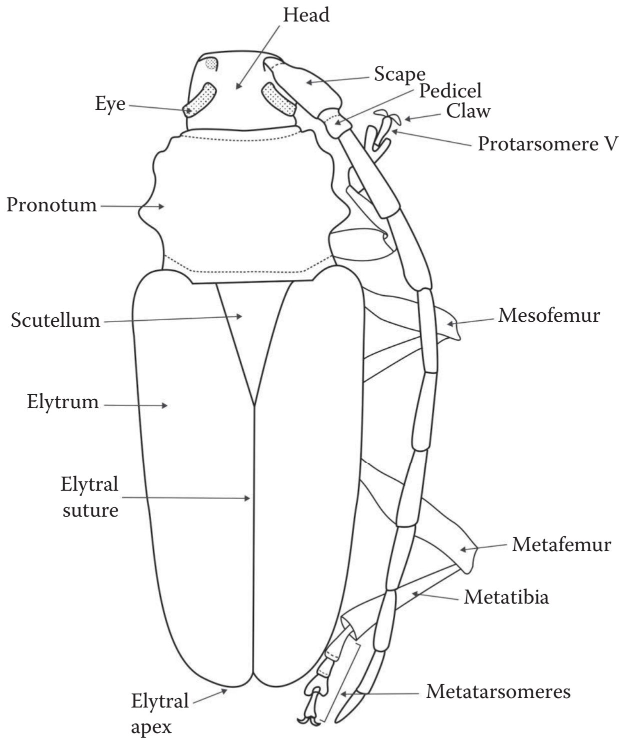

FIGURE 1.1 General morphology, dorsal view of *Trachyderes succinctus* (L.) (Cerambycinae).

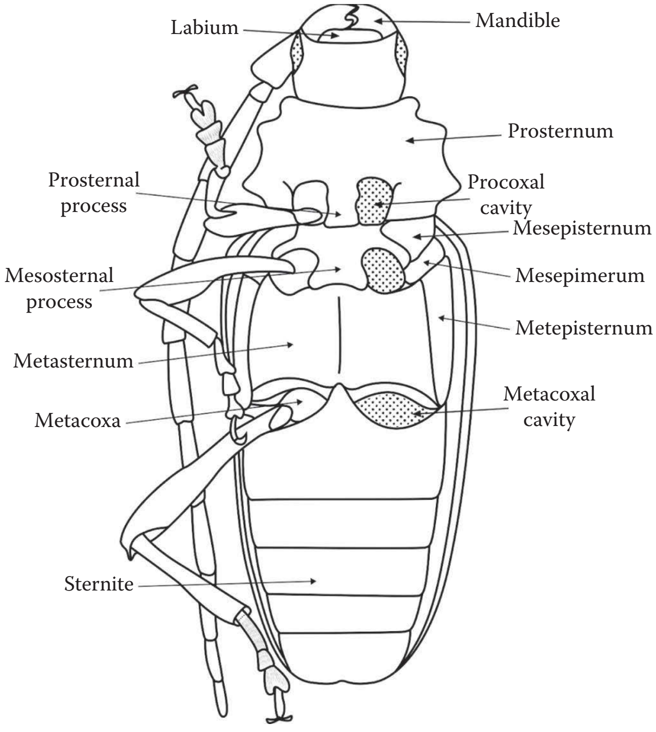

FIGURE 1.2 General morphology, ventral view of *Trachyderes succinctus* (L.) (Cerambycinae).

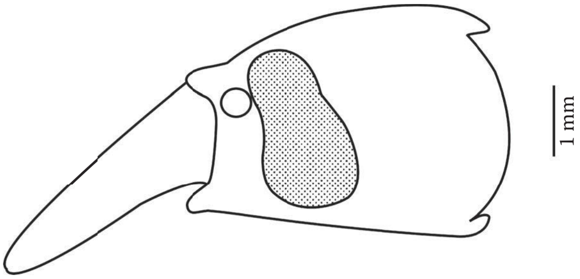

FIGURE 1.3 Head, lateral view of *Parandra (Parandra) glabra* (De Geer) (Parandrinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

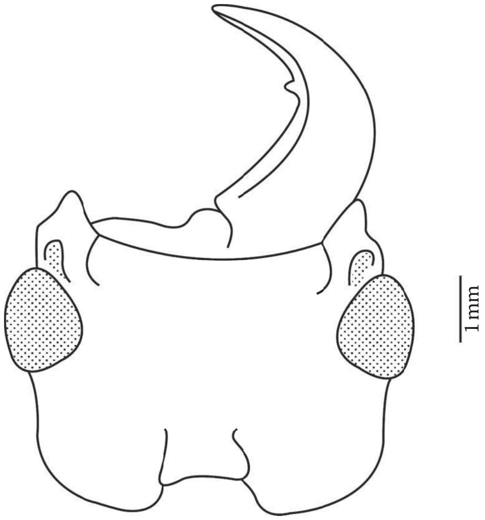

FIGURE 1.4 Head, dorsal view of *Parandra (Parandra) glabra* (De Geer) (Parandrinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

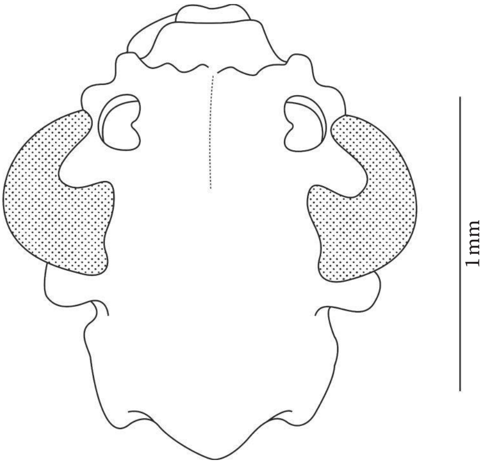

FIGURE 1.5 Head, dorsal view of *Leptura rubra* L. (Lepturinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

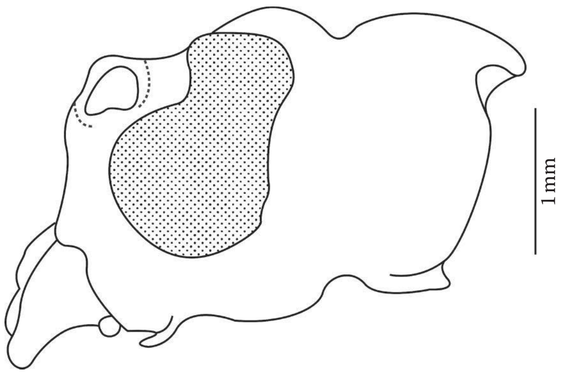

FIGURE 1.6 Head, lateral view of *Leptura rubra* L. (Lepturinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

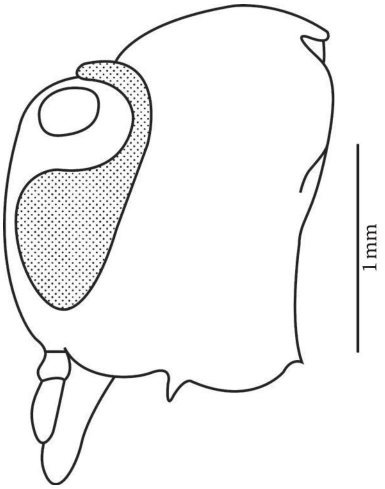

FIGURE 1.7 Head, lateral view of *Estola obscura* Thomson (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

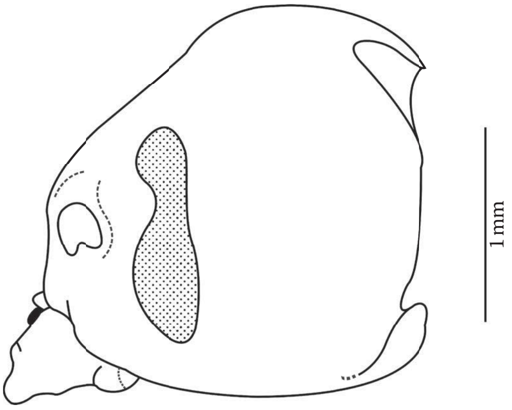

FIGURE 1.8 Head, lateral view of *Asemum striatum* (L.) (Spondylidinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

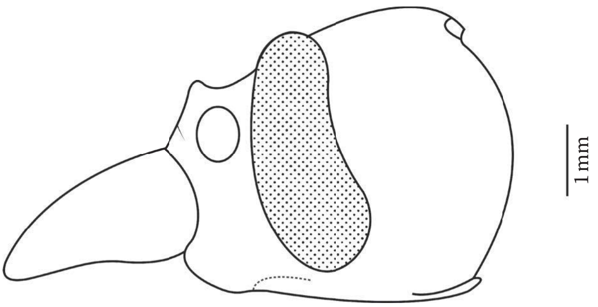

FIGURE 1.9 Head, lateral view of *Mallodon spinibarbis* (L.) (Prioninae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

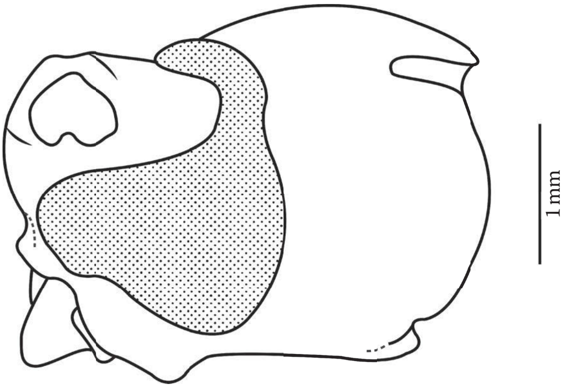

FIGURE 1.10 Head, lateral view of *Achryson surinamum* (L.) (Cerambycinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

are near the eyes in the Asemini and Lepturinae (Figure 1.6); and are usually more or less embraced by the eyes in the Cerambycinae (Figure 1.10) and Lamiinae (Figure 1.7). In some diurnal Lamiinae (e.g., *Octotapnia* Galileo & Martins and *Pseudotapnia* Chemsak & Linsley) and Prioninae, the antennae may have fewer antennomeres. In some Lamiinae (e.g., *Paratenthras* Monné), the first three antennomeres are long, whereas the remaining flagella are reduced and sometimes moniliform. The number of antennomeres may be 12 in a number of unrelated groups and more than 12 in a few Cerambycinae and Prioninae (up to 30 in some species of *Prionus* Müller). The antennal structure is similar between sexes in the Parandrinae, Spondylidinae, and Lepturinae, and strikingly dissimilar in many Prioninae and in most Cerambycinae and Lamiinae. In the Parandrinae and Spondylidinae, differentiation of antennomeres is not well marked; the scape is short, the second antennomere is not greatly reduced in size, half as long as, or subequal to the third antennomere, and the segments that follow are subequal in length. In the remaining subfamilies, the scape is usually more elongate, the second segment is greatly reduced, and the following antennomeres are unequal in length—with the third usually greatly elongated and those that follow diminishing to the ultimate antennomere. The antennal segments are glabrous in the Parandrinae, Prioninae, and Spondylidinae, and are pubescent in other subfamilies.

