Field Guide to Venomous and Medically Important Invertebrates Affecting Military Operations: Identification, Biology, Symptoms, Treatment

Version 2.0, 31 July 2006

If you can provide the origin of images listed as "source unknown" please e-mail the webmaster, <afpmb-webmaster@afpmb.org>.

Lt Colonel David E. Bowles and Colonel James A. Swaby

USAF Institute for Operational Health
2513 Kennedy Circle Drive
Brooks City-Base, TX 78235

Preface

This guide is intended to be a primary and expeditious information source for aiding deployed military personnel in the initial steps of pest identification related to surveillance and public health matters associated with invertebrates of medical importance. It is not intended to be a definitive or exhaustive treatise on the subject material. Furthermore, the contents of this manual represent only a compilation of the available literature, and it is not intended in any fashion to represent an original research paper. This document is intended to be a starting point for obtaining information and not an end point. Readers seeking additional information on a particular topic addressed herein should refer to the referenced material or other sources of information as appropriate.

Treatment guidelines, where presented, are based on current available information at the time this document was written. Practitioners have the sole responsibility to ensure the correct dosages of medicines are provided, and they also should ensure correct treatment regimes by consulting the most recent appropriate information sources.

Use of trade or brand names in this publication is for the sole purpose of illustration and does not imply endorsement by the United States Air Force.

Contents

- Sticktight flea
- Rabbit flea
- Squirrel flea
- Rodent flea
- Ground squirrel flea
- “Sand and beach fleas”

- Other Arthropods
  - Centipedes
  - Millipedes

- Other Invertebrates
  - Porifera
  - Coelenterates
    - Jellyfish
      - Moon jellyfish
      - Sea Nettles
      - Sea Wasp or box jellyfish
      - Small box jellyfish
      - False box jellyfish
      - Pink jellyfish
      - Thimble jellyfish
      - Lion’s mane jellyfish
    - Portuguese Man O’ War
    - Sea anemones
    - Sea Ferns
    - Corals
  - Bryozoans
  - Echinoderms
    - Sea stars and brittle stars
      - Crown of thorns starfish
      - Mosaic sea star
      - Chain-link brittle star
    - Sea urchins
    - Sea cucumbers
  - Annelid worms
    - Leeches
    - Polychetes or bristleworms
  - Mollusks
    - Squids, octopuses and cuttlefishes
    - Cone shells
    - Pteropods
    - Nudibranchs or sea slugs
    - Snails as hosts of schistosomiasis
    - Swimmer’s itch

SECTIONS

Introduction

The purpose of this guide is to present the reader with a basic yet sound understanding of the dangerous types of invertebrates that may be encountered during military operations worldwide. Brief descriptions of the physical and behavioral characteristics of these animals are presented. This field guide only considers those animals which pose a threat from direct contact and does not address toxic responses from food or contact allergies, or consumption of certain poisonous animals. In addition, a few invertebrates are included here not because they present a danger to people, but because they are often incorrectly presumed to be dangerous.

A considerable amount of literature was reviewed, digested and consolidated to create this field guide. In an effort to make a concise guide with streamlined text to facilitate ease of reading under the operational conditions it was intended to serve, individual information sources have not been cited in the text. To the maximum extent possible the information extracted from these references has been paraphrased. Some suggested references for obtaining additional information on these animals are included at the end of this document.

An attempt was made to use common language in this document to describe symptoms associated with arthropod attacks. However, for the sake of brevity in some situations, or where specific terms were essential to avoid confusion, we used medical and technical terminology. Those terms are defined in Appendix 1.

Threats from invertebrates encompass two broad categories: point source threats and psychological threats. Point source threats are those that can cause physical injury or death in a brief period of time. The sting of a wasp, and transmission of deadly disease agents are two examples of point source threats. Psychological threats, by comparison, are those that do not kill or directly threaten health, but rather present unpleasant situations for people to the extent that routine functioning is impaired. Both point source and psychological threats have the real potential to disrupt or even halt military operations, and they present serious concerns that commanders and the military medical community must address during both peacetime and contingencies.

There are several types of potential negative interactions associated with invertebrates including physical pain, disease, envenomation, myiasis, allergic reactions, psychological disorders, and death.

Physical pain- Bites, piercings, and stings caused by a wide variety of invertebrates can produce varying amounts of suffering among victims. Symptoms can range from mild annoyance to incapacitation. Although such physical trauma generally is not lethal, it may render a victim incapable of normal activity, and it can result in psychological disturbance among certain individuals.

Disease- Transmission of arthropod- or vectorborne disease agents represents the most substantial and continuous non-combat threat to military members during deployments. The World Health Organization has estimated there are 10 million cases annually of vectorborne diseases worldwide with many being fatal. Historically, vectorborne diseases have produced far

more morbidity and mortality (greater than 60%) among U.S. military forces during modern wars than battle injury and non-battle injury combined. In addition, vectorborne disease epidemics can serve as a severe detriment to force morale.

Envenomation, the injection of venom into the body through either bites and/or stings, is perhaps the most rapid and immediate deleterious response invertebrates can inflict on humans. The response of such envenomations can range from mild irritation and limited necrosis of tissue to systemic failure and death. The venoms producing these conditions are broadly grouped as either neurotoxic or necrotic. Neurotoxic venoms are those that negatively affect the nervous system while necrotic venoms are those that destroy blood and tissue. Occasionally, the venom of some invertebrates contains both neuotoxic and necrotic properties. In addition to injecting venom, some caterpillars and beetles produce toxins that cause dermatitis when contacted.

Myiasis is the invasion of the tissue of man or animals with the larvae (maggots) of certain flies (Diptera) that consume flesh or body fluids for sustenance. Such invasions may be benign or even asymptomatic, or they may result in more destructive disturbances. Myiasis is often described in terms associated with the site of entry. Types of myiasis recognized in humans include urogenital, gastrointestinal, ocular, auricular, and cutaneous which is the traumatic invasion of tissue and the most significant form of myiasis. Most instances of myiasis are accidental or opportunistic (facultative) rather than obligate. Although flesh-eating dipteran larvae can be successfully used to debride necrotic tissue from wounds under controlled medical conditions, myiasis under operational conditions potentially can damage healthy tissue and produce severe psychological distress in victims. When wounds are involved, the term

"traumatic" may be applied, and when the lesion is boil like, it is referred to as furuncular myiasis. When larvae burrow in the skin in such a way that the progress may be followed as the larva advances, the term "creeping myiasis" (creeping eruption) is applied. Myiasis has tremendous potential for psychological disturbance among afflicted military personnel.

Urtication is a physiological response to contact with toxins of certain invertebrate body parts, such as the setae of certain moth larvae, and nematocysts (stinging cells) of jellyfish and corals. Urtication can cause a painful burning and itchy skin eruption, or hives, at the point of contact. Although rarely fatal, urtication can be debilitating and may result in systemic shock in some individuals.

Allergic Reactions occur primarily through contact with venom, saliva, or certain body parts of invertebrates such as setae. Reactions can be either localized (wheals, swelling) or systemic (anaphylactic shock), and the range of severity, including death, is broad.

Delusory Parasitosis and Entomophobia are psychological disorders stemming from contact with insects and their relatives. Psychological threats posed by invertebrates often are cumulative in their effect. In other words, the more experience an individual has the greater the negative impact on health and welfare. The importance of such cumulative encounters is a function of the number and diversity of pests in an area, the quality of living conditions, ability to escape the pests, fatigue, and stress. Under certain conditions, such as an extended deployment, nuisance pests can become a more substantial threat to mission success than disease, especially when pest densities are high and disease incidence is low. Delusory parasitosis often is an intensely

emotional psychological disorder characterized by the unfounded belief that parasites, usually insects, are living on or in the body. This condition, although very rare, can become sufficiently severe in some individuals to be incapacitating, and these individuals often require professional mental health care. Entomophobia, by comparison, is simply an irrational fear of insects and their relatives, or the damage or diseases they are capable of inflicting. For example, some individuals may develop an irrational fear of bees after being stung. The primary difference between entomophobia and delusory parasitosis is that the former occurs only in the presence of certain insects while the latter encompasses a near constant state of agitation and distress.

Pesticide Use for Controlling Invertebrate Vectors and Pests

Pesticides for controlling vectors and pests should be applied only by qualified pest management personnel. Department of Defense guidance on pesticide selection and integrated pest management can be found in the Contingency Pest Management Guide (Technical Guide No. 24, Armed Forces Pest Management Board), and Guide to Operational Surveillance of Medically Important Vectors and Pests ("Operational Entomology") available from the USAF School of Aerospace Medicine. Additional information and instruction on pest management issues of military importance can be found on the website of the Armed Forces Pest Management Board (www.afpmb.org).

Personal Protective Measures Against Arthropods

Guidance on personal protection from arthropods and other invertebrates can be found in Personal Protective Measures Against Insects and Other Arthropods of Military Significance (Technical Guide No. 36, Armed Forces Pest Management Board), and Guide to Operational

Surveillance of Medically Important Vectors and Pests ("Operational Entomology"). Additional information and instruction on personal protection from arthropods can be found on the website of the Armed Forces Pest Management Board (www.afpmb.org).

Dangerous Invertebrates of Military Importance

Appendix 1 contains a list of the dangerous invertebrates of military importance including their geographic distributions.

Arachnids

(Spiders, Scorpions, Ticks, Mites, Camel Spiders)

Envenomation by arachnids causes significant medical illness worldwide. Among the most important groups of spiders are the widow spiders (*Latrodectus* spp.), recluse spiders (*Loxosceles* spp.), the Australian funnel web spiders (*Atrax* and *Hadronyche* spp.) and the wandering or banana spiders (*Phoneutria* spp.) of Brazil. Scorpions are widely distributed worldwide, but only a few species primarily distributed in Africa, the Middle East, and Latin America can inflict fatal stings. However, scorpion stings represent the most important source of arachnid envenomation in many of these areas occasionally causing morbidity among adults and death among children. Ticks and mites are notorious vectors of serious human disease and irritation. Finally, some arachnids such as camel spiders may be harmless if left alone, but their appearance can cause psychological distress among people.

Spiders

The vast majority of the approximately 25,000 species of spiders known worldwide are completely harmless to people. However, a few species are capable of causing substantial pain, suffering, and even death to their victims. Even the potentially dangerous species are shy and secretive, and contact with them is normally accidental. Because of the difficulty in accurately identifying spiders, all types should be avoided.

Banana spiders

Some banana spiders (*Phoneutria fera, Phoneutria ochracea, Phoneurtria spp*.) distributed in South America are aggressive and have been implicated in human envenomations leading to death. These spiders are also commonly referred to as wandering spiders in South America, but they are not related to the wandering spiders of Africa. Banana spiders do not spin a web. These spiders bite hundreds of South Americans yearly and most often during the winter months. The bites are painful, and after a few hours, the pain becomes deeply seated and generalized, and the area around the bite becomes swollen. The venom is a potent neurotoxin that affects both the central and peripheral nervous system. Envenomation may involve a variety of symptoms including altered pulse rates, irregular heartbeat, temporary blindness, sweating, fever, and increased glandular functions, especially the kidneys. Roughly 24 hours following the bite, the victim may suffer from general muscle pain and prostration. Fatalities are not common and children under 6 years of age are the most vulnerable. There is no antivenom available, and treatment may include use of analgesics and antihistamines although they are not always effective.

Figure 1. Banana spider (*Phoneutria fera*), South America. Photo: Danne Rydgren.

Black widows spiders and their relatives

Black widow spiders and their relatives (*Latrodectus* spp.) are among the most dangerous spiders to humans. Although timid and reclusive in behavior, they can inflict painful and potentially deadly bites when provoked or accidentally contacted. These spiders often are shiny black in appearance and approximately one inch or less in body length. Most widow spiders have the ventral (bottom) side of the abdomen is variously marked with red spots or other shapes, and some species may also have similar markings on the dorsum (top side). The red hourglass marking of the southern black widow, *Latrodectus mactans*, in North America, and the red dorsal spot of the redback, *Latrodectus hasselti*, in the Austro-Asian region are perhaps the most well known of such markings among these spiders. Approximatley 40 species of "black widows" occur worldwide. Medically important species occur in the Middle East, Europe, Madagascar, Africa, Asia, Australia, and throughout the Western Hemisphere. Geographically unique common names applied to the black widows include shoe-button spider (South Africa), katipo (New Zealand), redback (Australia), and malmignatte and karakurt (Europe). Other species of *Latrodectus* of concern that are not black in color include the brown widow (tropical areas worldwide; common in the southern United States), red widow (central and southern Florida, Africa), and northern widow (northern Florida to Canada).

Figure 2. Southern black widow (*Latrodectus mactans*), North America. Photo: Texas Parks & Wildlife Department.

Figure 3. Web of southern black widow (*Latrodectus mactans*) showing irregular pattern of silk threads. Photo: David Bowles & Mark Pomerinke.

Figure 4. Red back (*Latrodectus hassleti*), Australia. Photo: source unknown.

Figure 5. Brazilian black widow (Latrodectus curacaviensis), South America. Photo: source unknown.

Figure 6. African black widow (Latrodectus indistinctus), South Africa. Photo: source unknown.

Figure 7. Red widow, (*Latrodectus bishopi*). Photo: source unknown.

Figure 8. Brown widow (*Latrodectus geometricus*). Photo: Invasive Species Council.

