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Chapter 1

Introduction

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Medical entomology is the study of insects, insect-borne diseases, and other associated problems that affect humans and public health. **Veterinary entomology** is the study of insects and insect-related problems that affect domestic animals, particularly livestock and companion animals (dogs, cats, horses, caged birds, etc.). In addition, veterinary entomology includes insect-associated problems affecting captive animals in zoological parks and in wildlife in general. **Medical-veterinary entomology** combines these two disciplines.

Traditionally, the fields of medical and veterinary entomology have included health-related problems involving arachnids (particularly mites, ticks, spiders, and scorpions). This broad approach that encompasses insects and arachnids is followed in this text. Alternatively, the study of health-related problems involving arachnids is called **medical-veterinary arachnology** or, if just mites and ticks are considered, **medical-veterinary acarology**.

Historically, both medical and veterinary entomology have played major roles in the development of human civilization and animal husbandry. Outbreaks of insect-borne diseases of humans have profoundly influenced human history; such diseases include yellow fever, plague, louse-borne typhus, malaria, African trypanosomiasis, Chagas disease, and lymphatic filariasis. Likewise, livestock scourges such as bovine babesiosis, bovine theileriosis, scabies, pediculosis, and botfly infestations, all of which are caused or transmitted by arthropods, have greatly influenced animal production and husbandry practices. Arthropod-related disorders continue to cause significant health problems to humans, domestic animals, and wildlife. At the same time, new strains of known pathogens, as well as previously unrecognized disease agents transmitted by

arthropods, are causing newly recognized diseases (e.g., Lyme disease and human granulocytic anaplasmosis) and the resurgence of diseases that had been suppressed for many years (e.g., malaria, Chikungunya fever, and Zika encephalitis). Emerging and resurging arthropod-borne diseases are recognized as a growing health concern by public health and veterinary officials (Wilson and Spielman, 1994; Walker et al., 1996; Gubler, 1998; Winch, 1998; and Gratz, 1999; Marcondes, 2016).

GENERAL ENTOMOLOGY

Basic concepts of entomology such as morphology, taxonomy and systematics, developmental biology, and ecology provide important background information for medical and veterinary entomologists. General entomology books that the reader will find helpful in this regard include those by Gillot (1995), Elzinga (2000), Chapman (1998), Romoser and Stoffolano (1998), Gullan and Cranston (2005), Triplehorn and Johnson (2005), and Pedigo and Rice (2009). References that provide a more taxonomic or biodiversity-oriented approach to general entomology include works by Arnett (2000), Richards and Davies (1994), Bosik (1997), Daly et al. (1998), and Marshall (2006). General insect morphology is detailed in Snodgrass (1993), whereas a useful glossary of general entomology is provided by Torre-Bueno (1962) and was updated and revised by Nichols (1989). An encyclopedia of entomology (Resh and Cardé, 2009) and a dictionary of entomology (Gordh and Headrick, 2001) are also available. Texts on **urban entomology**, the study of insect pests in houses, buildings, and urban areas, which also has relevance to medical-veterinary entomology, have been prepared by Ebeling (1975), Hickin (1985), Mallis et al. (2004), and

Robinson (1996). General texts on acarology include works by Woolley (1987), Evans (1992), and Krantz and Walter (2009).

MEDICAL-VETERINARY ENTOMOLOGY LITERATURE

Textbooks or monographs pertaining to medical entomology, veterinary entomology, or the combined discipline of medical-veterinary entomology are listed under these headings at the end of this chapter. Most of these publications emphasize arthropod morphology, biology, systematics, and disease relationships, whereas some texts emphasize molecular aspects of medical-veterinary entomology, such as Crampton et al. (1997) and Marquardt et al. (2005). Other works are helpful regarding common names of arthropods of medical-veterinary importance (Pittaway, 1992), surveillance techniques (Bram, 1978), control measures (Drummond et al., 1988), repellents (Debboun et al., 2007; Strickman et al., 2009), or ectoparasites (Andrews, 1977; Marshall, 1981; Kim, 1985; Uilenberg, 1994; Barnard and Durden 1999; Clayton et al., 2015). Publications that devote substantial sections to arthropods associated with wildlife and the pathogens they transmit include those by Davidson et al. (1981), Fowler (1986), Davidson and Nettles (1997), and Samuel et al. (2001).

Several journals and periodicals are devoted primarily to medical and/or veterinary entomology. These include:

- *Journal of Medical Entomology*, published for the Entomological Society of America by Oxford University Press.
 - *Medical and Veterinary Entomology*, published by the Royal Entomological Society (UK).
 - *Journal of Vector Ecology*, published by the Society of Vector Ecologists.
 - *Review of Medical and Veterinary Entomology*, published by CAB International.
 - *Annals of Medical Entomology*, published in Bhopal, India.
 - *Vector-Borne and Zoonotic Diseases*, published in the United States by Mary Ann Liebert, Inc.
- Journals specializing in parasitology, tropical medicine, or wildlife diseases that also publish articles on medical-veterinary entomology include:
- *Parasitology*, published by the British Society for Parasitology.
 - *Journal of Parasitology*, published by the American Society of Parasitologists.
 - *Parasite-Journal de la Société Française de Parasitologie*, published in France.
 - *Advances in Disease Vector Research*, published by Springer-Verlag.
 - *Bulletin of the World Health Organization*, published by the World Health Organization.
 - *Journal of Wildlife Diseases*, published by the Wildlife Disease Association.
 - *Emerging Infectious Diseases*, published by the Centers for Disease Control and Prevention (CDC).
 - *American Journal of Tropical Medicine and Hygiene*, published by the American Society of Tropical Medicine and Hygiene.
 - *Memorias Do Instituto Oswaldo Cruz*, published in Brazil.