The labrum is fused with the epistoma in the Parandrinae and Prioninae but free in other subfamilies. The mandibles are acute in all of the Cerambycidae; large and often toothed in the Parandrinae (Figure 1.4) and Prioninae (Figure 1.11); long, slender, and untoothed in the Spondylidinae; shorter in most other groups; and are provided with a dense fringe of hairs in the inner margin of the Dorcasominae and Lepturinae. The maxillae are typically bilobed; the inner lobe is obsolete in the Parandrinae (Figure 1.12) and Prioninae (Figure 1.13). The ultimate segment of the palpi (both

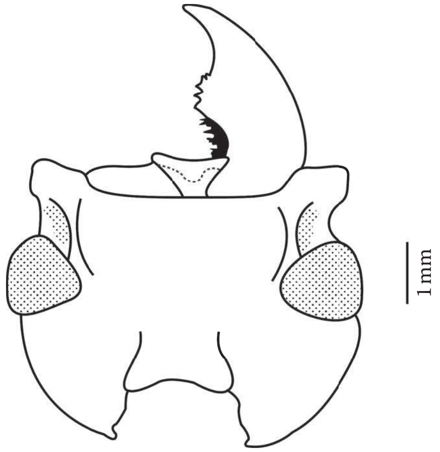

FIGURE 1.11 Head, dorsal view of *Mallodon spinibarbis* (L.) (Prioninae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

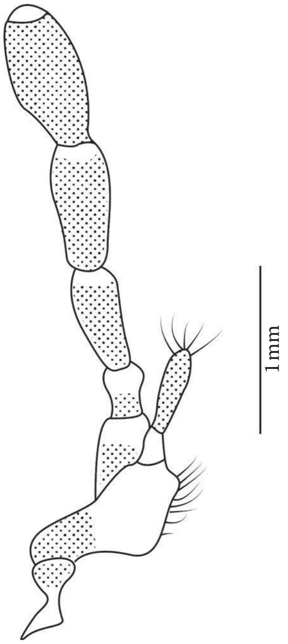

FIGURE 1.12 Maxilla, ventral view of *Parandra (Parandra) glabra* (De Geer) (Parandrinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

maxillary and labial) is pointed at the apex in the Lamiinae (Figures 1.14 and 1.15) and truncated (Figures 1.16 through 1.19) in other subfamilies. The submentum projects between the bases of the maxillae in the Lepturinae; is short in many Cerambycinae; and is absent in the Parandrinae, Prioninae, and Spondylidinae. The mentum is distinctly transverse in the Parandrinae (Figure 1.20), Prioninae, and Spondylidinae, and trapezoidal in the Lepturinae, Cerambycinae (Figure 1.18), and Lamiinae (Figure 1.14). The ligula is corneous in the Parandrinae and Spondylidinae, and membranous or coriaceous in the Lepturinae, Cerambycinae (Figure 1.18) (except Oemini and Methini), and Lamiinae (Figure 1.14).

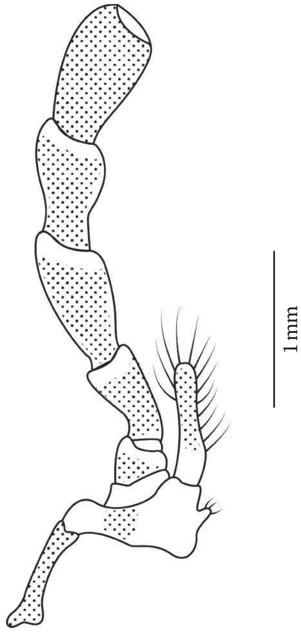

FIGURE 1.13 Maxilla, ventral view of *Mallodon spinibarbis* (L.) (Prioninae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

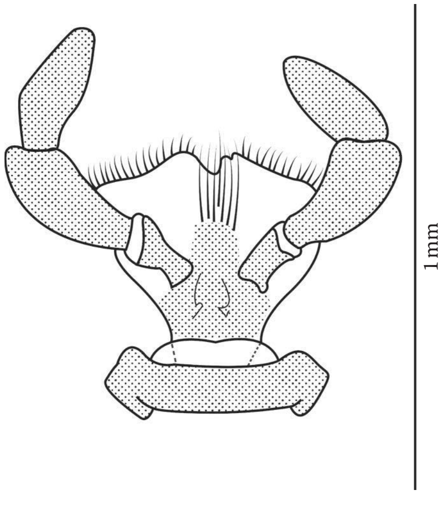

FIGURE 1.14 Labium, ventral view of *Estola obscura* Thomson (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

1.2.2.1.2.2 Thorax The prothorax bears lateral carinae in the Parandrinae (Figure 1.21) and Prioninae (Figures 1.22 and 1.23), which are lacking in other subfamilies (Figures 1.24 through 1.26). The procoxae are strongly transverse in the Parandrinae and Prioninae, less so in some Spondylidinae—such as Asemini, subconical in the rest Spondylidinae, conical in the Lepturinae, and usually rounded in the Cerambycinae and Lamiinae. The procoxal cavities are closed behind in some Parandrinae, in some Spondylidinae, and in most Lamiinae (Figure 1.26); wide open in the Prioninae (Figure 1.23), Asemini, and most Lepturinae (Figure 1.25); and open or closed in the Cerambycinae. The scutellum is visible, sometimes well developed (Figure 1.1) and usually is not abruptly elevated, anteriorly flat, or separated from

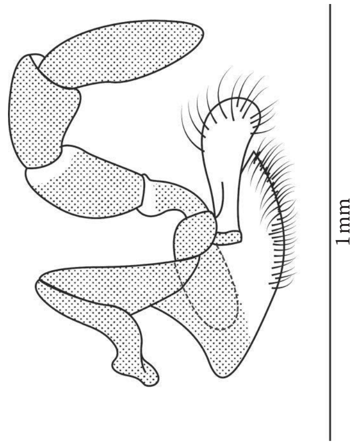

FIGURE 1.15 Maxilla, ventral view of *Estola obscura* Thomson (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

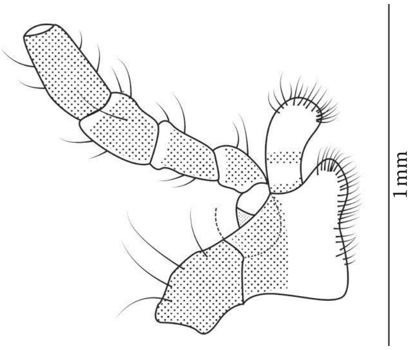

FIGURE 1.16 Maxilla, ventral view of *Asemum striatum* (L.) (Spondylidinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

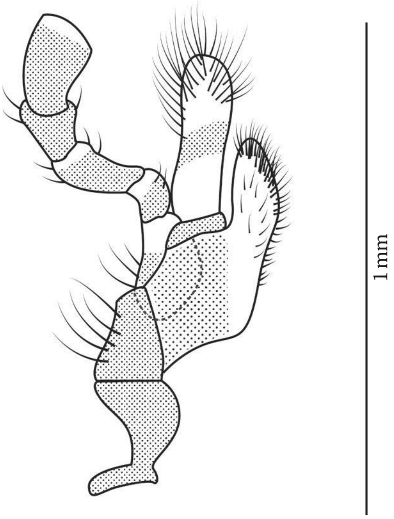

FIGURE 1.17 Maxilla, ventral view of *Necydalis major* L. (Necydalinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

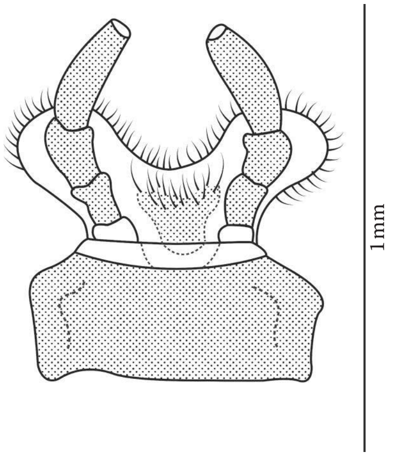

FIGURE 1.18 Labium, ventral view of *Rhopalophora collaris* (Germar) (Cerambycinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

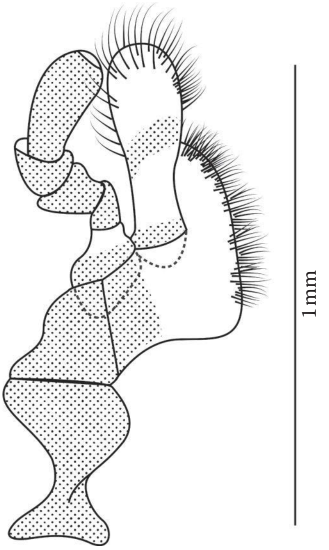

FIGURE 1.19 Maxilla, ventral view of *Trachyderes succinctus* (L.) (Cerambycinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

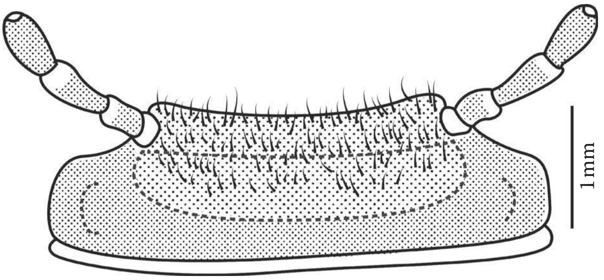

FIGURE 1.20 Labium, ventral view of *Parandra (Parandra) glabra* (De Geer) (Parandrinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