Figure 9. Brown widow (*Latrodectus geometricus*). Photo: F. J. Santana.

Figure 10. Brown widow (*Latrodectus geometricus*) showing red hourglass on ventral side of abdomen. Photo: F. J. Santana.

Although bites from black widows are relatively rare, and the toxicity of their neurotoxic venom varies widely, envenomation by these spiders can be dangerous. Widow spider bites can cause a clinical condition referred to as latrodectism. The most significant feature of latrodectism is severe and persistent pain, although some bites may cause only minor effects. Although the bite itself is often painless initially, significant systemic symptoms may ensue in a matter of minutes, beginning with severe localized pain of increasing intensity that may become generalized. Symptoms include severe muscle pain, rigid "boardlike" abdominal cramping, tightness through the chest, difficulty breathing, and nausea. The dermatologic responses of *Latrodectus* bites may be mild, and include localized redness of the skin, sweating, and erection or bristling of hair at the wound site within the first half hour. The nodes draining the wound site may become palpable and painful. In addition, cyanosis may develop around the bite site and there may be various dermatological eruptions such as hives or itchy wheals. Although death is rare, mortality can be 4-5% without treatment. Bite victims usually require medical treatment, including antivenom for non-sensitive individuals, and hospitalization. Black widow bites have been occasionally misdiagnosed as ruptured ulcers, acute appendicitis, kidney problems, or food poisoning.

There are several commercially available widow spider antivenoms. These antivenoms include those for the black widows (*L. mactans, L. indistinctus*) of North America (Merck), the red-back spider (*L. hasselti*) in Australia, and brown widow (*L. geometricus*) spiders of South Africa, the Argentinian *L. mactans*, and the Mexican widow spider. European widow spider (*L. tredecimguttatus*) antivenom is no longer produced. Although these antivenoms produce few allergic responses, and they have been shown effective under laboratory conditions in addition to having cross-reactivity between many species, they are seldom used. Treatments for envenomation by black widows may include use of antivenom for high-risk patients, but muscle relaxants such as calcium gluconate, magnesium sulfate, and diazepam are more commonly used treatments. Historically, an effective treatment included use of muscle relaxants and an intravenous solution of 10% calcium gluconate. Recommendations for pain control include intravenous morphine sulfate for severe cases and aspirin and acetaminophen for milder envenomations.

Brown recluse spiders

Brown recluse spiders (*Loxosceles* spp.), also known as fiddlebacks, are widely distributed throughout the world with over 100 described species in the genus. Envenomation by some of these species has well documented dangerous effects on people. Not all of the known species have been shown to be dangerous, but it is possible that many pose a potential health threat to people. Antivenoms are available for *Loxosceles* spp., but there is little evidence to support their effectiveness, particularly against local effects. The known and potentially dangerous species of *Loxosceles* are shown in Appendix 1.

Figure 11. Brown recluse (*Loxosceles reclusa*), North America. Photo: David Bowles & Mark Pomerinke.

Figure 12. Loxosceles valida, South Africa. Photo: Museums of Cape Town.

Figure 13. Fiddle-shaped marking on the cephalothorax of a brown recluse. Photo: Dr. Harold J. Harlan.

The fiddle-shaped mark on the cepahalothorax, long legs and sleek, brown to gray coloration are characteristic of all members of this genus. However, the fiddle-shaped mark is not well defined in some species. *Loxosceles reclusa*, a North American species, is perhaps the most recognized species in this group. The Chilean recluse, *Loxosceles laeta*, and the Mediterranean recluse, *Loxosceles rufescens* have been introduced to the United States, Canada, and likely other areas of the world as well. Although some of these introduced populations are thought to have been exterminated, others almost certainly have become naturalized and continue to exist. Generally, these spiders are shy and reclusive by nature, but they will bite when harassed or accidentally contacted, and multiple bites are not uncommon.

Considerable myth and misinformation surround the bites of brown recluse spiders. Many "bites" by these spiders reported by physicians are misdiagnosed, and the "bite" is often due to other factors. In reality, brown recluse bites are rare relative to their population densities in structures shared with people. Most bites by brown recluses are asymptomatic or self-resolving. Although the bite of a brown recluse produces little pain initially, the potent necrotic venom is capable of rapidly destroying living human tissue around the bite site. This phenomenon is known as necrotising arachnidism syndrome, but it occurs in only about 10% of victims.

Approximately 12-24 hours following envenomation, the area around the bite site becomes painful and swollen, the skin becomes reddened or mottled purplish-red, there may be some areas of hardened tissue, and a blister or pimple may form. In certain cases, there is further progression of the venom's action to include, a light-colored halo around the bite site with the central area appearing gray-blue in color, and the surrounding area become reddened. When these later symptoms appear, the patient will often develop deep tissue necrosis, and a typical lesion is about the size of a dime or smaller, raised around the edges and sunken in the center. While some bite victims do not show any reaction the range of responses in those that do varies from a small pimple-like lesion, to severe, full tissue necrosis and formation of ulcers that may take months to heal or require surgical intervention. Rarely, additional systemic reactions may occur including disseminated intravascular coagulation, passing blood in the urine, acute kidney failure, convulsions, coma, and rarely death.

Figure 14. Mild necrosis from a probable brown recluse bite in a deployed soldier. Photo: James A. Swaby.

Figure 15. First day response in a patient bitten by a brown recluse. Photo: source unknown.

Figure 16. Late stage necrosis in the same patient 10 days following a brown recluse bite. Photo: source unknown.

Treatment for brown recluse bites can include, to the extent possible, immediate immobilization and elevation of the affected area and use of cold compresses. Under direct care of a physician, analgesics can be used for pain relief, and the victim should have a tetanus booster when necessary. Corticosteroids can be injected into the bite wound to reduce pain and inflammation. Also, 100 mg of Dapsone given daily can limit cutaneous necrosis. Systemic antibiotics may be

used to treat secondary infections. In extreme cases of necrosis, surgical excision of the wound and skin grafts may be necessary, but only after the necrosis has completely stopped.

Funnel web spiders

Roughly 35 species are known among the genera *Atrax* and *Hadronyche*, the Australian funnel web spiders. Funnel web spiders are of moderate size with some species approaching 1.5 inches (40 mm) in length. Several of the funnel web spiders are known to envenomate humans with serious consequences, and bites of some species can be fatal. The genus *Atrax* is distributed in eastern and southern Australia and New Zealand, while *Hadronyche* is generally distributed throughout Australia and Tasmania. The distribution of *Atrax robutsus* (Sydney funnel web spider) is restricted to an area in a radius of approximately 100 miles (160 km) around Sidney, Australia. *Atrax robustus* and *Atrax formidabilis* arguably are the most venomous and dangerous spiders in the world. Several species of funnel web spiders have very serious bites, but there have been no reported fatalities. Less than a couple of dozen human deaths from funnel web spider envenomations have been recorded since the 1920's.

Figure 17. Funnel web spider (*Atrax robustus*) Australia. Photo: Danne Rydgren.

Figure 18. Funnel web spider in a defensive posture with fangs exposed. Photo: Marc Birat.

Unlike black widows where the bites of males are inconsequential, the neurotoxic venom of male funnel web spiders is much more virulent than that of the female even though the female secretes larger quantities of venom. Females normally have a limited territory while the males wander about seasonally searching from females. Thus, wandering males are responsible for the majority of bites attributed to these spiders. One unusual aspect of funnel web venom is that it appears to be toxic only to primates (monkeys and humans) which lack a naturally occurring inhibitor. When attacking, funnel web spiders grip the victim and bite repeatedly.

Reactions to envenomation by funnel web spiders includes skeletal muscle spasms and twitching, weakness, excessive salivation and sweating, bristling of hairs, rapid heartbeat, high blood pressure, irregular heartbeat, abdominal pain, nausea, vomiting, pulmonary edema, leaking of capillaries, kidney failure, unconsciousness, shock, and death. Once injected, venom can reach the circulatory system in as little as 2 minutes, and death can result in as little as 15 minutes, but fatalities can occur up to 3 days following the bite. Antivenom for the various dangerous funnel web spiders is available in Australia.

Hobo Spiders

The hobo spider (*Tegenaria agrestis*) was introduced to the United States from Europe and has been implicated in human envenomations in the Pacific Northwest, Alaska, and Idaho, and additionally throughout their natural distribution. Symptoms include a slight prickling sensation following the bite and a small insensitive hard area that appears within 30 minutes surrounded by an expanding reddened area of up to 6 inches in diameter. This area will become blistered between 15 and 35 hours after the bite, and, about a day later, the blisters break and ooze. Necrosis sometimes continues even after the wound starts to scab over. The necrotic lesion can vary from 1/2 to 1 inch (12-25 mm) or more in diameter and may take several months to heal. Painful headaches also have been associated with hobo spider envenomation. An effective antivenom is available for treating bites of this species, but it is not given to all patients.

Figure 19. Hobo spider (Tegenaria agrestis). Photo: Maxence Salomon.

Megalomorph spiders

Harpactirella lightfooti of South Africa is a large spider that is seldom encountered by most people, but the severity of their bites makes them of medical interest. One of the most distinguishing features of these spiders is that their spinnerets are very long and protrude well beyond the posterior margin of the body. The body length may exceed 30 mm. and the body and legs are thickly covered with brownish-gray hair-like setae. The exact distribution of *H. lightfooti* in Africa is not well established, but it appears to be restricted to the Southwestem Cape region. They reside in silk-lined tunnels beneath rocks and logs.

Figure 20. Megalomorph spider (*Harpactirella lightfooti*), South Africa. Photo: Ansie Dippenaar-Schoeman.

The severity of envenomation by *H. lightfooti* is still matter of speculation. However, bites of megalomorph spiders have been reported to produce symptoms that include a burning pain experienced at the bite site. After a latent period of 2 hours, patients may vomit continuously and show marked signs of shock, collapse, and be unable walk. No discoloration or swelling is usually visible at the site of the bite. *Latrodectus* antivenom has shown some promise for treating bites of this species in mice.

Six-eyed sand/crab spiders

Members of the genus *Sicarius* are medium-sized spiders with a body length up to 0.6 inches (15 mm), and the width across the legs is about 2 inches (50 mm). Most species are reddish-brown to yellow in color without any distinct patterns. They often camouflage themselves with sand particles wedged between body hairs in order to blend into the background of their specific habitat. These spiders are shy and secretive, but they will bite when accidentally contacted.

Figure 21. Six-eyed sand spider (*Siciarius* sp.), South Africa. Photo: Genevieve.

Figure 22. Six-eyed sand spider (*Siciarius* sp.), South Africa. Photo: Museums of Cape Town.

There are 22 known species in the genus *Sicarius* which are broadly distributed in Zimbabwe, South Africa, Central and South America, and the Galapagos Islands. They are arguably the most venomous group of spiders in southern Africa. Six-eyed sand spiders have a virulent cytotoxic poison capable of destroying tissue around the site of the bite and throughout the body, causing massive internal bleeding. Tissue damage from a bite can be extensive and severe, but bites to humans are not well documented. However, under experimental conditions, rabbits envenomated with *Sicarius* venom died within 4-6 hours and autopsies revealed extensive damage to subdermal tissue and skeletal muscle. Also, there was swelling of the liver and damage to heart and kidney tissues as well as blocked arteries in the lungs. The severity of the damage depended on the amount of venom delivered by the spider, the health of the patient, or if the patient has allergies, the age of the patient and the site of the bite. Small children and the elderly appear to be the most adversely affected. Some patients display symptoms of stress. No antivenom is available.

Wandering spiders

The various common names applied to these South African spiders include wandering spider, lizard-eating spider and dwaalspinaekop. The most common species implicated in human bites is *Palystes natalius* of South Africa. This is the largest spider in the region and females reach up to 1.6 inches (40 mm) in length with the male being only slightly smaller than the female. They are the only spiders which might be confused with the baboon spiders (Family Theraphosidae), but they can be distinguished from baboon spiders in having the eyes arranged

in two sets of four rather than clustered in single, small clump. Other distinguishing characteristics of *P. natalius* include having a brownish-gray colored body while the ventral surfaces of the legs are bright yellow with transverse black bands, and a reddish oral region. These free-living spiders are often found running on the walls of houses. *Palystes natalius* is medically important because its venom causes convulsions and death in guinea pigs under experimental conditions. However, some researchers have argued that the guinea pigs died from shock from being pierced by the spider's large chelicerae, and not from the venom. In one human case, the bite from this species produced a burning pain at the site of the bite accompanied by slight swelling, which persisted for few days.

Figure 23. Wandering spider (*Palystes natalius*), South Africa. Photo: Museums of Cape Town.

White-tailed spiders

The bite of white-tailed spider (*Lampona cylindrata*, *Lampona murina*) of Australia reportedly can cause a burning pain followed by swelling and itching. Whether or not there may be formation of necrotic lesions similar to those of the brown recluse is an area of active scientific debate, however. Although necrosis has been recorded for white-tailed spider bites, some suspect the necrosis actually stems from contamination of the bite wound with bacteria (*Mycobacterium ulcerans*) carried on the fangs of the spider. However, such necrosis is rarely reported. White-tailed spiders can grow to 0.8 inch (20 mm) in length, and they typically inhabit cool, outdoor locations such as under bark, rocks and leaf litter, and in houses. They are widely distributed in Australia and Tasmania.

Figure 24. White tail spider (*Lampona cylindrata*), Australia. Photo: source unknown.