Various Internet websites pertaining to medical-veterinary entomology also can be accessed for useful information. The CDC in Atlanta, Georgia, USA, provides two helpful resources: (1) a pictorial key to arthropods of public health importance, available as downloadable files (PDF), https://www.cdc.gov/nceh/ehs/Publications_Keys.htm; and (2) a comprehensive annual guide titled the “Yellow Book” that details travel medicine updates on a global basis (CDC, 2018). Although all aspects of travel medicine and infectious diseases are covered, much of the information addresses vector-borne diseases.

A BRIEF HISTORY OF MEDICAL-VETERINARY ENTOMOLOGY

Problems caused by biting and annoying arthropods and the pathogens they transmit have been the subject of writers since antiquity (Service, 1978). Homer (mid-eighth century BC), Aristophanes (c. 448–380 BC), Aristotle (384–322 BC), Plautus (c. 254–184 BC), Columella (5 BC–AD 65), and Pliny (AD 23–79) all wrote about the nuisance caused by flies, mosquitoes, lice, and/or bedbugs. However, the study of modern medical-veterinary entomology is usually recognized as beginning in the late 19th century, when blood-sucking arthropods were first proved to be vectors of human and animal pathogens.

Englishman **Patrick Manson** (1844–1922) (Fig. 1.1A) was the first to demonstrate pathogen transmission by a blood-feeding arthropod. Working in China in 1877, he showed that the mosquito *Culex pipiens fatigans* is a vector of *Wuchereria bancrofti*, the causative agent of Bancroftian filariasis. After this landmark discovery, the role of various blood-feeding arthropods in transmitting pathogens was recognized in relatively rapid succession.

In 1891, Americans **Theobald Smith** (1859–1934) (Fig. 1.1B) and **Frederick L. Kilbourne** (1858–1936) implicated the cattle tick, *Rhipicephalus (Boophilus) annulatus*, as a vector of *Babesia bigemina*, the causative agent of Texas cattle fever (bovine babesiosis). This paved



FIGURE 1.1 Historical figures in medical-veterinary entomology. (A) Patrick Manson (1844–1922). (B) Theobald Smith (1859–1934). (C) Ronald Ross (1857–1932). A and B, Courtesy of The Wellcome Collection, London; C, Courtesy of Wikipedia Commons.

the way for a highly successful *R. annulatus* eradication program in the United States directed by the US Department of Agriculture (USDA). The eradication of this tick resulted in the projected goal — elimination of indigenous cases of Texas cattle fever throughout the southern United States.

In 1898, Englishman Sir **Ronald Ross** (1857–1932) (Fig. 1.1C), working in India, demonstrated the role of mosquitoes as vectors of avian malarial parasites from diseased to healthy sparrows. Also in 1898, the cyclical development of malarial parasites in anopheline mosquitoes was described by Italian **Giovani Battista Grassi** (1854–1925). In the same year, Frenchman **Paul Louis Simond** (1858–1947), working in Pakistan (then part of India), showed that fleas are vectors of the bacterium that causes plague.

In 1848, American physician **Josiah Nott** (1804–1873) of Mobile, Alabama, published circumstantial evidence that led him to believe that mosquitoes were involved in the transmission of yellow fever virus to humans. In 1881, the Cuban-born Scottish physician **Carlos Finlay**

(1833–1915) (Fig. 1.2A) presented persuasive evidence for his theory that what we know today as the yellow fever mosquito, *Aedes aegypti*, was the vector of this virus. However, it was not until 1900 that American **Walter Reed** (1851–1902) (Fig. 1.2B) led the US Yellow Fever Commission at Havana, Cuba, which proved *A. aegypti* to be the principal vector of yellow fever virus.

In 1903, Englishman **David Bruce** (1855–1931) (Fig. 1.2C) demonstrated the ability of the tsetse fly *Glossina palpalis* to transmit, during blood feeding, the trypanosomes that cause African trypanosomiasis.

Other important discoveries continued well into the 20th century. In 1906, American **Howard Taylor Ricketts** (1871–1910) (Fig. 1.3) proved that the Rocky Mountain wood tick, *Dermacentor andersoni*, is a vector of *Rickettsia rickettsii*, the causative agent of Rocky Mountain spotted fever. In 1907, **F. Percival Mackie** (1875–1944) showed that human body lice are vectors of *Borrelia recurrentis*, the spirochete that causes louse-borne (epidemic) relapsing fever. In 1908, Brazilian **Carlos Chagas** (1879–1934) (Fig. 1.4) demonstrated transmission of the agent that



FIGURE 1.2 Historical figures in medical-veterinary entomology. (A) Carlos Finlay (1833–1915). (B) Walter Reed (1851–1902). (C) David Bruce (1855–1931). A and C, Courtesy of The Wellcome Collection, London; B, Courtesy of Wikipedia Commons.