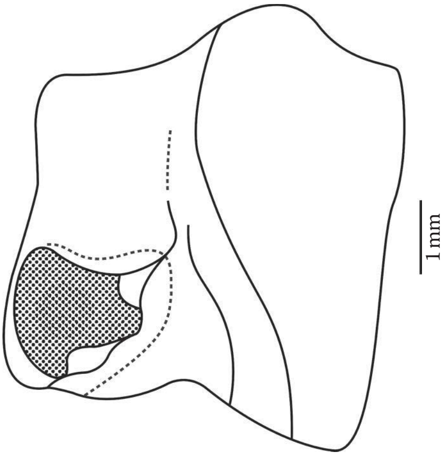

FIGURE 1.21 Prothorax, lateral view of *Parandra (Parandra) glabra* (De Geer) (Parandrinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

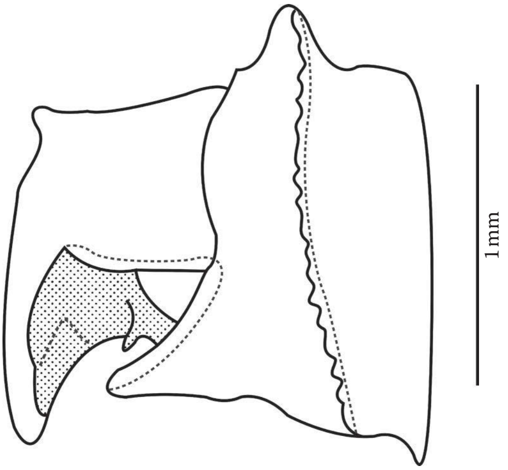

FIGURE 1.22 Prothorax, lateral view of *Mallodon spinibarbis* (L.) (Prioninae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

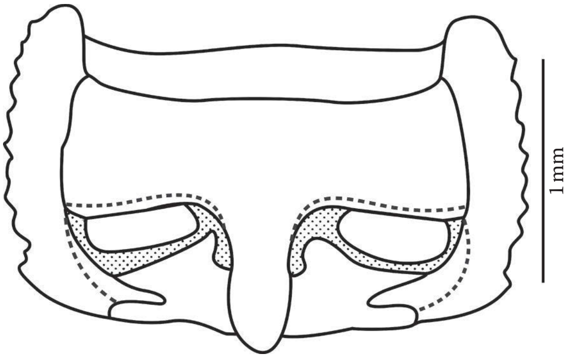

FIGURE 1.23 Prosternum, ventral view of *Mallodon spinibarbis* (L.) (Prioninae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

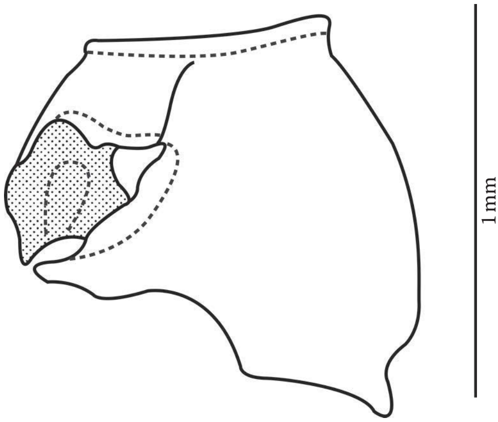

FIGURE 1.24 Prothorax, lateral view of *Leptura rubra* L. (Lepturinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

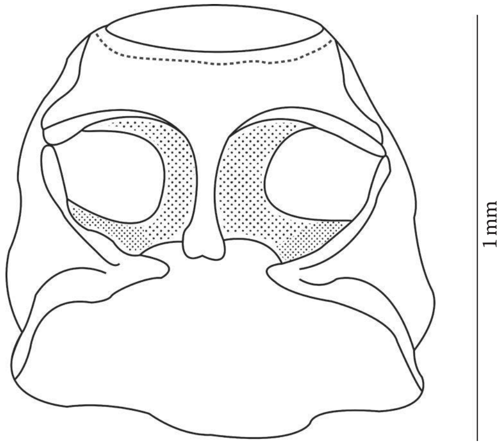

FIGURE 1.25 Prosternum, ventral view of *Leptura rubra* L. (Lepturinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

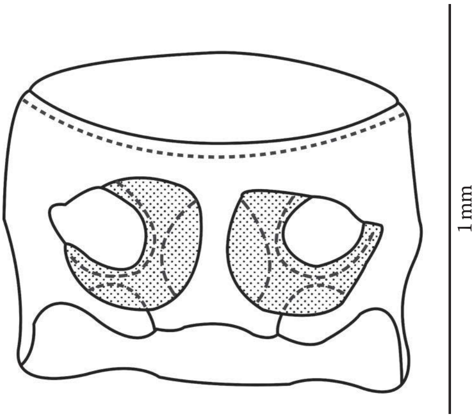

FIGURE 1.26 Prosternum, ventral view of *Adesmus hemispilus* Germar (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

mesoscutum by an impression. The mesonotum lacks a stridulatory plate in the Parandrinae (Figure 1.27), Prioninae, and some Spondylidinae; has a divided stridulatory plate in the Dorcasominae (if present), Asemini (Spondylidinae) (Figure 1.28), and Lepturinae (Figure 1.29), and an undivided stridulatory plate in the Necydalinae (Figure 1.30), Cerambycinae (Figure 1.31), and Lamiinae (Figure 1.32).

Legs mostly are cursorial (Figure 1.1) and usually moderately long in most longicorn beetles but can be very long in some species such as males of lamiine *Gerania* (Audinet-Serville); fore legs are enlarged in some (particularly males) Prioninae and Lamiinae and extremely long in the lamiine *Acrocinus* Illiger (fore femora in large males can be as long as body), where they reportedly are used for traversing tree branches; hind legs may be enlarged, such as metafemora in the male cerambycine *Utopia* Thomson, or plate-like tibial extensions in some Cerambycinae, but are never adapted for jumping. The tibia usually has two spurs at the terminal end (Figure 1.33). The legs exhibit an oblique groove along the inner side of the protibiae and a notch or groove on the outer face of the mesotibiae in the Lamiinae; these grooves and notches are lacking in other subfamilies. The tarsi are distinctly pentamerous without pubescent ventral

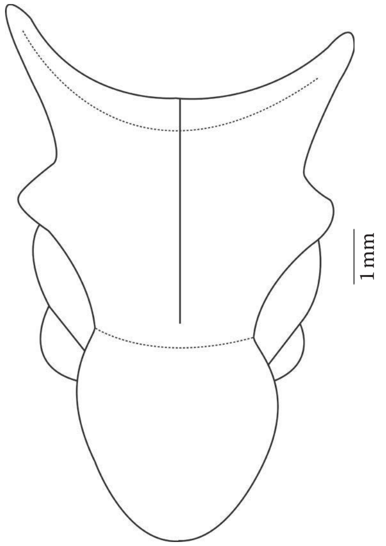

FIGURE 1.27 Mesonotum, dorsal view of *Parandra (Parandra) glabra* (De Geer) (Parandrinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

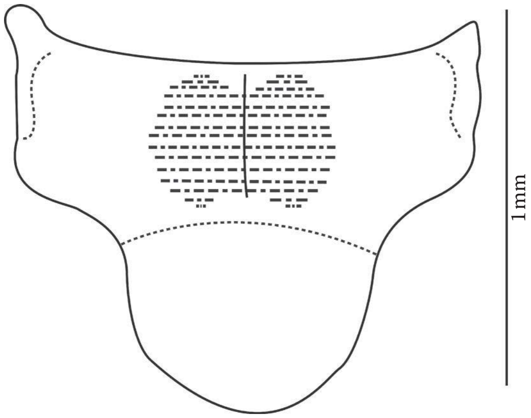

FIGURE 1.28 Mesonotum, dorsal view of *Asemum striatum* (L.) (Spondylidinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

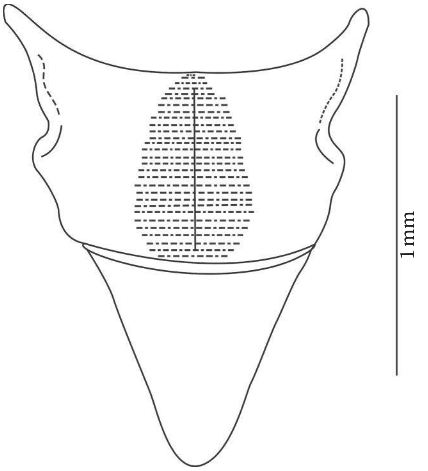

FIGURE 1.29 Mesonotum, dorsal view of *Leptura rubra* L. (Lepturinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

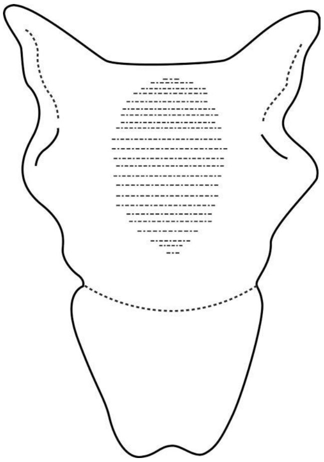

FIGURE 1.30 Mesonotum, dorsal view of *Necydalis major* L. (Necydalinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

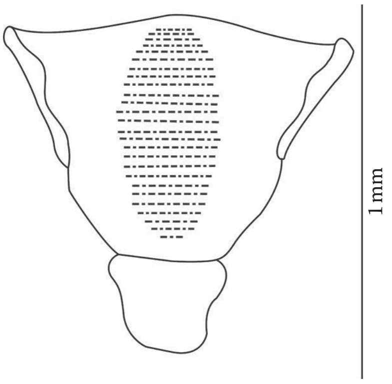

FIGURE 1.31 Mesonotum, dorsal view of *Rhopalophora collaris* (Germar) (Cerambycinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

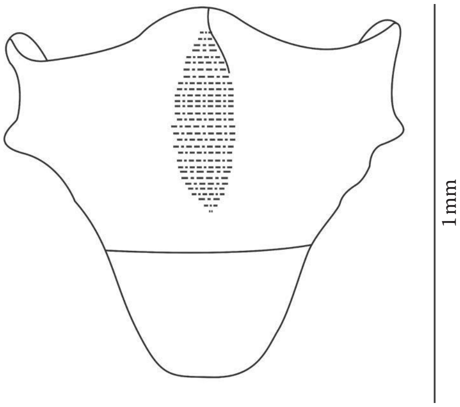

FIGURE 1.32 Mesonotum, dorsal view of *Adesmus hemispilus* Germar (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

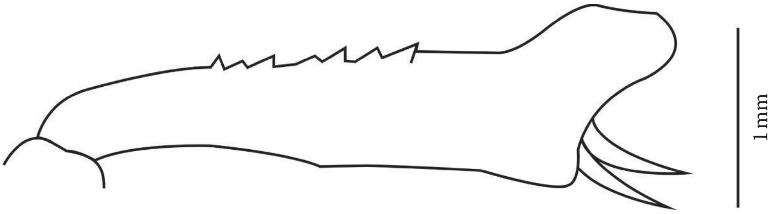

FIGURE 1.33 Protibia, lateral view of *Spondylis buprestoides* (L.) (Spondylidinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.*, 38, 265–419, 1994.)

pads in the Parandrinae (Figure 1.34), although they are pseudotetramerous with ventral pads in the Prioninae, Lepturinae, Cerambycinae, Spondylidinae (Figure 1.35), and Lamiinae. The third tarsomere is simple in the Parandrinae but dilated in the remaining subfamilies (Figure 1.35). The tarsal claws are appendiculate or cleft in the most specialized Lamiinae but simple in all other subfamilies.