Yellow Sac spiders

More than 200 species of yellow sac spiders in the genus *Cheiracanthium* are distributed worldwide. Some of the known dangerous species of *Cheiracanthium* are shown in Appendix 1. These spiders are relatively small (0.4 inch or 10 mm, body length), and yellowish in color. Sac spiders construct sack-like, silken tubes in foliage or under bark or stones in which they hide. Although fairly reclusive in nature, sac spiders will occasionally enter houses and other structures. Yellow sac spiders are aggressive and will bite defensively. The clinical significance of these spiders is not well known, but they have been shown capable of causing a painful bite with associated necrosis and occasionally systemic effects. However, several species of *Cheiracanthum* have been implicated in human envenomations, and they reportedly are responsible for upwards of 90% of all dangerous spider bites in South Africa.

The number of species of yellow sac spiders which can inflict dangerous bites is not known, but because some species are considered dangerous, all sac spiders should be considered a potential threat. Many reported “brown recluse” bites outside the known range of *Loxosceles reclusa* in the United States may be due to envenomation by yellow sac spiders or perhaps other spiders. In the United States *C. inclusum* is native while *C. mildei* is introduced. *Cheiracanthium mildei* was first identified as a cause of necrotic arachnidism in 1970, when it was linked with skin lesions in the Boston, Massachusetts area where it is the most common spider found in houses. This species also is common in houses in New York City, and may well be the cause of "brown recluse” bites rumors mistakenly reported from that area. In the late 1970's and early 1980's *C. mildei* produced a significant number of bites in the Provo, Utah area. Similarly, *C. inclusum* is reportedly responsible for bites in Georgia and southwestern Canada. Bites by *C. inclusum* are

probably far more common and widespread than reported, and it is likely that more reports will surface as yellow sac spiders become better known as clinically significant species.

Figure 25. Yellow sac spider (*Cheiracanthium sp.*). Photo: Darwin Vest.

Figure 26. Hobo spider (*Cheiracanthium mildei*). Photo: Jeff Barnes.

Figure 27. Hobo spider (*Cheiracanthium mildei*) showing the eyes. Photo: Peter DeVries.

The bites of yellow sac spiders are not life threatening, but they can result in substantial necrosis due to their cytotoxic venom. Bites are generally characterized as producing instant, intense stinging pain, similar to that of the sting of a wasp or hornet. Following the initial sting there may be localized redness, swelling and itching; and eventual formation of a necrotic lesion. Healing of the necrotic lesions typically is complete within eight weeks. Systemic effects are usually not severe, but may include chills, fever, headache, dizziness, nausea, loss of appetite, and sometimes shock. Treatment of the local lesion should follow the same protocols as outlined for the hobo and brown recluse spiders. Corticosteroid therapy may be beneficial when systemic effects are present.

Other potentially dangerous spiders

Other spiders that have been implicated in arachnidism include *Argiope* spp. (garden spiders), of which representatives can be found worldwide, and *Phidippus* spp. (jumping spiders) found primarily in the Western Hemisphere. However, the responses to the necrotic envenomations from these species are generally mild, although victims may exhibit localized distress. Similarly, some species of *Lycosa* (wolf spiders) distributed in the Western Hemisphere have cyanotic venom that may produce localized necrosis. Most envenomations by wolf spiders involve intense pain and reddening at the bite site, with variable amounts of swelling. In some instances there is bleeding at the puncture sites because of the powerful jaws of these spiders. The bites of

one South American species, *Lycosa raptoria*, have been shown to produce necrotic lesions, and victims may experience swollen lymph vessels around the bite area with eventual eschar formation and sloughing of the wound.

Figure 28. Garden spider (*Argiope* sp.), North America. Photo: Jeff Barnes.

Figure 29. Jumping spider (*Phidippus* sp.), Thailand. Photo: John Moore.

Figure 30. Wolf spider (*Lycosa avida*). Source uknown.

Other spiders from different regions of the world may also produce mild arachnidism, but such cases are seldom reported and are not generally considered medically significant. Treatment for these milder cases of necrosis should include immobilization and elevation of the bitten area, cold compresses, analgesics, tetanus boosters, and systemic antibiotics for secondary infections.

Tarantulas

Though widely feared, tarantulas (Family Theraphosidae) are not particularly dangerous to people. Bites from their long, needle-like fangs, can be quite painful, and the setae shed from their bodies can be a painful urticarial irritant when introduced into the eyes or mucous membranes. However, their venom produces a reaction comparable in physical character to that of bees and wasps. Localized reactions for a tarantula bite can be treated with topical corticosteroids, systemic antihistamines, and cold compresses.

Figure 31. Tarantula. Photo: David Bowles & Mark Pomerinke.

Scorpions

Scorpions (Order Scorpiones) are a largely nocturnal, secretive group of animals widely distributed in tropical, subtropical, and desert habitats worldwide generally located south of 45^{o}N latitude. Although all scorpions are venomous, only a few of the over 1000 known species are dangerous to humans. The stings of most species are similar to that of a bee or wasp. Most scorpions are not aggressive and stinging incidences usually occur only accidentally. However, scorpions stings remain a serious public health menace in many areas of the world. For example, approximately 200,000 people are stung by scorpions yearly in Mexico with 700-800 deaths. In Tunisia, data collected from 1986 to 1992 showed 30,000-45,000 cases per year of people stung by scorpions, and the number of deaths varied from 35 to 105 per year, largely among children. Some medically important scorpions and their geographic distributions are shown in Appendix 1.

Figure 32. Stinger of *Parabuthtus granulatus*. Photo: Museums of Cape Town.

Dangerous Scorpions

Most potentially lethal scorpions belong to the Family Buthidae which primarily is distributed in Africa and Southeast Asia. However, all scorpion stings, regardless of geographic location should be treated as potentially dangerous unless the scorpion can be positively identified. For example, several species of *Centruroides* distributed from Mexico southward in the Americas have stings with serious medical consequences but other species in this genus only produce painful encounters. Among the most dangerous scorpions in the world are *Centroides sufussus* in Mexico, *Tityus serrulatus* in Brazil, and the infamous yellow scorpion of the Middle East, *Leiurus quinquestriatus*. Of the 86 species of scorpions known from India, only two species

*Mesobuthus tamulus***,** the common red scorpion, and *Palamneits swammerdami*, are potentially lethal. Indeed, the common red scorpion has killed many people with a historic mortality rate around 30%. In the western Cape of Africa, *Parabuthus granulatus* is the most important venomous species while *Androctonus australis* and *Buthus occitanus* in northern Africa are regularly implicated in stinging humans with serious consequences. *Opistophthalmus glabrifrons*, Family Scorpionidae, is widespread in southern Africa, and is able to produce a variety of dangerous systemic symptoms, but no deaths have yet been attributed to this species. *Androctonus crassicauda* and *Buthus occitanus* generally are considered to be the two most dangerous scorpions in Jordan. Similarly, *A. crassicauda* is the second most frequent source of scorpion sting in southwest Iran where it is considered to be a significant social hazard. This species is responsible for many deaths annually, mostly among children. Of 2,534 patients in one study in southwest Iran, three scorpion species accounted for nearly all of the stings, i.e., *Androctonus crassicauda* (41%) and *Mesobuthus eupeus* (45%) (Family Buthidae), and *Hemiscorpion lepturus* (13%) (Family Scorpionidae). In the United States, the only scorpion capable of inflicting a fatal sting is *Centruroides exilicauda* (=*C. sculpturatus, C. gertschi*) which is distributed in Arizona, California, Utah, and western Mexico. However, no deaths in the United States have been attributed to this species since 1968.

Figure 33. *Androctonus crassicauda*, Middle East. Photo: Al Sirhan.

Figure 34. *Buthus occitanus*, Middle East. Photo: Danne Rydgren.

Figure 35. *Centruroides exilcauda*, North America. Photo: Kelly Swift.

Figure 36. *Hottentotta jayakari*, Middle East. Photo: Eric Ythier.

Figure 37. Yellow scorpion, (*Leiurus quinquestriatus*), Middle East. Photo: W. Wüster.

Figure 38. *Mesobuthus eupeus*, Middle East. Photo: G. Witt.

Figure 39. Red scorpion (*Mesobuthus tamulus*), India. Photo: Eric Ythier.

Figure 40. Thick-clawed scorpion (*Opisophthalmus glabifrons*), South Africa. Photo: R. David Gabon.

Figure 41. *Parabuthus transvaalicus*, South Africa. Photo: Kelly Swift.

Figure 42. *Tityus stigmurus*. Photo: W. Wüster.

Most dangerously venomous scorpions have long and slender pedipalps ("claws") in comparison to those of less venomous species which tend to have more robust pedipalps. This has led to the simple, although not universal, rule that scorpions with thin claws and thick tails tend to be more venomous than those with stout pedipalps and thinner tails. The toxicity of the venom is therefore associated with the ability of the scorpion to subdue prey with the pedipalps. In southern Africa, thick clawed scorpions belonging to the families Scorpionidae, Bothriuridae and Ischnuridae, and are generally assumed to be harmless. However, *0pistophtalmus glabrifrons* is an exception to the rule. *Opistophthalmus* species are burrowing scorpions, and probably never leave their burrows except when coming out to mate. This probably accounts for the timing and relative rarity of their stings.

Figure 43. Stripped bark scorpion (*Centruroides vittatus*), North America. Photo: University of Missouri.

Figure 44. *Euscorpius italicus*, Europe. Photo: James Cokendolpher.

Figure 45. Giant hairy scorpion (*Hadrurus arizonensis*), North America. Photo: Liberty Haven Ranch.

Effects of scorpion venom

The effects of scorpion venom on people are highly variable with severity ranging from localized, self-resolving pain to death. For all scorpion stings, every effort should be made to establish the species responsible because the relative seriousness of envenomation is species dependent and varies widely. Additionally, the response to scorpion envenomation may vary with the general health and age of the victim, their physiology and genetics, and emotional condition. Further variability may be attributed to the site and depth of sting penetration, quantity of the injected venom, and the proportion of the venom reaching the circulatory system. The severity of complications often seen in children likely is due to the higher concentration of venom per unit volume of blood. Although individual play a key role in determining the reaction of stinging victims, other factors also may be involved.

Figure 46. Blister at the base of the big toe in an airman deployed to the Middle East approximately two days following a scorpion sting by an unidentified species. The victim suffered no affects other than the initial pain, swelling, and headache. Photo: James A. Swaby.

Scorpion venom contains both hemolytic and neurotoxic components of which the former produces the pain and swelling associated with stings. The local and systemic responses associated with envenomation often are quite different and variable. The venom of some species may produce severe swelling and discoloration at the site of the sting while that of other species causes pronounced swelling, inflammation and pain. Although the general initial response to a scorpion sting is immediate local burning pain, some species with potentially lethal venom often cause little initial pain and produce minimal or no swelling, inflammation, and discoloration. However, the sting site may become painful to the touch and have a "woody" feeling. Some patients develop dark blue skin patches usually surrounded by a red halo within the first hour

following a sting. These areas may gradually become hardened and inflamed followed by necrosis and subsequent sloughing of the skin. Large blisters may develop around the sting site, and extensive ulceration may follow. In cases of severe envenomation, the hemolytic components of venom can destroy red blood cells, disrupt the blood ability of blood to clot, and other cardiovascular complications can occur. Onset of acute kidney failure following scorpion envenomation can result within 24 hours to a few days following the sting and is sometimes typified by the presence of blood in the urine, and associated anemia and jaundice from destroyed blood cells. Some patients may require kidney dialysis. Although most patients have difficulty producing urine, other patients may start secreting abnormal amounts of urine between 6 and 21 days after a sting.

The neurotoxic fraction of the venom, depending on the species involved, can produce a broad range of dangerous and potentially fatal reactions when present in sufficient quantity. This fraction of the venom contains a variety of polypeptides that interfere with ionic balance and channel activity in the nervous system. The primary and initial effects are on the peripheral nervous system which causes intense pain, altered heart activity, and numbness. Other symptoms associated with the neurotoxic component of the venom include muscle twitching, crying, salivation, profuse sweating, respiratory distress, urinary urgency, nausea, paresthesia of the tongue, restlessness, stiffness of the joints, convulsions, and increased muscle activity around the eyes. For the stings of some species, pain can be negligible initially, but patients may seek medical treatment hours to days later when they have already developed swelling and inflammation with gradually increasing local pain. Another common response in children is an extreme form of restlessness characterized by excessive neuromuscular activity (jerking and spasms). Typically, blood pressure, body temperature, and tendon reflexes often increase while

motor skills become impaired. Other striking features include the inability to write or manipulate small objects, difficulty articulating speech, and varying degrees of loss of pharyngeal reflexes. Heightened sensitivity to touch, cold or heat, muscle pain and cramps also occur in many patients. Systemic symptoms and signs usually develop within 4 hours of the sting, and anaphylaxis and death from cardiac or respiratory failure can occur within 24 hours. However, despite the seriousness of such symptoms in victims, death from scorpion stings has become less common due to the availability of antivenom in some areas where highly venomous species occur. Recovery often is complicated by varying degrees of respiratory dysfunction which tend to be more serious in children.