The hind wing usually has a moderately to very long apical field (though this is short in some very large forms, such as *Titanus* Audinet-Serville) with two more or less complete radial extensions converging and then diverging to form a scissor-like figure, with a dark sclerite apicad of radial cell and a subtriangular sclerite crossing r4. The radial cell often is well developed and more or less elongate (although sometimes it is short and broad or lacking basal limit). Cross-vein r3 is slightly to strongly oblique and sometimes is absent. The basal portion of radius posterior (RP) is long to very short and not surpassing r4. The medial field usually has four or five free veins (sometimes with three or, rarely, fewer) and always lacks medial fleck. The wedge cell is well developed in almost all Prioninae and some Lepturinae and Spondylidinae and is absent in all other subfamilies. If the elytra are shortened in macropterous forms, the hind wings are exposed (often giving the beetles a hymenopteran appearance) and their apex is then sometimes not folded (all Necydalinae, Figures 1.36 and 1.37). The hind wings are highly reduced or disappear in numerous Cerambycinae (such as males of *Torneutes* Reich), Lamiinae (usually both sexes) and Prioninae (more often only females), Lepturinae, and Spondylidinae (both sexes of *Michthisoma* LeConte); in some taxa, the beetles apparently are flightless even if wings are present.

1.2.2.1.2.3 Abdomen The abdomen usually has five free, visible ventrites (belonging to segments III–VII; sternites 1 and 2 form the posterointernal wall of metacoxal acetabula) (Figure 1.2), with the first usually not much longer than the second; rarely, it is almost as long as the remaining combined (females of the cerambycine Obriini). The intercoxal process is acute to broadly rounded or angulate—or absent, with the medial part of reduced sternum II visible between the hind coxae (Necydalinae and some slender wasp-mimicking

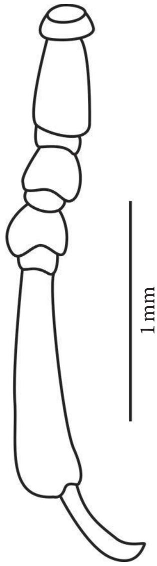

FIGURE 1.34 Metatarsus, lateral view of *Parandra (Parandra) glabra* (De Geer) (Parandrinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

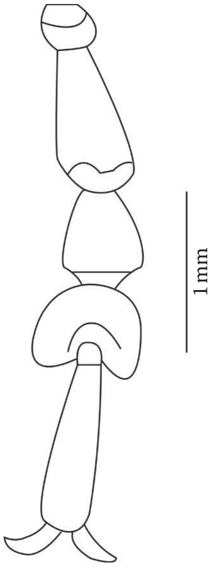

FIGURE 1.35 Metatarsus, dorsal view of *Spondylis buprestoides* (L.) (Spondylidinae). (Reprinted with permission from C. J. B. Carvalho, editor. Napp, D. S., *Rev. Bras. Entomol.,* 38, 265–419, 1994.)

Cerambycinae and the telescoped, with segment II forming a petiolus-like basal piece). The abdominal tergites 1–6 are semisclerotized. Functional spiracles are present on each side of abdominal segments I–VII (the first pair is very large, particularly in flying forms), and spiracles VIII are rudimentary and closed.

1.2.2.1.2.4 External Morphology of Terminalia Male terminalia (Figures 1.38 through 1.40) consist of three abdominal segments. The anterior edge of sternite VIII (Figure 1.38) usually bears a median strut (that is rudimentary or absent in some taxa); the anterior edge of sternite IX has spiculum gastrale; tergites IX and X are fused together and usually membranous. The anterior edge of tegmen (Figure 1.39)

FIGURE 1.36 *Necydalis major* L. (Necydalinae).

FIGURE 1.37 *Ulochaetes leoninus* LeConte (Necydalinae).

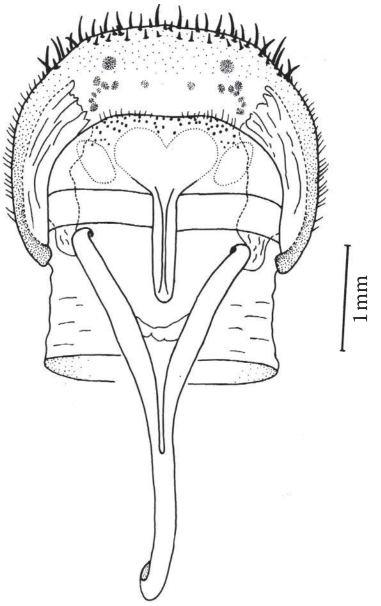

FIGURE 1.38 Male sternite VIII of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

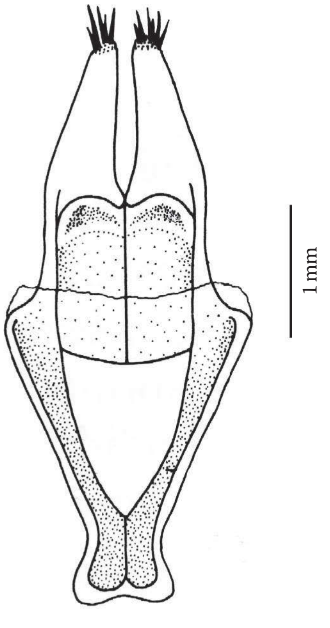

FIGURE 1.39 Tegmen of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

has a single or no strut; the parameres usually are fused to phallobase and free from one another, but they are more or less completely fused in some Cerambycinae (such as the Molorchini–Obriini complex—very short in some and nearly absent in the Neotropical Ectenessini). The aedeagus is cucujiform and symmetrical, but usually is rotated to one side in the abdominal cavity when at rest. Surrounding structures therefore may not be entirely symmetrical. The anterior edge of the aedeagus (Figure 1.40) almost

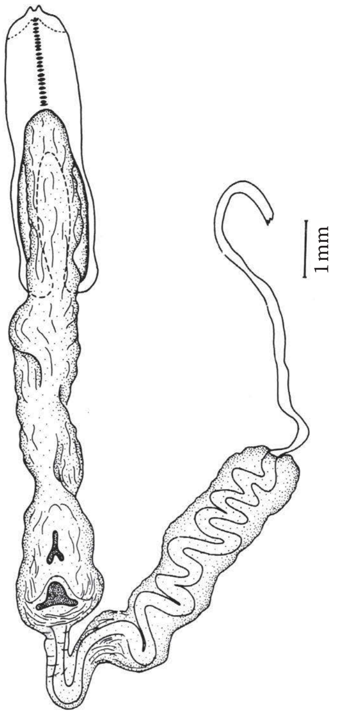

FIGURE 1.40 Aedeagus and internal sac of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

always has paired struts; the internal sac (endophallus) (Figure 1.40) may bear distinctive sclerotized structures such as asperities, paired or unpaired sclerites, or longitudinal sclerotized rods.

The terminalia of female cerambycids (Figures 1.41 and 1.42) follow the same structural plan as the male, with sclerites sequentially distributed along a more or less membranous tube, which is kept invaginated at rest. Segment VIII is entirely contained within the partially double-walled segment VII (where the first invagination occurs). Sternite VIII (Figure 1.41) bears a long ventral apodeme that is closely related with the ovipositor length among different taxa. Sternite and tergite VIII are mostly partly desclerotized and tend to fuse into a tube enclosing the "anus–ovipositor" complex, sometimes protruding from the abdomen, either "naked" or protected by posterior sternal and tergal projections of segment VII (e.g., some Acanthocinini of Lamiinae). The ovipositor (Figure 1.42) usually is long but secondarily shortened and modified—particularly in some Cerambycinae (such as Trachyderini) ovipositing on the host surface; the paraprocts are short without baculi (in all Lamiinae) and flexible with subapical styli; in some groups, the apex of the ovipositor is sclerotized with styli being lateral or laterodorsal and often reduced or virtually inbuilt in coxitis (this type occurs in several subfamilies depending on biology but is common in the Prioninae and universal in the Parandrinae). One or two pairs of glandular integumental invaginations often are present at the base of the ovipositor on both sides of anus.

1.2.2.1.2.5 Reproductive System Testes (Figure 1.43) consist of one to several pairs of testicular lobes, with each lobe having a number of radially arranged testicular follicles. The basal parts of vasa deferentia may be broadened into seminal vesicles. Usually, there are two pairs (or at least one pair) of accessory glands at or before the fusion of vasa deferentia. Ducts are more or less completely paired (mostly up to paired gonopores on the internal sac) in Lamiini and several related tribes of Lamiinae. Primary gonopore seldom projects into a long sclerotized flagellum.