Treatment of envenomation by scorpions

Scorpion stings should always be treated as a medical emergency that requires treatment as soon as possible, especially when young children are concerned. Victims of scorpion sting, particularly if known dangerous species are involved, should be closely observed for at least 24 hours. Children and other high-risk patients should be hospitalized. Treatments for scorpion envenomation may range from using only a cold compress or ice on the sting site to administration of antivenom. Local pain can safely be relieved with a local anesthetic (*e.g.*, xylocain or ice pack), and physician prescribed medications such as barbiturates, diazepam and atropine can be used for cases involving neurological symptoms. However, some analgesics like morphine, demerol, codein or other morphine derivatives, or paraldehyde, valium and thorazine may increase the toxicity of venom as much as seven times and should be administered cautiously. Corticosteroids, adequate hydration, blood transfusion and diuretics may help in management of severe cases. All patients with symptoms and signs of systemic envenomation

should receive antivenom if available. The success of antivenom therapy depends on the conditions of the antivenom application (dose, route and time of injection after envenomation, etc.) and/or on the quality of antivenom. Serotherapy is more efficient when given as soon as possible after envenomation and with adequate quantities of antivenom. Surgical excision of the sting site may prevent harmful or fatal consequences in some patients.

Because the range of severity of envenomation is so variable among scorpions, the relative threat for a particular region should be assessed prior to deployment to that location to determine the requirement for obtaining appropriate antivenoms.

Mites

Chiggers or harvest mites

Chiggers are larval mites belonging to the family Trombiculidae. They are obligate ectoparasites on mammalian host before molting to the nymph and adult stages. Adults and nymphs are free-living and eat small invertebrates and their eggs, and organic matter. The microscopic larval stage cannot be seen without magnification, but the bright red, eight-legged adult, or harvest mite, is readily visible with the unaided eye. Chiggers occur in overgrown brush or grassy areas, especially where small rodents are abundant. Females lay eggs on the ground in groups of several hundred, and the resulting clumps of larval mites that hatch from these eggs can result in severe infestations of their hosts. Chiggers produce one generation each year, and they are most abundant during late summer and early autumn.

Larval chiggers actively crawl to the tips of vegetation such as grasses and wait for a host to pass. Various rodents and other small mammals are the normal hosts of chiggers, but unwary humans become hosts when they venture into chigger habitat without personal protection. Once on the host, the larval chiggers move to an ideal feeding spot where they attach themselves tightly to the skin. Contrary to popular belief, chiggers do not burrow into the skin or suck blood. They pierce the skin (often around a hair follicle) to feed on lymph and dander and in the process they introduce digestive enzymes into the host tissues. The chiggers then begin to feed on the liquefied host tissues. Subsequently, and usually after the chigger has left the host, the sourronding tissues to become inflamed and each bite has a characteristic red welt with a white, hard central area. The rash and intense itching associated with chiggers therefore is an allergic reaction to the mite's salivary secretions. Secondary infections ma result from scratching the bite site. After becoming fully fed, the chigger drops from its host, goes into the ground and enters a quiescent stage. In the fall of the year, it becomes a bright red adult that overwinters in that stage.

Two genera of chigger mites, each containing many species, are of concern to deployed military forces. They are *Eutrombicula* and *Leptotrombidium*. Chiggers in the genus *Eutrombicula* do not transmit any known pathogens to people, but they can cause irritating bites, dermatitis and severe itching when they feed on the unsuspecting host. They are widely distributed in the Western Hemisphere, and Europe. By comparison chiggers in the genus *Leptotrombidium* are the vectors of scrub typhus throughout Asia and portions of Australia. The bite of *Leptotrombidium* often does not itch, or at least not as intensely, as those of *Eutrombicula*. Also, a black necrotic lesion known as an eschar develops where the chigger fed.

Figure 47. Chigger (*Eutrombicula* sp.), North America. Photo: Richard C. Russell.

Figure 48. *Leptotrombidium deliense*, Asia. Drawing: D. S. Kettle.

Figure 49. *L. orientale*, Asia. Photo: Tai Soon Yong.

Figure 50. *L. scutellare*, Asia. Photo: Infectious Diseases Surveillance Center, Japan.

Figure 51. Eschar at the site of a Leptotrombidium bite. Photo: Richard C. Russell.

Itching associated with chigger bites can be alleviated through use of over-the-counter topical corticosteroids and antihistamines. Hot showers/baths also will help reduce itching. In cases of severe dermatitis associated with chigger bites, a physician should be consulted for appropriate treatment options.

Scabies mites

Scabies mites (*Sarcoptes scabei*) are obligate parasites of humans that feed on skin. All life stages, exclusive of the eggs, are parasitic. The mites are tiny (0.01 inch, or <0.4 mm), but they have a rapid life cycle of 14 days or less. Mites are spread from person to person through direct contact or exchange of infested clothing. Positive identification is done through skin scrapings and microscopic identification.

Figure 52. Scabies mite (*Sarcoptes scabei*). Illustration: D. S. Kettle.

Scabies mites produce two general types of lesions on the host including burrows and reddened rash-like lesions. The burrows can be either intact or excoriated (open to the surface) and are created by the female mite as she tunnels into human skin while laying eggs in the process. The intact burrows appear as distinct raised, linear, and reddened marks, and those that are excoriated can become secondarily infected resulting in the formation of pustules and encrustations. Although infestations on a person may be widespread most are found on the extremities such as hands, wrists, elbows, armpits, breasts, and genitalia. The reddened rash-like skin lesions are most commonly found on the trunk while the burrows may be more generally distributed on the patient. Secondary infections may result from scratching the bite site.

Figure 53. Rash in patient caused by bites from scabies mites. Photo: Seattle STD-HOV Prevention Training Center, University of Washington.

Patients infested with scabies can be successfully treated with any of a variety of prescribed topical chemical treatments that most commonly include permethrin as an active ingredient. However, itching may still occur for several weeks following successful treatments which can be minimized with use of topical corticosteroids and systemic antihistamines. Bed linens recently used by scabies patients should be washed in hot water to reduce the chance of reinfestation.

Other medically important mites that bite people

Several other types of mites are occasionally known to attack humans, but such attacks are relatively rare in comparison to chiggers and scabies mites. Unlike the chigger or scabies mites, these mites feed on the host's blood, and the initial bites are usually painful. They include the chicken mite (*Dermanyssus gallinae*), spiny rat mite (*Laelaps echidninus*), house mouse mite

(*Liponyssides sanquineus*), tropical rat mite (*Ornithonyssus bacoti*), tropical fowl mite (*Ornithonyssus bursa*), northern fowl mite (*Ornithonyssus sylviarum*), and straw itch mite (*Pyemotes tritici*). Their natural hosts include various rodents and birds. Exposure to these mites often is occupationally related and attacks are self-limiting when the victim is no longer exposed to the source of the mites. They do not attach to the host for long periods, but rather they only attach long enough to take a blood-meal.

Figure 54. Tropical fowl mite (*Ornithonyssus bursa*). Photo: Richard C. Russell.

Figure 55. Spiny rat mite (*Laelaps echidnina*). Drawing: Australia, CISRO.

Figure 56. Straw itch mite (*Pyemotes tritici*). Photo: USDA-ARS.

Figure 57. Straw itch mite bites. Photo: source unknown.

The house mouse mite is medically important because it is the vector of rickettsial pox (*Rickettsia akari)* in humans. It is distributed worldwide and it normally inhabits the nests of rodents. However, in the absence of rodents, or when rodent populations are very large, these mites will attack people. In habitats where rodents have been killed, the mites will leave their dead hosts, congregate around heat soures, such as hot pipes and stoves and seek alternative food sources, including people. Similarly, the tropical rat mite occasionally feeds on humans causing painful bites, but this species is not known to transmit any diseases to humans. This species has a much wider distribution than the tropics and it has also is known from temperate regions. The spiny rat mite commonly parasitizes Norway rats and roof rats. Although the spiny rat mite also will bite people in the absence of their natural hosts, this species is not a known vector of disease pathogens that can affect people.

Reactions from the bites of these various mites can be either localized or widespread depending on the number of bites inflicted. The resulting reactions are produced through a combination of allergic sensitization and toxins secreted by the mites during feeding. Skin lesions generally appear as a reddish papule with a central hemorrhagic area around the puncture wound, or occasionally a fluid-filled vesicle occurs. Often these lesions itch intensely, and become crusted and secondarily infected. Treatment typically includes use of topical corticosteroid and anti-pruritic (itching) ointments.

Dust Mites

There are two common dust mites of concern to human health, the American house dust mite (*Dermatophagoides farinae*) and the European house dust mite (*D. pteronyssinus*). Both mites are likely distributed worldwide. Due to their microscopic size (<300 µm, or <0.01 inch in length) and translucent bodies, dust mites are not visible to the naked eye. They live in bedding materials, furniture, carpet, stuffed toys and old clothing.

Figure 58. European house dust mite (*Dermatophagoides pteronyssinus*). Illustration: D. S. Kettle.

Figure 59. American house dust mites (*Dermatophagoides farinae*). Photo: USDA.

Dust mites feed on the dead skin (dander) from the bodies of people and animals and other organic material. Some people experience allergic reactions from exposure to dust mites and their fecal pellets. Symptoms are usually respiratory in nature and include sneezing, itching, watery eyes, wheezing. Occasionally a red rash develops, especially around the neck. Other allergic reactions may include headaches, fatigue and depression. Some studies have suggested that dust mites may be a key factor in 50 to 80 % of asthma cases. The heaviest infestations of

house mites typically occur in beds and a mattress that may serve as home to millions of mites. Carpeting and upholstery also can support large mite populations. Dust mites thrive in warm, moist surroundings where relative humidity is above 50%.

Because complete control of dust mites in houses is not possible, reducing their populations and associated allergins through source reduction and humidity control are the most practical management approaches. Effective control of mites requires maintenance of relative humidity below 50% which can be achieved with a dehumidifer. Use of HEPA filters on air conditioner or heater vents is not considered to be practical or necessary, and may actually aggravate mite problems because the small holes of the filters will force air out of vents at a higher velocity, stirring up more dust than if filters were not used. Chemical control is not necessary, nor will it have a lasting effect on dust mite populations. For people who are extremely sensitive to dust mites, several control measures, consisting primarily of sanitation, can be taken to reduce dust mite populations. Control measures may include frequently vacuuming carpets and other surfaces that collect dust and disposing of the dust bag immediately after use. Alternately, carpeting in homes can be removed and replaced with tile or wooden floors. Bedding materials, including pillow cases, sheets, blankets and mattress pads should be washed every other week in hot water (130 °F or 54 ^{o}C), or enclose mattresses, box springs and pillows in zippered allergen- and dust-proof covers. Eliminating or reducing fabric wall hangings such as tapestries or pennants, and covering or replacing upholstered furniture also is beneficial.

Flour and Grain mites

Grain or flour mites (*Acarus siro*) are important pests of a wide variety of grains and dried fruit and vegetables including human food and animal feed products. Flour or grain mites are tiny (<0.03 inch or 0.76 mm) pale, soft-bodied, pearly or grayish-white, with legs varying in color

from pale yellow to reddish-brown. Each leg has one claw at the end. The males have enlarged forelegs which bear a thick spine on the bottom side. These two characters can be used to separate *Acarus* from other mite genera. Grain mites are widely distributed throughout temperate regions worldwide, and they are less common in tropical areas. These mites do not feed on people, but they are the cause of an itchy rash known as "grocer's itch" and related allergic reactions in sensitive individuals exposed to their setae and spines. Grain mites thrive under high moisture conditions and are often found in conjunction with fungal growth. Severe infestations by these mites can result in brownish tinge over grain products known as "mite dust". When the mites are crushed during handling, they give off a "minty" odor.

Figure 60. Grain mite (*Acarus siro*). Photo: source unknown.

Ticks

Ticks are grouped into two families: the Ixodidae or hard ticks, and the Argasidae or soft ticks. Hard ticks are responsible for transmitting the majority of tickborne diseases to humans while soft ticks are the primary vector of relapsing fever. Some of the more common and medically important ticks and their general distributions are shown in Appendix 1. In addition to transmitting disease agents, certain hard ticks may cause tick paralysis in people and other animal hosts they feed on. Tick paralysis at onset involves leg weakness and dysfunction, but it eventually can progress to complete paralysis of the extremities and respiratory failure. Recovery is usually quick once the tick is removed. General reactions associated with tick bites can include swelling, erythema, parathesia, blistering, itching, discoloration and hardening of the skin, necrosis, and nodule formation usually resulting from the mouthparts remaining in the host following removal of the tick. Secondary infections and localized gangrene can occur if the bite wound is not disinfected. Although uncommon, systemic symptoms can include nausea,

vomiting, diarrhea, irregular pulse, shortness of breath, fever, gastrointestinal irregularities, restlessness, muscular weakness, drooping eyelids, sensitivity to light, delirium, hallucinations, and generalized pain. However, many of these latter symptoms can overlap with those of various tick-borne disease and tick paralysis making it difficult to determine their true source. Another unusual condition associated with tick bites is tick-bite alopecia or the loss of hair around the bite wound with associated mild necrosis. This condition apparently stems from a reaction of the victim to toxins in the tick saliva. The patches of lost hair may be as large as 2 inches (50 mm) in diameter and scarring from the necrosis. Tick-bite alopecia is self-limiting and hair regrowth is usually complete within about two months, but scarring may be long-term.

Figure 61. Relapsing fever tick (*Ornithodoros hermsi*). Photo: University of Georgia, College of Veterinary Medicine.