Ovaries (Figure 1.44) are paired, each with a variable number (up to several tens) of ovarioles. There is a single more or less sclerotized spermatheca of simple shape (often an elongate, curved capsule bridged

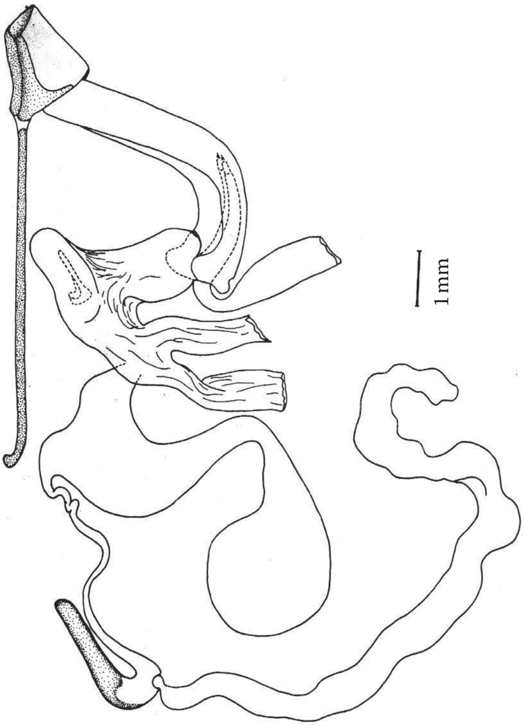

FIGURE 1.41 Female terminalia of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

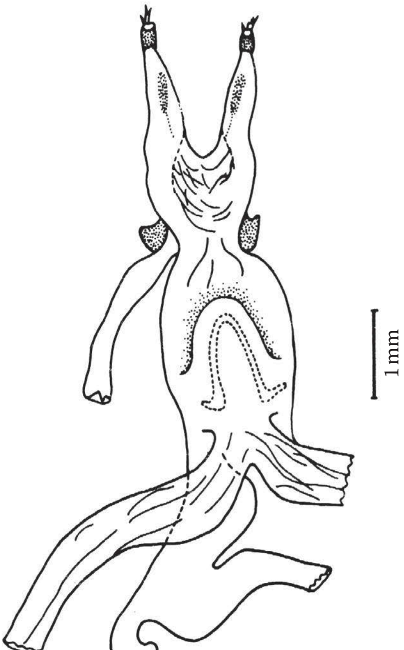

FIGURE 1.42 Ovipositor of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

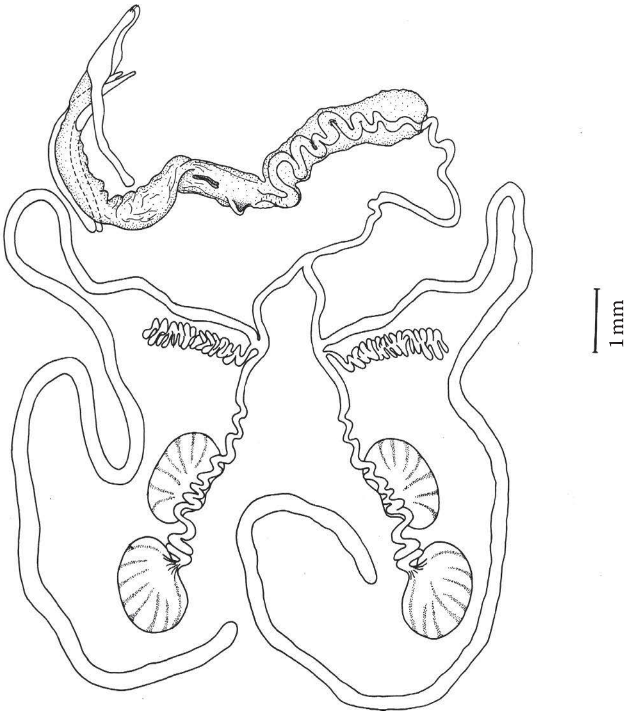

FIGURE 1.43 Male reproductive system of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

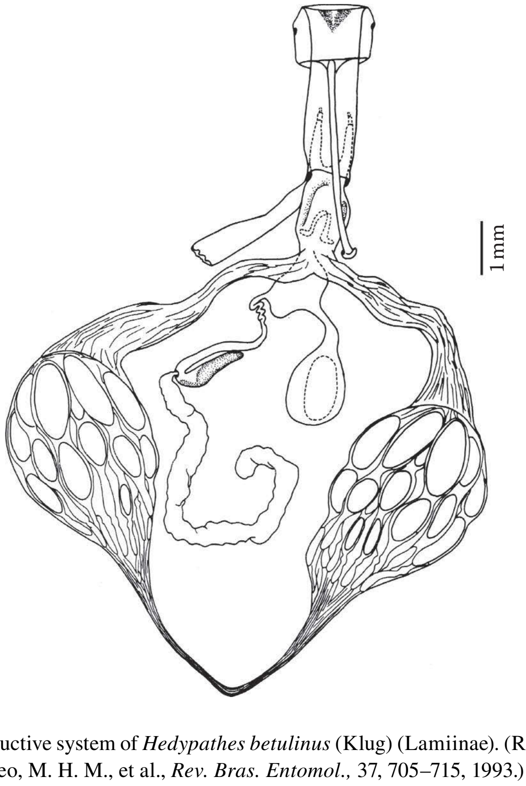

FIGURE 1.44 Female reproductive system of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

by spermathecal compressor) with a distinct, sometimes very large, spermathecal gland attached to it. A bursa copulatrix usually is present in the form of a soft diverticulum of various sizes and locations; the spermathecal duct arises on its base.

1.2.2.1.2.6 Digestive System The adult gut may be primitively rather reduced. In prionines and some cerambycines, the midgut is short and reduced with the posterior midgut being extremely reduced and thread-like (slightly less so in some floricolous Clytini of the Cerambycinae), suggesting adult aphagy. However, the gut is long and well developed in the Lamiinae whose adults feed extensively.

The digestive tube (Figure 1.45) usually does not have a distinct crop/proventriculus. The anterior midgut in some taxa (Necydalinae, Spondylidinae, and most Lepturinae) produces morphologically distinct mycetomes in the form of gut wall diverticula whose cells harbor intracellular yeast-like symbionts. The posterior midgut often bears numerous small, scattered evaginated crypts. Six cryptonephridial Malpighian tubules enter the gut separately in two clusters of three.

1.2.2.2 Immature Stages

The following morphological descriptions are based on Butovitsch (1939), Duffy (1953, 1957, 1960, 1968), Gardiner (1966), and Švácha and Lawrence (2014).

1.2.2.2.1 Eggs

The eggs (Figure 1.46) are elongate, ovoid, or fusiform and often have thin, flexible chorion so that their shape can adapt to the tight spaces in which they usually are laid. A female can lay a dozen to several hundred eggs in her lifetime. They usually hatch in a few days to a few weeks after oviposition, depending on species and climates. In some lamiine species, the larvae may overwinter within the chorion, particularly if the eggs are laid late in the season.

1.2.2.2.2 Larvae

The larvae are soft-bodied, eucephalic, oligopodous to apodous, prognathous, more or less elongate, and subcylindrical to dorsoventrally depressed (Figures 1.47 through 1.58). Their body shape and mechanics largely depend on hemolymph pressure.

The cranium (particularly its anterior part, which supports mouthparts, often called the "mouth-frame") may be strongly sclerotized and pigmented, whereas the body generally is soft and white to yellow (Figures 1.51 through 1.54). In rare cases, the body can be grayish with some prothoracic regions and the abdominal end sclerotized and pigmented. The skin of the prothorax is not attached to the submentum. The ventral mouthparts are protracted; the mandibles (Figure 1.59) lack a molar tooth or other appendage; the labium bears a setose ligula, and gula and hypostoma are present. The abdomen, at least dorsally, has more or less retractile and often characteristically sculptured, protuberances called ambulatory ampullae, providing support in galleries; abdominal segments 1 to 6 or 7 have dorsal ampullae. The spiracular system is peripneustic, with one pair of functional spiracles on the mesothorax (Figure 1.60) and one pair on each of eight abdominal segments. The digestive system is similar to that of adults.

1.2.2.2.3 Pupae

The pupae (Figure 1.61a and b) are similar to adults in size, shape, and proportions of cephalic and thoracic appendages. Secondary sexual differences in adults generally are evident in the pupae. They are adecticous, exarate, and generally soft and pale (except for some special structures like spines or gin traps), with a strongly ventrally bent head so that mouthparts point caudally (except for some Prioninae). The body usually is waxy or milky white to testaceous, often with scattered setae or spinose areas or combinations of both.

The antennae extend at least as far as the mesothorax but generally to the abdominal segments, where they are nearly always curved downward beneath the body. The elytra are always glabrous (except Acanthocinini). The abdomen usually has nine movable segments, with the tenth (and occasionally

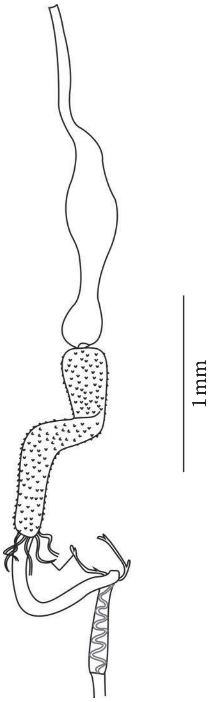

FIGURE 1.45 Digestive system of *Oxymerus luteus luteus* (Voet) (Cerambycinae). (Reprinted with permission from W. F. de Azevedo, Jr., editor. Moura, L. A., and A. F. Franceschini, *Biociências,* 2, 135–143, 1994.)

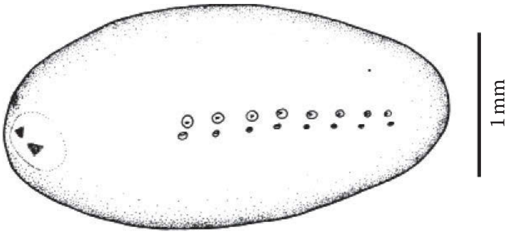

FIGURE 1.46 Egg of *Hedypathes betulinus* (Klug) (Lamiinae). (Reprinted with permission from C. J. B. Carvalho, editor. Galileo, M. H. M., et al., *Rev. Bras. Entomol.,* 37, 705–715, 1993.)

the ninth) being telescoped within the preceding segments. Abdominal segments 7 and 8 usually are more elongate than the preceding ones but sometimes considerably produced. The abdomen has five to seven pairs of functional spiracles. Segment 9 often ends in a vertical or horizontal spine or process or with a pair of incurved or outwardly curved urogomphi. Some prionines (tribes Callipogonini and Macrotomini) have paired paramedian gin-traps. The legs often have subapical setae on the femora and sometimes one or two setae on the tarsi.

1.3 Key to Subfamilies of the Family Cerambycidae

The key to adults is based on the work of Linsley (1962b), Ślipiński and Escalona (2013), and Švácha and Lawrence (2014). The key to larvae is based on Duffy (1953, 1957, 1960, 1968), Švácha and Danilevsky (1987, 1988, 1989), and Švácha and Lawrence (2014).

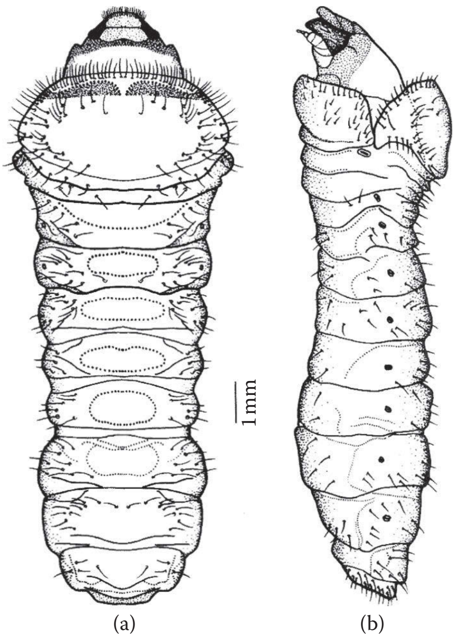

FIGURE 1.47 Larvae of *Acanthoderes (Psapharochrus) melanosticta* White (Lamiinae), dorsal view (a) and lateral view (b). (Reprinted with permission from C. J. B. Carvalho editor. Mermudes, J. R. M., and M. L. Monné, *Rev. Bras. Entomol.,* 45, 331–334, 2001.)

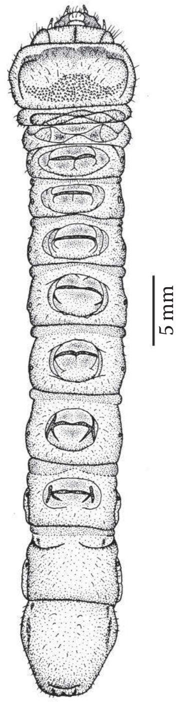

FIGURE 1.48 Larva of *Parandra* sp. (Parandrinae), dorsal view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

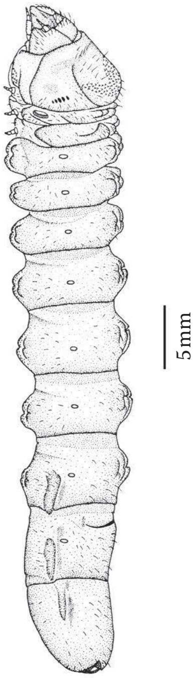

FIGURE 1.49 Larva of *Parandra* sp. (Parandrinae), lateral view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

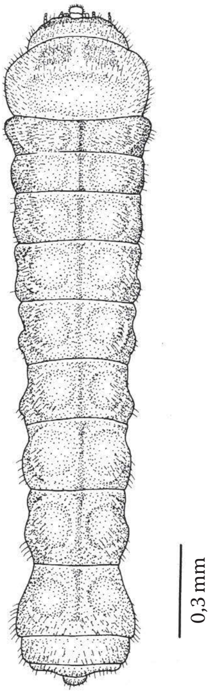

FIGURE 1.50 Larva of *Acyphoderes aurulenta* (Kirby) (Cerambycinae), dorsal view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

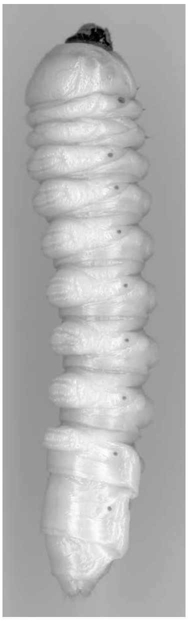

FIGURE 1.51 Larva of *Tsivoka simplicicollis* (Gahan) (Dorcasominae), laterodorsal view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

FIGURE 1.52 Larva of *Tsivoka simplicicollis* (Gahan) (Dorcasominae), ventral view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

FIGURE 1.53 Larva of *Judolia sexmaculata* (L.) (Lepturinae), ventral view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

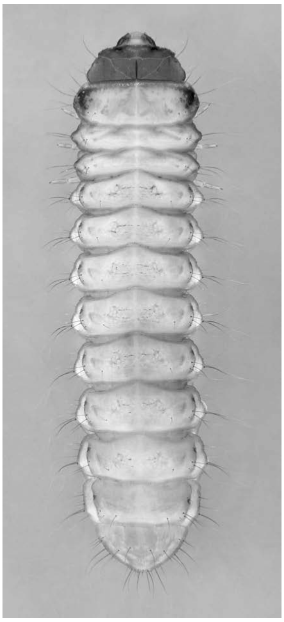

FIGURE 1.54 Larva of *Dinoptera collaris* (L.) (Lepturinae), dorsal view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

FIGURE 1.55 Larva of *Prionus coriarius* (L.) (Prioninae), lateral view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

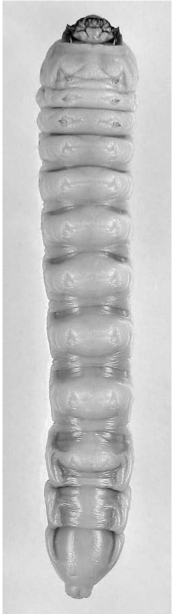

FIGURE 1.56 Larva of *Prionus coriarius* (L.) (Prioninae), ventral view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

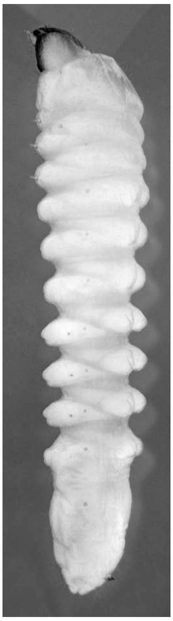

FIGURE 1.57 Larva of *Atimia okayamensis* Hayashi (Spondylidinae), lateral view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

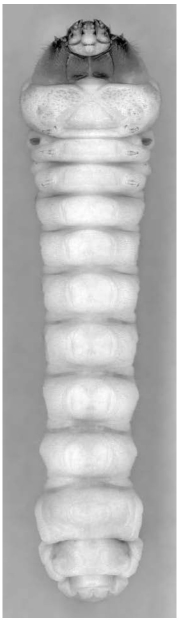

FIGURE 1.58 Larva of *Arhopalus rusticus* (L.) (Spondylidinae), ventral view. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

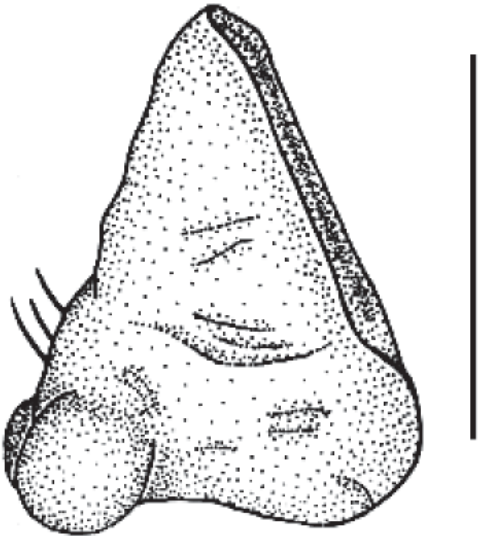

FIGURE 1.59 Mandible of the larva of *Acyphoderes aurulenta* (Kirby) (Cerambycinae), dorsal view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

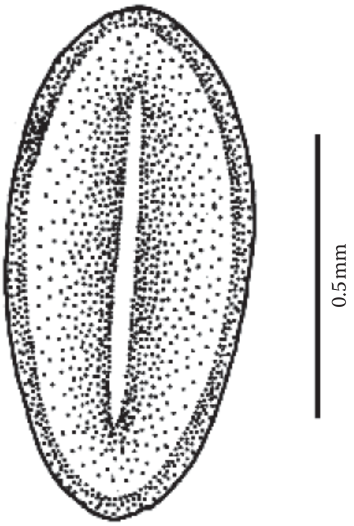

FIGURE 1.60 Thoracic spiracle of the larva of *Acyphoderes aurulenta* (Kirby) (Cerambycinae). (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

1.3.1 Adults

1. Tarsi distinctly pentamerous (Figure 1.34); lateral pronotal carinae entire and simple (Figure 1.21) .... **Parandrinae**
   a. Tarsi pseudotetramerous (Figure 1.35); lateral pronotal carinae absent (Figure 1.24), or present, often dentate or spinose (Figures 1.22 and 1.23) 2

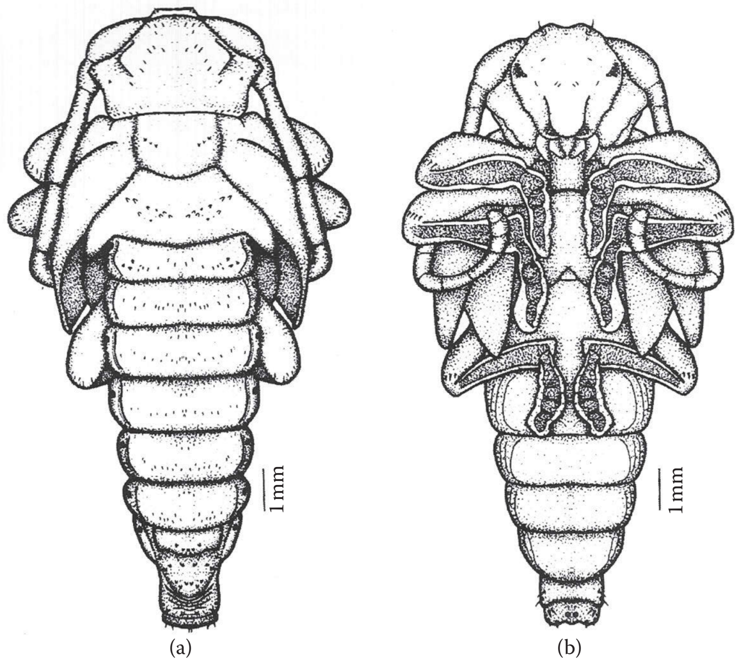

FIGURE 1.61 Pupae of *Acanthoderes (Psapharochrus) melanosticta* (White) (Lamiinae), dorsal view (a) and ventral view (b). (Reprinted with permission from C. J. B. Carvalho, editor. Mermudes, J. R. M., and M. L. Monné, *Rev. Bras. Entomol.,* 45, 331–334, 2001.)