Figure 62. Lone star tick (*Amblyomma americanum*). Photo: Mat Pound.

Figure 63. Bont tick (*Amblyomma hebraeum*). Photo: Mat Pound.

Figure 64. Rocky Mountain wood tick (*Dermacentor andersoni*). Photo: Mat Pound.

Figure 65. American dog tick (*Derrmacentor variablis*). Photo: Mat Pound.

Figure 66. Australian paralysis tick (*Ixodes holocyclus*), female. Photo: Stephen L. Doggett.

Figure 67. Australian paralysis tick (*Ixodes holocyclus*), male. Photo: Stephen L. Doggett.

Figure 68. Black-legged tick (*Ixodes scapularis*). Photo: Scott Bauer.

Figure 69. Brown dog tick (*Rhipicephalus sanguineus*): Photo: Mat Pound.

The best means of avoiding tick bites is situational awareness and avoidance. However, when ticks are found on the body they should be removed properly and as soon as possible. The

longer a tick remains attached, the more engorged and difficult it becomes to remove, and the more likely it may transmit a disease agent. Ticks can also shed pathogens in their feces, and cuts or abrasions can become contaminated if handled with bare fingers. Pathogens in tick feces can also be introduced through the mucus membranes of the nose or eyes.

There are several inappropriate ways of removing attached ticks including covering them with vaseline, applying fingernail polish or similar chemicals, burning them off with fire or matches, and detaching them with various commercial "gadgets." However, such methods may actually do more harm than good, generally do not work as intended, and therefore should not be used. The most appropriate method for removing an attached tick is to: 1) place the tips of medium-tipped forceps around the area where the mouthparts enter the skin; 2) with steady slow motion, pull the tick away from the skin or slide the removal device along the skin; 3) do not jerk, crush, squeeze or puncture the tick; 4) after removal, place the tick directly into a sealable container. Disinfect the area around the bite site using standard procedures. If possible, keep the tick alive for identification and pathogen testing. Place it in a labeled (date, patient), sealed bag or vial with a lightly moistened paper towel then store at refrigerator temperature. If forceps are unavailable and the fingers must be used to remove the tick, contamination of the skin can be avoided by using rubber gloves, plastic, or a paper towel.

Figure 70. Proper procedure for removing an attached tick. Drawing: USAF School of Aerospace Medicine.

Camel Spiders

Camel Spiders (Order Solifugae) are more properly known as wind scorpions, sunscorpions, or sunspiders. They are not spiders or scorpions, but a distinct arachnid group consisting of several

hundred species distributed in tropical and desert regions worldwide. They are primarily nocturnal creatures that hide in animal burrows, and under rocks and other objects. Although windscorpions lack venom glands, their powerful jaws are capable of inflicting painful bites. Reports of camel spiders chasing people, are simply a result of their seeking shade from the sun—as the person moves to avoid the camel spider, it follows them in an effort to stay in the shade thus giving the impression of being chased. Tales of their ferocity and gargantuan sizes are greatly exaggerated. They do not attack or prey on large mammals, and they feed on a variety of other invertebrates. Situational awareness and avoidance are the keys to avoiding camel spiders.

Figure 71. Camel spider. Photo: Australian Air Force.

Insects

Collembola

Collembola, or springtails, generally are free-living, primitive insects that feed on organic debris or decaying matter. However, some species belonging to the families Isotomidae and Entomobryidae have been found in skin scrapings of patients whose symptoms originally were attributed to lice or scabies. In some instances, these patients were initially thought to be suffering from delusory parasitosis. Collembola are not considered to be parasitic and their association with human skin may be due to its high moisture content and/or the association of dead tissue, fungal infections, or pollen. Therefore, patients who complain their "skin is crawling" may not be delusional and they should be referred to a dermatologist for skin scrapings to rule out the occurrence of collembolans.

Figure 72. Examples of different types of Collembola. Photo: John R. Meyer.

Human lice

Lice in the families Pediclulidae and Pthiridae (Order Phthiraptera) are exclusive and obligate parasites of humans that are distributed worldwide wherever people live. Lice are wingless, variously colored (usually gray, brown or black), equipped with prominent tarsal claws, and they range in size from about 0.09-0.13 inch (2.5 to 3.5 mm). The eggs of lice, or nits, are cemented to hairs in the case of head and pubic lice, and seams of clothing or bedding materials for body lice. Nits hatch in only a few days and this allows lice populations to grow rapidly. People infested with lice may experience itching, and develop reddened patches of skin, lesions and wheals, and severe itching. Secondary infections may result from scratching of the bite sites. Successful treatment of lice infestations must include both killing and/or removal of both the lice and their nits. Body lice are always a threat when large numbers of people are crowded in unisanitary living conditions such as after disasters and refugee camps. Under these conditions, lice will spread rapidly from infested to uninfested people and, if epidemic typhus is introduced, there is potential for an explosive epidemic of this deadly disease.

Head Louse (*Pediculus humanus capitis*)- Any human can become infested with head lice, particularly refugees, prisoners of war, concentration camp detainees, and others in poor socio-economic or stressful situations. However, infestations are most common among children regardless of socioeconomic condition. Head lice can be controlled using any of various chemical (pesticide) treatments, and through the use of louse (nit) combs. Permethrin-based shampoo is a safe and effective choice for controlling head lice. Head lice are secondary vectors of epidemic typhus although their role in the transmission cycle of this disease is not considered to be significant.

Figure 73. Head louse (*Pediculus humanus capitis*). Photo: J. Kalisch.

Figure 74. Head lice and comb. Photo: source unknown.

Body Louse (*Pediculus humanus humanus*)- body lice live and lay eggs in the seams of clothing or bedding material, and they normally only contact human skin when they feed. These lice often infest people such as refugees, prisoners of war, concentration camp detainees, vagrants, and other individuals with poor hygiene. Washing clothing and bedding materials in hot water with detergent, and rigorous personal hygiene can control body lice infestations. However, heavy infestations, particularly among refugees, detainees, and prisoners of war, may require use of insecticides. Body lice are the primary vectors of epidemic typhus, louse-borne relapsing fever, and trench fever.

Figure 75. Body louse (*Pediculus humanus humanus*). Photo: James L. Castner.

Figure 76. Bites on a patient from body lice. Photo: Department of Dermatology, University of Iowa.

Pubic Louse (*Pthirus pubis*)- Also known as crab lice, pubic lice primarily infest pubic hair, but they also may occur in other hairy areas such as beards, eyelashes, and eyebrows. Infestations result primarily through sexual contact with infested individuals. Pubic lice are controlled with any of a variety of chemical (pesticide) treatments. Permethrin-based topical ointments represent a safe and effective means for controlling pubic lice. In addition, clothing and bedding materials of infested individuals can be washed in hot water with detergent. Pubic lice are not known to transmit any diseases to humans, although their presence may cause psychological distress.

Figure 77. Pubic louse (*Pthirus pubis*). Photo: source unknown.

Cockroaches

Cockroaches are not medical pests in the strictest sense, but some domestic species can mechanically transmit bacteria and viruses to food products and food preparation surfaces. Some people may develop allergic reactions from contacting the feces and body parts of cockroaches, but such reactions are uncommon unless the exposure is frequent and cockroach populations are high. Other people may experience psychological distress at the sight of cockroaches resulting in lowered morale. However, the presence of cockroaches normally does not present a threat to people. Of the several thousand described species of cockroaches in the world, only a few are considered to be serious pests and they are closely associated with human habitation. All of these nuisance species have been widely introduced throughout the world. The primary pest cockroaches worldwide include the German cockroach (*Blattella germanica*), brown-banded cockroach (*Supella longipalpa*), smoky brown cockroach (*Periplaneta fuliginosa*), Asian cockroach (*Blatella asahinae*), and Oriental cockroach (*Blatta orientalis*). The American cockroach (*Periplaneta americana*) can be a pest in the southern United States and Mexico, but it tends to be more of an incidental entrant to homes rather than a true pest. Other cockroach species may occasionally enter houses, but they are not considered to be significant pests.

Figure 78. Oriental cockroach (*Blatta orientalis*), male. Photo: University of Michigan.

Figure 79. Oriental cockroach (*Blatta orientalis*), female. Photo: University of Michigan.

Figure 80. German cockroach (*Blattella germanica*). Photo: James L. Castner.

Figure 81. Brown-banded cockroach (*Supella longipalpa*). Photo: Texas A&M University.

Figure 82. American cockroach (*Periplaneta americana*). Photo: Museums of Cape Town.

True bugs

Many true bugs (Order Hemiptera) are capable of inflicting painful bites with their piercing-sucking mouthparts, and some species are capable of transmitting potentially deadly parasitic diseases.

Assassin and kissing bugs- several members of this predatory family Reduviidae can inflict painful bites and others can transmit pathogens resulting in serious and potentially fatal human disease (i.e., Chagas' disease, or American trypanosomiasis). Kissing bugs (Subfamily Triatominae) usually bite for the purpose of taking a blood meal. This bite is relatively painless which allows them to feed on their hosts without disturbing them. However, they also can deliver a painful bite for defensive purposes. Most bites by kissing bugs occur at night when the victim is sleeping and the bites generally occur on the face. The bite wounds typically appear as lesions with purplish-colored puncture marks. Some individuals may develop localized urticarial reactions to the kissing bug saliva, and acute systemic reactions including swelling (usually unilateral and known commonly as Romana's sign), low blood pressure, itching, vomiting, headache, and abdominal cramping. Uterine bleeding in women also may occur.

Figure 83. Kissing bug (*Panstrongylus geniculatus*), Panama. Photo: David Bowles and Mark Pomerinke.

Figure 84. Kissing bug (*Rhodnius prolixus*), Brazil. Photo: Marcelo de Campos Pereira.

Figure 85. Kissing bug (*Triatoma* sp.), Texas. Photo: Texas A&M University.

Figure 86. Kissing bug (*Triatoma infestans*), Brazil. Photo: Marcelo de Campos Pereira.

Figure 87. Head of *Triatoma* infestans showing piercing-sucking beak. Photo: Marcelo de Campos Pereira.

Figure 88. Romana's sign. Photo: World Health Organization.

Although bites of kissing bugs normally are intentional for the purpose of feeding, the bites from the predatory assassin bugs (Subfamilies Harpactorinae, Reduviinae) are entirely defensive and usually received after accidentally contacting or handling these bugs. Assassin bug bites are extremely painful and the pain may last for a few hours. In general, initial pain often is followed by residual pain and numbness that can last for several days. The afflicted area often becomes reddened and hot to the touch, but later may become white and hardened at the puncture area. Subsequently, the hardened core of the wound may slough off, leaving a small hole at the puncture site. Healing time varies from about two weeks up to 6 months in some cases, especially in hypersensitive people. The most commonly recognized assassin bug in North America is the wheel bug, *Arilus cristatus,* but several closely related species of wheel bugs occur throughout Central and South America. Other species of assassin bugs are distributed worldwide. Among these is the masked hunter, *Reduvius personatus*, of North America which sometimes bites humans. Due to the red and black coloration of this species and a tendency for it to bite on the face, it is sometimes incorrectly identified as a kissing bug. Assassin bugs do not transmit any known diseases pathogens to humans. Treatment of bites from assassin bugs can include ice packs, topical corticosteroids, systemic antihistamines, and antibiotics for secondary infections.

Figure 89. Wheel bug (*Arilus cristatus*), Texas. Photo: David Bowles and Mark Pomerinke.

Figure 90. Wheel bug (*Arilus* sp.), Panama. Photo: David Bowles and Mark Pomerinke.

Figure 91. Masked hunter (*Reduvius personatus*). Photo: W. Müller.

Figure 92. Assassin bug (*Zelus bilobus*): Photo: Clemson University/USDA.

Treatment of kissing bug bites includes use of cool compresses and mild analgesics to relieve the itching. Occasionally, patients who are hypersensitive to kissing bug bites may develop severe

allergic reactions, which are treated like any other severe allergic reaction. For individuals who demonstrate sensitivity to bites, immunotherapy can be beneficial in the long term.

Bed bugs- Bed bugs (Family Cimicidae, *Cimex lectularius, Cimex hemipterus*) are associated with harborage such as mattresses and other bedding. In heavy infestations, they may hide behind picture frames, under carpet, behind wallpaper, and in cracks and crevices in walls of human dwellings. They may be found in some bird nests or associated with bats. Although the potential for contact with bed bugs is worldwide, they are most problematic in third world nations, the Middle East, eastern Europe, or in any location where poverty or poor living conditions occur. However, infestations of bed bugs are on the rise worldwide, and they are becoming increasingly common in the United States.

Bed bugs are small (≤6 mm, or 0.24 inch), oval, dorsoventrally flattened, and reddish-brown in color. All life stages of the bed bug, exclusive of the egg, are obligate bloodfeeders. Most bites occur at might while the victim is sleeping. Stages of reactions to feeding by bed bugs include 1) no reaction, 2) delayed reaction (several minutes), 3) immediate reaction and delayed reaction, 4) immediate reaction. The initial bite from their piercing-sucking mouthparts typically is painless and feeding lasts only a few minutes, but toxic saliva injected during feeding can cause development of an inflamed wheal that may itch intensely. Some individuals develop allergic reactions to the saliva injected into the host after repeated feedings, and this can result in dermatitis, localized inflammation, and formation of prominent wheals. Rarely, some individuals become hypersensitive to bed bug saliva and may develop asthma, urticaria, arthralgia, and anaphylaxis, but such responses usually cease when the victim is removed from

the source of bed bugs. Under normal circumstances itching associated with bed bug bites can be managed with the use of topical corticosteroids and systemic antihistamines. Bed bugs have not been shown to transmit any disease pathogens to people.