2. Head vertical or retracted (Figure 1.7), genal margin always directed posteriorly; protibiae with mesial sinus; mesotibiae usually notched or grooved externally; last segment of maxillary palpi usually pointed at apex (Figures 1.14 and 1.15) .... **Lamiinae**
   a. Head usually prognathous or weakly deflexed (Figure 1.10), genal margin never directed posteriorly; protibiae without mesial sinus; mesotibiae never notched or grooved externally; last segment of maxillary palpi obtuse or truncate at apex (Figures 1.13 and 1.16 through 1.19) 3
3. Pronotum with elevated, often dentate or spinose lateral carinae (Figures 1.22 and 1.23); labrum fused with epistoma; inner lobe of maxillae obsolete (Figure 1.13); procoxae strongly transverse (Figure 1.23); mesoscutum without a striated stridulatory area .... **Prioninae**
   a. Pronotum without distinct lateral carinae; labrum free; inner lobe of maxillae usually well developed (Figures 1.16, 1.17, and 1.19); procoxae rarely transverse, usually rounded; mesoscutum with a finely striated stridulatory area (Figures 1.28 through 1.30) or without a stridulatory area 4
4. Mesoscutum without a median endocarina (Figure 1.30); elytra shortened, covering only the pterothorax, exposed hind wings with unfolded apex (Figures 1.36 and 1.37) ..... **Necydalinae**
   a. Mesoscutum with a median endocarina (Figures 1.28 and 1.29); elytra usually well developed, hind wings folded at apex 5
5. Head with region behind eyes usually having prominent temples followed by a constricted neck (Figures 1.5 and 1.6); procoxae conical, prominent, and strongly projecting below prosternal process .... **Lepturinae**
   a. Head may be gradually narrowing to abruptly constricted behind eyes, without prominent temples, followed by a constricted neck; procoxae of variable shape usually subglobular, seldom strongly projecting below prosternal process 6

6. Mandibula with incisor edge without fringe of hairs; hind wing with edge cell .... **Spondylidinae**
   a. Mandibula with incisor edge usually with fringe of long hairs; hind wing without edge cell 7
7. Mesonotum with an undivided stridulatory plate (Figure 1.31); notosternal suture rarely complete, usually indistinct or incomplete anteriorly or absent; empodium usually small or indistinct .... **Cerambycinae**
   a. Mesonotum with a divided stridulatory plate; notosternal suture may be relatively distinct and complete; empodium indistinct .... **Dorcasominae**

1.3.2 Larvae

1. Clypeus (Figure 1.62) very narrow, with only slender basal arms reaching to mandibular articulations; these arms may be more or less sclerotized and fused with epistomal margin. Mandibular apex and dorsal angle lacking; mandibles (Figure 1.59) short and apically rounded, spoon-like .... **Cerambycinae** (Figure 1.50)
   a. Clypeus more or less trapezoidal, filling entire space between dorsal mandibular articulations. Mandibles with distinct apex and more or less distinct dorsal angle 2
2. Legs absent, or present with only two minute segments visible under high magnification. Cardo extremely reduced, labiomaxillary base firmly attached to cranium along whole width; maxillae movable only from stipes .... **Lamiinae** (Figure 1.47a and b)
   a. Distinct four-segmented legs (Figure 1.65) present though may be strongly reduced and inconspicuous. Free movable cardo present 3
3. Main antennal sensillum flat, rarely convex, never conical 4
   a. Main antennal sensillum prominent and conical 5
4. Basal half of pronotum more or less roughly asperate. Labrum cordate (Figures 1.63 and 1.64), very long. Epistomal, frontal, and postcondylar carinae absent ..... **Parandrinae** (Figures 1.48 and 1.49)
   a. Body without coarse asperities. Labrum never as long as in *Parandra*. Distinct epistomal, frontal, and postcondylar carinae often present .... **Prioninae** (Figures 1.55 and 1.56)
5. Pretarsus without setae. Abdominal epipleurum protuberant on segments 7–9. Lateral furrows of pronotum long and distinct 6
   a. Pretarsus with distinct setae. Abdominal epipleurum protuberant on at least segments 6–9. Lateral furrows of pronotum rarely long and distinct 7
6. Large postnotal fold present. Urogomphi absent. Dorsal ampullae with one lateral impression on each side .... **Dorcasominae** (Figures 1.51 and 1.52)
   a. Postnotum absent. Urogomphi present or absent. Dorsal ampullae with two lateral impressions on each side .... **Spondylidinae** (Figures 1.57 and 1.58)
7. Dorsal ampullae with two broadly separate lateral impressions on each side (Figure 1.66) Prothoracic lateropresternum largely microspiculate .... **Necydalinae**
   a. Dorsal ampullae with one lateral impression. Prothoracic lateropresternum microspiculate at most along anterior margin .... **Lepturinae** (Figures 1.53 and 1.54)

1.4 Diagnosis, Biodiversity, Distribution, and Biology of Subfamilies

Phylogenetic relationships within the Cerambycidae are still highly controversial (e.g., Wang and Chiang 1991; Napp 1994; Švácha and Lawrence 2014). As a result, we order subfamilies alphabetically in this section. Morphological features of subfamilies mainly are extracted from Linsley (1962a, 1962b, 1963, 1964), Linsley and Chemsak (1972, 1984, 1995), Chemsak (1996), Ślipiński and Escalona (2013), and Švácha and Lawrence (2014).

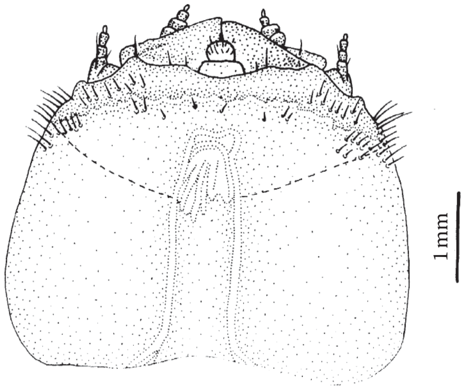

FIGURE 1.62 Head of the larva of *Acyphoderes aurulenta* (Kirby) (Cerambycinae), dorsal view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

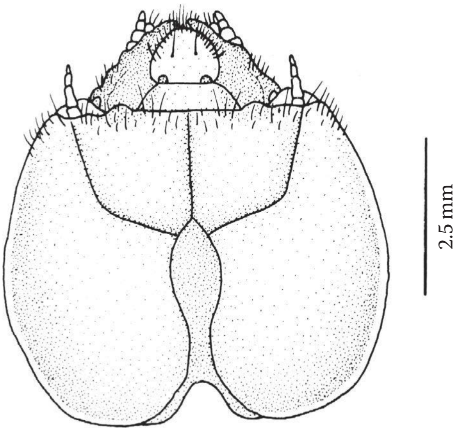

FIGURE 1.63 Head of the larva of *Parandra* sp. (Parandrinae), dorsal view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

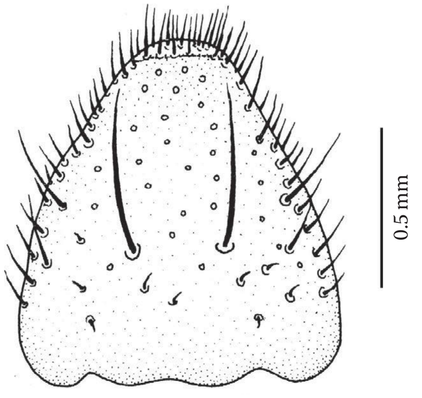

FIGURE 1.64 Labrum of the larva of *Parandra* sp. (Parandrinae), dorsal view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil,* Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

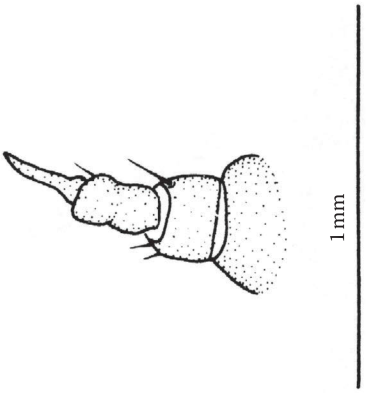

FIGURE 1.65 Proleg of the larva of *Parandra* sp. (Parandrinae), dorsal view. (Reprinted from Costa, C., et al., *Larvas de Coleoptera do Brasil*, Museu de Zoologia, Universidade de São Paulo, São Paulo, 1988. With permission.)

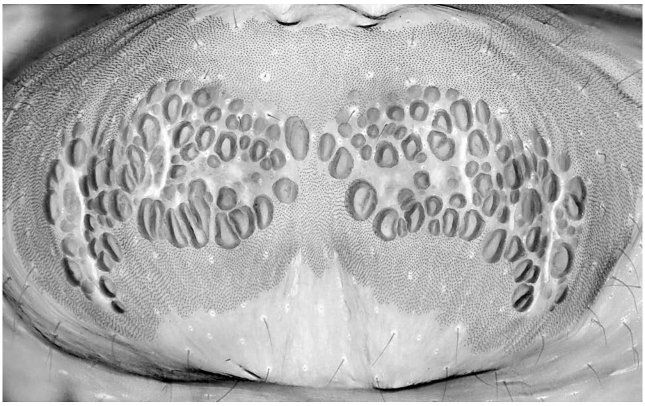

FIGURE 1.66 Larva of *Necydalis major* L. (Necydalinae), detail of ventral ambulatory ampulla 4. (Reprinted with permission from Petr Švácha, owner. Švácha, P., and J. F. Lawrence, 2.1 Vesperidae Mulsant, 1839; 2.2 Oxypeltidae Lacordaire, 1868; 2.3 Disteniidae J. Thomson, 1861; 2.4 Cerambycidae Latreille, 1802, In *Handbook of zoology, Arthropoda: Insecta; Coleoptera, beetles, Volume 3: Morphology and systematics (Phytophaga)*, eds. R. A. B. Leschen and R. G. Beutel, Walter de Gruyter, Berlin, 2014, 16–177.)

1.4.1 Subfamily Cerambycinae Latreille, 1802

1.4.1.1 Diagnosis

Small to large, elongate beetles (Figures 1.67 through 1.76). Head (Figure 1.10) subvertical, scarcely narrowed behind eyes; antennae inserted high on frons between eyes, usually very elongate, second antennomere short; eyes reniform, usually embracing antennal insertion; mandibles acute without molar plate; incisor edge with or without pubescent fringe; maxillae and labium variable, lacinia usually well developed (Figure 1.19); mentum usually trapezoidal (Figure 1.18); submentum sometimes produced between bases of maxillae as a short process. Pronotum without lateral margin; procoxae rarely prominent, usually rounded, cavities variable; notosternal suture rarely complete, usually indistinct or incomplete anteriorly, or absent; mesoscutum with a median endocarina; stridulatory plate, when present, undivided (Figure 1.31). Elytra usually not abbreviated; hind wings without closed cell in anal sector, radial cell closed. Legs moderately long; protibiae without mesial sinus; tarsi pseudotetramerous, padded beneath, third tarsomere dilated, bilobed concealing minute fourth tarsomere, empodium small or absent.

FIGURE 1.67 *Coccoderus sexmaculatus* Buquet (Cerambycinae).

FIGURE 1.68 *Compsibidion divisum* Martins (Cerambycinae).

FIGURE 1.69 *Compsocerus deceptor* Napp (Cerambycinae).

FIGURE 1.70 *Disaulax hirsuticornis* (Kirby) (Cerambycinae).

FIGURE 1.71 *Lissonotus spadiceus* Dalman (Cerambycinae).

FIGURE 1.72 *Megacyllene (Megacyllene) patruelis* (Chevrolat) (Cerambycinae).

FIGURE 1.73 *Mionochroma chloe* (Gounelle) (Cerambycinae).

FIGURE 1.74 *Neoregostoma coccineum* (Gory) (Cerambycinae).

FIGURE 1.75 *Pronuba decora* Thomson (Cerambycinae).

FIGURE 1.76 *Psygmatocerus wagleri* Perty (Cerambycinae).

1.4.1.2 Comments

Due to the diversity of forms, the subfamily is one of the most difficult to define, with uncertain limits and relationships (Napp, 1994). Two groups of genera previously included in the Necydalinae are recognized as incertae sedis of Cerambycinae by Švácha and Lawrence (2014): (1) *Atelopteryx* Lacordaire, *Callisphyris* Newman, *Hephaestion* Newman, *Parahephaestion* Melzer, *Planopus* Bosq and *Stenorhopalus* Blanchard; and (2) *Cauarana* Lane, *Mendesina* Lane, *Rhathymoscelis* Thomson and *Hephaestioides* Zajciw.

1.4.1.3 Diversity and Distribution

This is the second largest subfamily in Cerambycidae, with 1,757 genera and more than 11,200 species in the world (Bouchard et al. 2011; Monné 2012; Tavakilian 2015) (Table 1.1). The Cerambycinae are widely distributed in all biogeographic regions. In the Australian, Nearctic, and southern Neotropical regions, the Cerambycinae are the most speciose subfamily compared to other subfamilies (e.g., Forchhammer and Wang 1987; Švácha and Lawrence 2014).

1.4.1.4 Biology

Adults are extremely diverse, from dark nocturnal forms to brightly colored mimetic diurnal species (Švácha and Lawrence 2014) (Figures 1.67 through 1.76). Linsley (1962b) has attempted to divide this subfamily into two groups based on adult activity patterns. Adults of many species from the Callidiopini, Gracilliini, Opsimini, Methiini, and so on are active during the night, for example, *Oemona hirta* (F.) (Wang et al. 1998). Some adults may be crepuscular (vespertine) such as *Nadezhdiella cantori* (Hope) (Wang et al. 2002), *Phoracantha semipunctata* (F.), and *P. recurva* Newman (Wang at el. 2008). Nocturnal or crepuscular adults may or may not need to feed depending on species. Adults of most species appear to be diurnal, such as species from the Aphneopini, Callidiini, Cleomenini, Clytini, Molorchini, and so forth. Many diurnally active adults visit flowers and feed on pollens and nectar, such as *Zorion guttigerum* Westwood (Wang 2002). Some cerambycine adults feed on tree foliage, such as *Lissonotus spadiceus* Dalman (Figure 1.71) (M. L. Monné, personal observation) and *Xylotrechus pyrrhoderus* Bates (Guo 1999); a few in Trachyderini feed on fruit. Adults can live for a week to a few months depending on whether they feed. Male-produced long-range sex and aggregation pheromones have been identified in many cerambycine species (see Chapter 5). Mating may occur on larval hosts or adult feeding sites (see Chapter 4). Depending on the nature of larval feeding biology, adults may be attracted to larval hosts of certain conditions for oviposition (Hanks 1999; see Chapter 3). They then lay their eggs on the surface of larval host plants or in crevices and wounds of bark or under loose bark. Each female can lay dozens to hundreds of eggs in her lifetime.

The distinctive cerambycine larval mouthparts are well suited for solid hosts; most larvae do not occur in soft rotten wood or in soil, and species feeding in soft herbs are rare (Švácha and Lawrence 2014). Although larvae of many species feed on dead (not rotten) plants, most species probably attack living plants that may be perfectly healthy, weakened, or stressed (Hanks 1999). The larval host range of cerambycine species can be from oligophagous to highly polyphagous across both angiosperms and gymnosperms (see Chapters 11 and 12). Larvae bore in branches and stems of host plants and sometimes enter roots, such as *O. hirta* (Wang et al. 1998). Mature larvae usually pupate in their host plants. The life cycle usually lasts one to four years. Many cerambycine species are important pests of trees and logs.

1.4.2 Subfamily Dorcasominae Lacordaire, 1868

1.4.2.1 Diagnosis

Small to moderately large, usually elongate beetles with tapering or subparallel elytra and often long cursorial legs; no strongly depressed forms. Head prognathous or distinctly rostrate, usually constricted immediately behind eyes but never with prominent temples followed by a constricted neck; antennal insertions of variable position but at least slightly away from mandibular condyle, antennal sockets usually facing laterally or laterodorsally; eyes moderate to very large, emarginate to entire; mandibles never enlarged, apex unidentate, inner margin usually with a distinct fringe of hairs; maxillae and labium well developed, lacinia distinct, submentum with a very short to long intermaxillary process, ligula usually large, membranous and emarginate or bilobed, terminal segments of both palps usually more or less truncate. Pronotum without lateral carina, often with a pair of lateral tubercles or spines; procoxal cavities closed internally and at least narrowly open posteriorly, prosternal process usually narrow but complete; notosternal suture may be relatively distinct and complete; mesonotum usually with a divided stridulatory plate; mesocoxal cavities open laterally. Elytra in some taxa strongly narrowed and separate or also shortened posteriorly, partly exposing hind wings yet almost always distinctly surpassing posterior pterothoracic margin; hind wing with radial cell closed proximally but without edge cell. Legs short to moderately long; procoxae transverse to subglobular, prominent, projecting at least slightly below prosternal process; tarsi pseudotetramerous and padded beneath, tarsomere 5 in males of some taxa remarkably broadened distally, claws free, divaricate to moderately divergent. Empodium indistinct.

1.4.2.2 Comments

Some authors treat this group of cerambycids as two separate subfamilies, Dorcasominae and Apatophyseinae, each with one tribe (e.g., Danilevsky 1979; Tavakilian 2015). However, most authors accept that these two subfamilies should be two tribes, Apatophyseini and Dorcasomini, under the subfamily Dorcasominae (e.g., Švácha and Danilevsky 1987, 1989; Özdikmen 2008; Švácha and Lawrence 2014; Adlbauer et al. 2015; Vives 2015). We adopt the latter opinion in this chapter.

1.4.2.3 Diversity and Distribution

There are about 340 described species in 95 genera and two tribes occurring in the Oriental, southern Palaearctic, and Afrotropical regions (Švácha and Lawrence 2014; Adlbauer et al. 2015; Tavakilian 2015; Vives 2015) (Table 1.1).

1.4.2.4 Biology

Similar to the Lepturinae, adults of many dorcasomine species are diurnal with some apatophyseine species being floricolous (Švácha and Lawrence 2014). Most adults may be nocturnally active and hide under the bark of trees or between dead logs and the ground. For example, the nocturnal *Apterotoxitiades vivesi* Adlbauer adults are found under one- to two-year-old pine logs lying on the ground adjacent to grassland (Adlbauer et al. 2015). It is not clear whether adults feed and how they reproduce. No long-range pheromones have been found.

Švácha and Lawrence (2014) summarized the known biology of this subfamily. Larvae of *Dorcasomus gigas* Aurivillius make wide galleries along the center of stems and branches of living trees and pupate in the host plant. Larvae of *Apatophysis* Chevrolat develop in dead or moribund underground parts of trees and shrubs and in dry, often treeless, habitats with large perennial herbs. Adlbauer et al. (2015) speculate that *A. vivesi* larvae may feed on grass roots. Undescribed larvae of many Madagascan and one South African (*Otteissa* Pascoe) genera were found in dead, often rotting, wood, mostly above the ground; but some species are subterranean (and larvae also tend to lose stemmata). They are found less frequently in relatively fresh dead branches where larvae usually feed subcortically; unidentified dorcasomine larvae were also found in the outer bark layer of large living broad-leaved trees. Mature larvae of nearly all known species leave the host material and pupate in soil. The life-cycle length is unknown for this subfamily.

1.4.3 Subfamily Lamiinae Latreille, 1825

1.4.3.1 Diagnosis

Small to large, elongate to robust beetles (Figures 1.77 through 1.91). Head (Figure 1.7) vertical in front or retracted and hypognathous, genal line directly posterior; antennae inserted high on frons between eyes;

FIGURE 1.77 *Demophoo hammatus* (Chabrillac) (Lamiinae).

FIGURE 1.78 *Hamastatus conspectus* Monné (Lamiinae).

FIGURE 1.79 *Hydraschema fabulosa* Thomson (Lamiinae).

FIGURE 1.80 *Hylettus stigmosus* Monné (Lamiinae).

FIGURE 1.81 *Lycaneptia nigrobasalis* Tippmann (Lamiinae).

FIGURE 1.82 *Macronemus filicornis* (Thomson) (Lamiinae).