The occurrence of bed bugs in the lodging of deployed military members may be demoralizing for some individuals. For this reason, deployed military personnel are strongly encouraged to practice sound sanitation in their quarters, and spacing requirements of bunks and cots should adhere to appropriate military regulations.

Figure 93. Bed bug (*Cimex hemiterous*). Photo: Marcelo de Campos Pereira.

Figure 94. Bed bug (*Cimex lecturlaris*). Photo: Richard C. Russell.

Other biting Hemiptera

Several aquatic, predatory hemipterans can inflict painful bites if accidentally contacted or handled. These include the families Belostomatidae (giant water bugs), Corixidae (water boatmen), Naucoridae (creeping water bugs), and Notonectidae (backswimmers). All of these families have representatives distributed worldwide. Although their bites generally self-resolve without incident, the stinging and numbness they produce may last for several hours, especially those inflicted by the giant water bugs and creeping water bugs. Prevention of bites by aquatic Hemiptera is best accomplished through situational awareness and avoidance.

Figure 95. Giant water bug (*Belastoma* sp.). Photo: David Bowles and Mark Pomerinke.

Figure 96. Water boatman (Corixidae). Photo: North Carolina State University.

Figure 97. Creeping water bug (Naucoridae). Photo: North Carolina State University.

Figure 98. Backswimmer (Notonectidae). Photo: Martin H. Villet.

In desert environments where water resources are scarce, it is not uncommon for a variety of hemipterans, including plant feeding members of the family Miridae, to probe the skin of perspiring people in an attempt to obtain moisture resulting in a “pin-prick” irritation. Symptoms associated with these bites are self-resolving and treatment normally not necessary.

Ants, Wasps, and Bees

Ants, wasps and bees belong to the insect order Hymenoptera. Many members of this group are social and live in colonies exhibiting complex behavioral attributes. Hymenopterans having social or sub-social organizations are most often implicated in defensive attacks on people while those that live a solitary existence most often are not aggressive and primarily use their stingers for subduing prey. Among the social groups, certain females, who function as workers for the colony, have ovipositors modified into a stinging apparatus equipped with venom glands. Such stingers are for defensive purposes and they are capable of inflicting painful and potentially deadly reactions in their victims. The three families of Hymenoptera responsible for most stings in humans are the Vespidae (wasps, hornets, and yellow jackets), the Apidae (honey bees and bumble bees), and the Formicidae (ants). Wasps and ants can retract their stings after use and can sting repeatedly. Conversely, the stinging apparatus of honey bees is barbed allowing it to hold firmly in the victim’s skin. This causes the bee's abdomen to rupture when it tries to pull the stinger out of the skin. The bee's poison gland, which is attached to the stinger, continues injecting venom after separation.

Although not all hymenopteran venoms have been fully characterized, they generally contain complex mixtures of allergenic proteins and peptides as well as substances such as histamine and

norepinephrine that affect the ability of the blood vessel to relax and contract. There is no allergic cross-reactivity between honeybee and wasp venoms, although cross-reactivity may exist to some extent between different wasp venoms. Therefore, a person sensitized to the venom of one species of wasp potentially could have a reaction to the sting of another member of the vespid family.

Reactions to hymenopteran stings are grouped into three broad categories based on the response of the victim and they include: 1) immediate localized reaction or swelling, 2) systemic toxic response associated with multiple stings, and 3) systemic allergic reactions that may occur with as little as a single sting. Local reactions are non-allergic responses generally characterized by erythema, swelling, and transient pain at the sting site that subsides within a few hours. More substantial local reactions may involve an entire extremity and be characterized by painful swelling. Swelling of the airway, tongue and uvula also can occur. Systemic reactions vary from mild hives to more severe reactions such as vomiting, dizziness, confusion, rash, general weakness, shortness of breath and wheezing, and chest pain. Severe, potentially lethal reactions due to allergic responses are rare, but they can result in anaphylactic shock, difficulty in breathing, and death within 30 minutes. For these severe responses, rapid onset of symptoms is the rule and 50% of deaths occur within 30 minutes of the sting, and 75% occur within 4 hours. Therefore, immediate medical attention must be given when shock symptoms first occur following a sting. Reactions tend to be more severe the shorter the time interval since the previous sting.

Other, extremely rare, responses to hymenopteran stings known to occur include serum sickness, acute inflammation of the kidneys, and a neurological condition called Guillain-Barré syndrome. Stings in the mouth or throat also may require immediate medical assistance due to swelling that can close the airway. Multiple stings in a short period of time may cause systemic symptoms such as nausea, malaise and fever. Typically, it takes 500 or more honeybee stings to kill an adult human by the toxic effects of the venom alone.

A patient's reaction to a hymenopteran sting determines the treatment required, if any. Emergency health personnel should attempt to determine degree of reaction based on both patient history and a physical examination. People having previously experienced anaphylaxis from hymenopteran stings, should always carry an Epi-Pen, or similar instrument. Commercially available kits include antihistamine tablets and syringes preloaded with epinephrine. Sensitive individuals should also consider wearing a Medic-Alert tag to alert medical personnel of their allergy in case they lose consciousness. Venom immunotherapy for sensitive individuals will reduce but not eliminate the risk of anaphylactic reactions. Delayed reactions to Hymenoptera envenomation are uncommon but usually present as large local swellings or, rarely, systemic syndromes. The cause of delayed reactions is unclear and may not always involve immunologic mechanisms. Topical corticosteroids and analgesics and systemic antihistamines can be used to treat most hymenopteran stings, but anaphylaxis is a medical emergency requiring immediate medical intervention.

Individuals can practice a number of precautions to avoid stinging hymenopterans. For example, when outdoors avoid wearing brightly colored floral-pattern clothes, and do not go barefoot in fields where bees and wasps may be feeding at ground level. To the extent possible and

practical, scented sprays, perfumes, shampoos, suntan lotions, and soaps should be avoided when working outdoors. Additionally, caution should be exercised around rotting fruit, garbage cans, and littered picnic grounds, since large numbers of yellow jackets often feed in these areas. Foods and drinks, especially sodas and fresh fruits, and other sweets serve to attract bees and yellow jackets. Finally, bees, wasps and ants are most aggressive around their nests and they should not be disturbed.

Honey bees (*Apis mellifera*)- Honey bees are social insects that typically are non-aggressive and are managed for the benefit of people. Honey bees are not considered to be dangerous insects with the exception of attacks by swarms, and allergic reactions in some individuals in which a single sting can produce anaphylactic shock, and may result in death if not properly and rapidly treated (see the discussion on responses to envenomation presented above).

Because honey bee stingers remain in the skin of the victim following a sting, the detached stinger continues to respond to nervous impulses and venom continues to be delivered to the victim. For this reason, honeybee stingers, especially in multiple sting attacks, should be removed by the fastest means possible after the stings occur. It is best to use a hard, straight edged instrument or tool to scrape the stinger from the skin. The stinger should not be removed with the fingers because this pinching action may compress the venom glands which are still attached to the stinger thus forcing more venom into the wound. Although a knife blade or credit card or similar object make ideal instruments for removing stingers, the victim should no waste time looking for such devices, and the most readily available means of removing the stingers should be employed. Taking this immediate action will minimize the amount of venom entering

the victim. Similar objects, or even a fingernail, can be used to remove single stings as this minimizes squeezing additional venom into the wound. Systemic antihistamines and cold compresses can be used to treat stinging victims under normal conditions, but, for individuals who experience allergic reactions, the stings may require emergency medical treatment. Individuals with a history of allergic reactions to bee stings should carry Epi-pens, or similar devices, at all times when under field conditions.

Africanized bees, or killer bees, are a subspecies or genetic strain of honey bee that are more aggressive and will fiercely attack any perceived threat. Because Africanized bees are so aggressive, they can be extremely dangerous and victims may receive literally hundreds of stings if they are unable to flee. Victims can die from the toxic effects of such a large number of stings. The most appropriate response to an attack by Africanized bees is to run, if possible, through brushy or wooded areas because this breaks up their search image making it easier to elude them. Because Africanized bees will pursue a victim for substantial distances (up to 2 miles or 3 km), the victim should flee the attack until they can reach the safety of a house or other building, vehicle, or other closed space. Jumping into water for protection is not advised because the bees will stay in the area searching for their victim for up to an hour which is substantially longer than the average person can swim or hold their breath under water.

Figure 99. Honey bee (*Apis mellifera*). Photo: John Moore.

Figure 100. Honey bees on hive. Photo: Carl Dennis.

Figure 101. Swarm of honey bees. Photo: source unknown.

Bumble bees and carpenter bees- Although these bees are in different families, they strikingly similar in general appearance. Bumble bees (*Bombus* spp.) are social and may occur in colonies of 100-200 individuals, but colonies are usually much smaller in size. Normally passive, bumble bees will sting in defense of their nest. By comparison, carpenter bees (*Xylocopa* spp.) are solitary, but similar to bumble bee they will sting when provoked or contacted accidentally. Stings from these bees are painful and have similar reactions to other bee stings, including anaphylaxis. However, analphylaxis occurs with much less frequency than for honey bees.

Figure 102. Bumble bee (*Bombus* sp.). Photo: Robert G. Bellinger.

Figure 103. Carpenter bee (*Xylocopa virginica*). Photo: Jerry A. Payne.

Other bees

Many other species of bees from a variety of families are capable of stinging people. However, the stings from these non-aggressive, solitary bee species typically are only mildly painful (i.e., a "pinprick") and are of little consequence. Therefore, these groups are not addressed in detail here.

Figure 104. A solitary bee (Family Andrenidae), Thailand. Photo: John Moore.

Figure 105. A solitary bee (Family Andrenidae), Thailand. Photo: John Moore.

Figure 106. A solitary bee (Family unknown). Photo: John Moore.

Wasps and hornets

Although all true wasps have the ability to sting people, most are solitary and normally use their sting to kill or paralyze prey. However, paper wasps, yellow jackets and hornets (Family Vespidae) are social wasps that aggressively defend their nests when disturbed or threatened. Social wasps live in colonies of various sizes and their nests are constructed of "paper"

constructed from wood particles, foliage, and their saliva. Most are variously marked with black, yellow, reddish or whitish markings. Most notable among the vespids are the hornets (*Dolichovespula* spp., and *Vespa* spp.), yellow-jackets (*Vespula* spp.), and paper wasps (*Polistes* spp.). Social wasps construct their nests aerially, attached to tree limbs or sheltered areas such as roof gables (hornets, paper wasps), or in protected areas including underground spaces (yellow-jackets). Stings from these insects are painful and may cause localized swelling, but they rarely produce significant consequences such as anaphylactic reactions. However, they can sting multiple times because the stinger is not pulled from the abdomen upon stinging as is in honey bees. Stings can be treated with cold compresses or systemic antihistamines. Patients exhibiting actual or suspected systemic responses should seek immediate emergency medical attention.

Figure 107. Bald-faced hornet (*Dolichovespula maculata*), North America. Photo: R. Bercha.

Figure 108. Nest of bald-faced hornet. Photo: Jack DeAngelis.

Figure 109. Yellow-jacket (*Vespula* sp.), North America. Photo: Jack DeAngelis.

Figure 110. Yellow-jacket nest. Photo: Gerald J. Lenhard.

Figure 111. Yellow-jackets (*Vespula* sp.) feeding on an apple. Photo: Scott Camazine.

Figure 112. Paper wasp *(Polistes sp*.) guarding their nest. Photo: David Bowles.

Figure 113. European hornet (*Vespa crabo*), Europe. Photo: Jeff Barnes.

Figure 114. Asian hornet (*Vespula mandarainia* sp.), southeast Asia. Photo: John Moore.

Figure 115. Unidentified hornet, southeast Asia. Photo: John Moore.

Figure 116. Unidentified paper wasp, southeast Asia. Photo: John Moore.

Velvet ants (Family Mutillidae) are wingless female wasps having an ant-like appearance. Their bodies are covered with dense setae giving them a “hairy” appearance, and they typically

are their bodies are commonly distinguished with bright red or orange colored markings. Velvet ants can inflict an excruciatingly painful sting if handled, but they are normally not aggressive. Because of their size and potent sting, velvet ants are sometimes referred to as "cow killers."

Figure 117. Velvet ant (*Dasymutilla* sp.). Photo: Scott Camazine.

Figure 118. Velvet ant (*Dasymutilla* sp.). Photo: Liberty Haven Ranch.

Figure 119. Thistledown velvet ant (*Dasymutilla gloriosa*). Photo: Steven J. Prchal.

Other wasps

Many other species of wasps from a variety of families are capable of stinging. However, the stings from many of these non-aggressive species typically are only mildly painful (i.e., a "pinprick") and are of little consequence, or the wasps tend not to sting. Perhaps most notably among these are members of the family Sphecidae including the brightly colored muddaubers (*Sceliphron* spp., *Chalybron* spp., *Trypoxylon* spp.) which construct variously shaped nests from mud, and the large-bodied cicada killers (*Sphecius* spp.). The spider-hunting wasps (Family Pompilidae, Pepsis spp.) are large (3 inches, 76 mm) and distinctly marked with orange-yellow colored wings and iridescent purple-blue bodies. Spider-hunting wasps are distributed worldwide, and like the ciacada killers and mud daubers, they are not aggressive and rarely sting. However, their sting has been described as excruciatingly painful.

Figure 120. Black mud dauber (*Chalybion caementarium*). Photo: Pest Control Canada.

Figure 121. Cicada-killer (*Sphecius speciosus*), North America. Photo: David Bowles and Mark Pomerinke.

Ants- Some 10,000 known species of ants (Family Formicidae) occur in a variety of terrestrial habitats worldwide. The capability of inflicting venomous stings and producing poisonous droplets and secretions are nearly universal among ants although many species will not sting. However, a few species are capable of causing significant harm to people, and ant venom is similar to that of other hymenopterans. Depending on the species of ant, the venoms may have neurotoxic, histolytic, or both, properties. Included below are those ants capable of causing severe reactions in humans.

Bulldog and jumper ants (*Myrmecia* spp.)- Approximately 90 species of *Myrmecia* are known from southeastern Australia, Tasmania, and New Caldeonia. These large ants (up to 1 inch or 25 mm long) produce painful stings and that also may cause allergic reactions. Jumper and bulldog ants are aggressive and are so named because, in addition to their powerful bite, they can jump significant distances when attacking. Their venom contains histamine and histamine-releasing factors that cause substantial pain in victims. One species, *Myrmecia pilosula*, the jumper ant, is responsible for the great majority of arthropod-related allergic reactions in Australia. Although the prevalence of allergic reactions to ant venom in Australia is unknown, one study suggested roughly 50% of victims had life-threatening reactions to jumper ant envenomations. Bulldog ants, *M. gulosa* and *M. pyriformis*, stings also have allergenic properties, but the extent of cross-reactivity between the venoms of different species of *Myrmecia* is not well known. Jumper and bulldog ants are found in sandy or mountainous areas. Bulldog ants can be distinguishable from the jumper ant by their larger size and darker color.

Figure 122. Bulldog ant (*Myrmecia* sp.). Photo: source unknown.

Figure 123. Bulldog ant mandibles. Photo: Richard C. Russell.

Bullet ants are large (~1 inch or 25 mm long) ants occurring in Central and South America, and they are capable of inflicting excruciatingly painful stings that leave swollen, fluid-filled wounds. *Paraponera clavata* is considered to have the most painful and crippling sting of any ant species. Pain may come in waves for up to 24 hours following the sting, and it sometimes is accompanied by parathesia, vomiting, trembling, and severe inflammation.

Figure 124. Bullet ant (*Paraponera clavata*). Photo: Scott Camazine.

Fire ants- both the red imported fire ant (*Solenopsis invicta*) and black imported fire ant (*Solenopsis richteri*) are aggressive ants that construct large colonies. Fire ants aggressively defend their mounds, and they will inflict painful bites and stings in response to such disturbances. When a fire ant attacks they first pinch the victim with their mandibles, and then begin stinging. A single ant may sting several times in succession and usually in a line or semicircular pattern. Other species of fire ants, including forms native to the United States can also inflict painful stings, but these species are much less common and seldom encountered.

Figure 125. Fire ant (*Solenopsis invicta*). Photo: USDA-APHIS-PPQ.

Figure 126. Fire ant mound. Photo: Texas A&M University.

The initial reaction to a fire ant sting is an intense burning sensation followed shortly thereafter by the formation of a wheal up to 0.5 inch (13 mm) in diameter followed by itching and swelling. Approximately 4 hours or more after these initial symptoms, fluid-filled vesicles begin forming. These vesicles form white necrotic lesions or pustules after roughly 24 hours. Pustules may last for week or more, and, if broken, itch intensly. After these wounds heal, a

small scar is left were the pustule formed. Itching associated with the broken pustules can be managed through use of topical corticosteroids and systemic antihistamines. Hot showers and baths can also relieve itching to a limited extent.

Figure 127. Mass numbers of fire ant bites. Photo: Murray S. Blum.

Figure 128. Fire ant bites showing the typical pustules that form several hours following the sting. Photo: source unknown.

Harvester ants (*Pogonomyrmex* spp.) are large ants noted for the circular cleared area around their mounds. Harvester ants can inflict painful stings when they are handled, but they are relatively gentle ants and generally do not become defensive unless provoked. Following the sting of a harvester ant, pain may not occur for up to 30 seconds afterward, but the pain is exrutiating and may last several hours. These ants are fairly common in the arid portions of the United States and Mexico.

Figure 129. Red harvester ant (*Pogonomyrmex barbatus*). Photo: Dale Ward.

Figure 130. Harvester ant mound. Photo: David Bowles.

Many other kinds of ants are capable of stinging people, but he majority of these only cause local reactions at worst. Occasionally, however, such stings may cause allergic reactions. For example, the sting of the samsum ant, *Pachycondyla sennaarensis*, distributed in the Middle East have caused serious systemic reactions in people. Pavement ants, *Tetramorium caespitum*, are also known to sting people. This native European species was introduced to the United States where it has become established in some urban areas. While *T. caespitum* can sting, this species has difficulty piercing human skin. However, the sting it is characterized by temporary but intense itching followed by the appearance of reddened spots and subsequent chronic itching

which resolves within a few days. Some protein-feeding ants such as the Pharaoh ant, *Monomorium pharaonis*, have been incriminated as mechanical vectors of pathogens in hospitals. Army ants (*Eciton hamatum),* despite the threat idealized in the mass media, are harmless to humans. However, the majors (large workers) have formidable mandibles and can inflict a fairly painful defensive bite.

Fig. 131. Head of an army ant. Photo: Sean Brady.

Lepidoptera

(moths)

Of the some 300,000 species of Lepidoptera known worldwide, about 100 species or so are capable of producing severe reactions in people who contact the urticarial setae of the caterpillars and occaioanlly the adult moths. These dangerous caterpillars belong to the families Limacodidae, Lymantriidae, Megalopygidae, Saturniidae, and Thaumetopoeidae. Caterpillars in these families are distributed worldwide in temperate and tropical environments.

Urticarial reactions are generally broken into two broad groups termed lepidopterism caused by contact with the adult stage, egg cases and pupal cocoons, and erucism caused by contact with larvae. The setae or "hairs" of some adult moths, their egg cases, or pupal cocoons may produce irritating contact dermatitis. Contact with moth setae or urticating setae of larvae can produce reactions ranging from a mild burning sensation to extreme pain lasting upwards of 12 hours, and residual pain lasting for up to two weeks. The initial pain is often followed by reddening of the skin, dermatitis with lesions, blisters or pustules, reddened wheals, localized swelling and rash at the envenomation site, and itching. Conjunctivitis may occur when the eyes are involved.

The ultimate outcome can include inflamed nasal membranes and sinuses which obstruct breathing, destruction of red blood cells, hemorrhage, and necrosis. Other serious systemic complications known to occur include swelling of lymph nodes in the underarm and groin areas, headache, nausea, fever, difficulty in breathing, and prostration. Reactions depend on individual sensitivities, the part of the body contacted, time and pressure of contact, and the size of the caterpillar. Several families and species of moths known to have urticating properties are shown in Appendix 1.

Figure 132. Urticating setae embedded in a finger. Photo: Richard C. Russell.

Figure 133. Marks from a puss caterpillar sting. Photo: source unknown.

Figure 134. Urticarial reaction caused by caterpillar in the Family Lymantriidae. Photo: Richard C. Russell.

Among the most dangerous of the urticating caterpillars belong to the genus *Lonomia* in South America. A bleeding syndrome induced by contact with *Lonomia achelous* caterpillars was first described in Venezuela, and similar reactions have been reported for *Lonomia obliqua* from Brazil. Symptoms are similar in all cases starting with burning pain after the initial contact followed by reddened skin with a feeling of heat, swelling, blisters, headache, and vomiting. The onset of hemorrhagic syndrome occurs within about 12 hours and manifests as hematoma throughout the body, hemorrhage from the nose, and other bleeding. An intense dissolution of fibrin which allows blood clots to form has been detected in the blood of the patients, but the mechanism of this activity is unknown. Another group of dangerous caterpillars are the puss caterpillars (*Megalopyge* spp.) whose painful stings have been known to produce hemorrhagic lesions with significant swelling, swollen lymph nodes, and shock with low blood pressure. Species in this genus are sometimes referred to as stinging asps.

Certain species (brown-tail moth, tussock moth, and *Hylesia* spp. in South America) possess urticating setae as larvae and adults. These include members of the genus *Anaphae* (Thaumetopoeidae) and *Hylesia* (Saturniidae) distributed in Africa and South America, respectively, which can cause substantial skin eruptions following contact with their setae. Similarly, Tussock moths, *Euproctis (Lymantridae),* of the Pacific northwest region of North America, South America, Europe, Japan and Southeast Asia are reportedly responsible for large outbreaks of dermatitis among people living in those areas. Moths in the genera *Dirphia* in South America, and *Latoia consocia* in Japan are all known to have urticarial setae.

Figure 135. *Calcarifera ordinata*, Australia. Photo: Darren Jew.

Figure 136. Spitfire (*Doratifera vulnerans*), Australia. Photo: Don Herbison & Stella Crosby.

Figure 137. Spiny oak slug (*Euclea delphini*), North America. Photo: University of Kentucky.

Figure 138. Crowned slug (*Isa textula*), North America. Photo: Clemson University-USDA.

Figure 139. *Latoia consocia*, Japan. Photo: Kon-Gaaoira.

Figure 140. *Parasa indetermina*, North America. Photo: Jeff Barnes.

Figure 141. Hag moth slug (*Phobetron pithecium*), North America. Photo: University of Kentucky.

Figure 142. Saddleback caterpillar (*Sabine stimulea*). Photo: Gerald J. Lenhard.

Figure 143. Unknown caterpillar, Family Limacodidae, Thailand. Photo: John Moore.

Figure 144. Unknown caterpillar, Family Limacodidae, Thailand. Photo: John Moore.

Figure 145. Cup moth caterpillar (*Euproctis* sp.), Australia. Photo: Richard C. Russell.

Figure 146. Adult gypsy moth (*Lymantria dispar*). Setae on the egg masses can produce urticarial reactions. Photo: Kenneth H. Knauer.

Figure 147. Brown puss caterpillar (*Megalopyge opercularis*), North America. Photo: University of Florida.

Figure 148. Gray puss caterpillar (*Megalopyge* sp.), North America. Photo: MDChoice.com.

Figure 149. Io moth caterpillar (*Automeris io*), North America. Clemson University-USDA.

Figure 150. *Dirphia panamensis*, Central America. Photo: Bernhard Wenczel.

Figure 151. Buck moth caterpillar (*Hemileuca maia*), North America. Photo: Gerald J. Lenhard.

Figure 152. *Hylesia ebalus*, larva, South America. Photo: Bernhard Wenczel.

Figure 153. *Hylesia* sp., adult, South America. Photo: source unknown.

Figure 154. *Leucanella lama*, Central & South America. Photo: Bernhard Wenczel.

Figure 155. *Lonomia obliqua*, Brazil. Photo: Robert Morales.

Figure 156. Mass of *Lonomia obliqua*, Brazil. Photo: Roberto Morales.

Figure 157. *Molippa basina*, South America. Photo: Bernhard Wenczel.

Treatment of stings by urticating lepidopterans should include using adhesive tape to strip the setae from the wound site, and thorough washing with soap and water, to protect the patient and care provider from further envenomation. Ice packs can be used to minimize swelling, and oral antihistamines and systemic corticosteroids can be used for serious cases. Analgesics may be used to manage pain, and baking soda paste is an acceptable home remedy in the absence of medications. For dangerous systemic symptoms such as bleeding syndrome, emergency medical care should be provided to the victim.

Beetles

Blister beetles (Family Meloidae)- Some species of blister beetles (ex. *Lytta, Epicauta* spp.) are capable of excreting a toxin known as cantharadin through the joints of their legs when they are threatened or contacted accidentally. This chemical excretion can cause burning and tingling when it contacts human skin followed by blistering or development of fluid-filled vesicles. The blisters are reported to be relatively painless, but secondary infections can result when they rupture. Following breaking of the vesicles, the fluid contaminates adjacent skin causing formation of satellite blisters. Extensive contact of the skin with cantharadin can cause further complications including inflammation of the mouth, excess salivation, vomiting of blood, abdominal pain, diarrhea, and painful urination. Following contact with blister beetles, the skin should be washed with soap and water, isopropyl alcohol, or other cleansers to dilute the toxin. Topical corticosteroids can be used to treat blisters. Emergency medical care should be sought in severe cases or when secondary infection occurs.

Figure 158. Vesicle caused by contact with blister beetle (Family Meloidae). Photo: source unknown.

Figure 159. Striped blister beetle (*Epicauta vittata*), North America. Photo: University of Florida.

Figure 160. Spanish-fly (*Lytta vesicatoria*), Europe. Photo: S. Aubert, R. Hurstel, and M. Noël.

Figure 161. *Mylabris quadripunctata*, Middle East. Photo: Rittner Oz.

Figure 162. Unknown species of blister beetle, Panama. Photo: David Bowles and Mark. Pomerinke.

Rove Beetles (Family Staphylinidae)- Some rove beetles produce a toxin known as pederin that is known to cause contact dermatitis in people. An Asian species, *Paederus fuscepes* is

particularly harmful to people. This small species (0.24 inch, 6-7 mm) occurs in coastal areas where itattracted by light, and flies into houses at night where it comes into contact with people. Contact with this species begins as a burning sensation followed by reddening of the skin, swelling, and pustule formation in a line following the track the insect walked on the skin. Pustules commonly are large and can approach 0.6 inch (15 mm) in diameter. Full recovery is within 7 to 10 days without any long-term consequences. However, both hyper- and hypo-pigmentation can occur at the location where the pustule formed and healed. Treatment can include various topical preparations including calamine lotion or topical corticosteroids for most cases. Oral antibiotics can be administered in severe cases where the pustules are compromised or infected, but their use should not be routine. Large outbreaks (>190 cases) of contact dermatitis attributed to this species have been reported among deployed military personnel in Pakistan. Other instances of contact dermatitis caused by rove beetles have been reported from Nigeria and the southwestern United States. The potential for contact with rove beetles and associated dermatitis is worldwide.

Figure 163. Rove beetle, Family Staphylinidae. Photo: North Carolina State University.

Dermestids (Family Dermestidae)- These beetles can be economically important pests of stored food products and other materials. In addition, some species (e.g., Khapra beetle, *Trogoderma granarium*) also represent a potential public health threat because the setae shed by the larvae when they infest food products can cause serious allergic reactions to some people when consumed, and the setae have been known to penetrate the gastrointestinal lining. Military personnel involved in humanitarian operations, or dealing with prisoners in concentration camps

should consider the potential health risks of foods stocks when they are contaminated with dermestids.

Figure 164. Khapra beetle larva (*Trogoderma granarium*). Photo: Agriculture Western Australia.

Figure 165. Khapra beetle (*Trogoderma granarium*). Photo: Andreas Herrman.

Flies

True flies (Order Diptera) are the source of considerable human suffering throughout the world. They can be generally grouped into three artificial groups in terms of their annoyance to people. They include flies that cause myiasis, flies that bite and cause annoyance and/or transmit diseases, and filth flies.

Flies that Cause Myiasis

Although many different flies may cause myiasis in humans, only a few species produce myiasis with such frequency and severity to merit inclusion here. For example, at least fifty species of fly larvae have been reported in cases of enteric or intestinal "pseudomyiasis" in people. These species primarily belong to the families Muscidae, Calliphoridae, and Sarcophagidae, and most often the infestation originates from the patient consuming fly eggs attached to food. This type of myiasis is usually self-limiting although it may cause psychological trauma in some patients. By comparison, fly larvae that normally breed in meat, carrion, or living tissue may become involved in traumatic and cutaneous myiasis. Some of the notable species that cause traumatic myiasis in people include the human bot fly (*Dermatobia hominis)*, the Tumbu fly (*Cordylobia anthropophaga)*, Lund's fly (*Cordylobia rodhaini*) and the New World screwworm fly

(*Cochliomyia hominivorax*). Infestation by these species may cause significant physical and psychological trauma in the patient.

Figure 166. The life stages of a fly: eggs, larvae (maggots), pupae, adults. These life stages are typical of most flies. Photo: source unknown.

Human bot fly

The eggs of the human bot fly are carried to the host attached to the legs of a mosquito or biting fly. After the young bot fly larva penetrates the host's skin, it feeds continuously for 5-12 weeks from a dermal pocket causing pain and itching to the host. At the prepupal stage, the bot leaves the host, falls to the ground and pupates. The distribution of the human bot fly extends from Mexico throughout most of Central and South America. Although human bot flies cause some pain and irritation in the host, this infestation is self-limiting as the larvae completes it development.

Figure 167. Human bot fly larva (*Dermatobia hominis*). Photo: Marcelo de Campos Pereira.

Tumbu and Lund's fly

Tumbu fly and Lund's fly are two African species that can cause myiasis in humans. The Tumbu fly, or Mango fly, is a common in tropical Africa south of the Sahara Desert, and it has been recorded in southwestern Saudi Arabia since 1980. By comparison, Lund's fly is distributed in rainforest areas of tropical Africa, from Senegal to Central Africa and south to Angola and Rhodesia where it usually is associated with rodents. However, Lund's fly is implicated in human myiasis less often than Tumbu fly. Females of these two species deposit their eggs below the surface of sandy soil and occasionally on clothing tainted with traces of

feces or urine. The life cycle of both species takes 10-12 days to develop into the prepupal stage which then leaves the host to pupate in the soil. When the soil surface is disturbed the larvae respond by rapidly migrating to the surface where they penetrate the skin of the host and burrow into subcutaneous tissue. Myiasis caused by these two species is characterized by painful and itching boil-like lesions. Several species of wild rodents are the preferred hosts for Tumbu and Lund's flies, and dogs are the most common domestic host. Infestatations from soiled clothing can be prevented by allowing the clothing to dry in full sunlight or laundering. Situational awarness and proper wear of the uniform can prevent infestation by soil-dwelling larvae.

Figure 168. Tumbu fly (*Cordylobia anthrophaga*). Illustration: D. S. Kettle.

Congo Floor Maggot

Larvae of the Congo floor maggot, *Auchmeromyia senegalensis*, feed on blood from a wide variety of animals including humans. The night-feeding larvae attach to the host by making a small incision with their mouth hooks. Approximately 20 minutes are necessary for the larvae to take a complete bloodmeal. Attacks occur when a person comes into contact with infested soil for extended periods. Elevating sleeping areas off of the bare ground can prevent parasitism by A. senegalensis since the larvae cannot climb.

Figure 169. Congo floor maggot (*Auchmeromyia senegalensis*). Illustration: D. S. Kettle.

Sheep Bot Fly

Ocular myiasis by the sheep bot fly, *Oestrus ovis*, is a widespread occurrence in the Middle East, Africa and Central America. A few human cases have been reported from North America.

Larvae are obligate parasites in the nostrils and frontal sinuses of sheep, goats, camels and horses, while people are usually are only incidental hosts. However, ocular infestation of humans by *O. ovis* is not uncommon, and several cases occurred among U.S. military personnel during the Persian Gulf War. Female flies are larviparous, and they deposit larvae directly into the human eye while in flight. Normally, infestations produce a painful form of conjunctivitis that usually self-resolves. However, larvae are capable of penetrating the inner eye, causing serious complications.

Sheep Maggot

The genus *Chrysomya* is confined to the Old World where it is restricted to tropical and semi-tropical regions. One species, *C. chloropyga*, is an important sheep maggot in South Africa, although there are numerous examples of this species infesting wild and domestic animals, and people. Female flies lay eggs singly or in batches inside wounds, sometimes on the unbroken skin covering bruises and abscesses, and occasionally on places soiled by blood from wounds. Young larvae feed on liquids exuding from the interior of the wound for about a day; and later they embed in the living tissue. The larvae become full fed in about 6 days, exit the wound and drop to the ground where they bury themselves beneath the surface of the soil. Pupation takes place in 1-2 days and typically lasts 7-9 days. The biotic potential of the fly is enormous as a single female may produce 500-600 eggs and there may be 8 or more generations per year.

Figure 170. Adult *Chrysomya* sp. Photo: Anabel Martinez.

Figure 171. Adult *Chrysomya* sp. Photo: Marcelo de Campos Pereira.

Screw Worm Flies

Chrysomya bezziana (Calliphoridae), Old World screwworm fly, is the most important myiasis-producing fly in tropical areas of Africa, Asia, India, some Indo-pacific islands, and the Middle East. Cattle and other ungulates are the primary hosts. This species ranks second only to the tsetse flies as a pest of cattle in central and southern Africa, and is of considerable importance as a pest of people in India. For unknown reasons, people are attacked with relatively more frequency in India than in other parts of the fly's range. Larvae attack wounds on various parts of the body, but infestation of the eyes, nasal cavities, and head wounds are the most frequent locations. This species does not breed in carrion or excrement, and it is dependent upon living tissue for its existence.

Cochliomyia hominivorax historically was distributed from the southern U.S. southward throughout most of Latin America and the Caribbean. However, this pest is now eradicated as far south as Panama, and many areas of the Caribbean. These flies historically produced devastating economic losses throughout their range by damaging and killing livestock. Military personnel with battlefield wounds or other injuries also can be susceptible to invasion by screwworms. Several soldiers wounded in Operation Just Cause, returned to the U.S. from Panama with active screwworm infestations. Adult screwworm flies find superficial wounds on warmblooded animals and feed on fluids in the wound. Early stages of the larvae feeding in a wound are very difficult to see and only slight movements are normally observed. As the larvae feed, the wound is gradually enlarged, becoming wider and deeper. By the third day of infestation, as many as 100 to 200 tightly packed, vertically oriented larvae can be observed embedded deep in the wound. Screwworm larvae tend to burrow deeper in a wound when disturbed and generally they do not crawl on the surface. A discharge often exudes from the

infested wounds, and a distinct, unpleasant odor may be detected. In some cases, the openings in the skin may be small with extensive pockets of screwworm larvae beneath.

Figure 172. Screwworm fly, *Cochliomyia hominovorax*. Illustration: D. S. Kettle.

Larvae reach the terminal or 3rd instar, exit wounds, and drop to the ground where they burrow in the soil and pupate. After 3-5 days the flies are ready to mate. Females usually mate once. Female New World screw worm flies oviposit up to 400 eggs in a single egg mass and one fly may oviposit 6 to 8 batches of eggs in her life with each egg mass having about 100 to 250 eggs. Eggs of the New World screwworm are creamy white and deposited in shingle-like fashion on the border of a superficial wound into which the newly hatched larvae migrate and begin feeding. Small screwworm larvae up to 0.08 inch (2 mm) in length hatch from the eggs in 8 to 12 hours.

Old World screwworm flies differ from the New World screwworm flies in several ways. One distinguishing character in adults is the number of longitudinal stripes on the thorax. New World screwworm flies have three prominent, black stripes while Old World screwworm flies have only two stripes. A simple character useful for distinguishing between the larvae of the two species is the number of finger-like processes on the anterior spiracles; Old World screwworm larvae have 4-5 processes, while New World screwworm larvae have 7-9 processes.

Wohlfahrtia magnifica

Wohlfahrtia magnifica (family Sarcophagidae) is an important obligatory parasite in the wounds and natural orifices of warm-blooded animals, including humans. Cases of myiasis caused by this species have been reported from Turkey, but occurrences are relatively rare.

Figure 173. An adult sarcophagid fly. Photo: source unknown.

Other Flies That Cause Myiasis

Many other flies are known to cause obligative myiasis in people. Sporadic cases of gastrointestinal myiasis, caused by larvae of a number of flies have been reported from various parts of the world but these are generally innocuous and self-limiting. For example, gastrointestinal myiasis attributed to *Lucilia cuprina* (Diptera: Calliphoridae) has been reported from people in Jordan. Intestinal myiasis in humans usually is caused by the accidental ingestion of undercooked food infested with larvae. Phorid flies (Phoridae, especially *Megaselia scalaris*) have been implicated in passive myiasis in humans.

Figure 174. *Lucilia serricata*. Photo: Alan Hadley.

Figure 175. *Megaselia scalaris*. Photo: Brian Brown.

Treatment of Myiasis

Treatment of myiasis can be done by forcing the maggots to the skin's surface by cutting-off their air supply, or by physical removal to include surgical procedures. For bot flies, an application of petroleum jelly or similar substance will encourage the maggot to move towards the surface, exposing more of the maggot's body which can then be extracted. A local anesthetic and incision to extract the maggot is another common method of treatment. Myiasis is rarely a

fatal disease, but troops living in the field during combat are at a higher risk of infestation. Good sanitation can prevent most cases of accidental and facultative myiasis. Extra care should be taken to keep wounds clean and dressed. At field facilities, proper waste disposal and fly control can reduce fly populations and the risk of infestation. Although most human cases of myiasis are uneventful and typically resolve without medical intervention, patients should be examined for the presence of additional and subsequent lesions because the development of the maggots is not always synchronous or isolated, and their growth phase may be prolonged.

Biting Flies

Mosquitoes (Family Culicidae)

Mosquitoes are the most serious arthropod threat to people worldwide. In addition to being a nuisance because of their biting, mosquitoes also are capable of transmitting pathogens to humans and animals that cause dangerous and often fatal diseases such as malaria, filariasis, yellow fever, dengue, and various encephalitides (refer to Appendix 2). There are approximately 3,500 species of mosquitoes grouped into 41 genera distributed worldwide. Thus, no attempt is made here to specifically address the many species of mosquitoes. However, an assessment of the common medically important genera of mosquitoes is briefly presented below.

All four life cycle stages of mosquitoes (egg, larva, pupa and adult) can be used in surveillance. The mode and method of laying eggs is highly variable among mosquito genera. Species of *Culex* and *Culiseta* lay up to 200 eggs in floating rafts. By comparison, other genera such as *Aedes, Anopheles, Ochlerotatus* and *Psorophora* lay their eggs singly. *Ochlerotatus and Psorophora* lay their eggs on damp soil that will be flooded by water while *Aedes* often attach their eggs to the walls small artificial and natural containers such as old tires and treeholes. Most

mosquito eggs hatch into larvae within 48 hours. Eggs can be used as a surveillance tool such searching for the floating egg rafts of *Culex*, and using ovitraps to monitor the presence of container breeding *Aedes* species.

Figure 176. *Culex* sp. laying egg raft. Photo: CDC.

Mosquito larvae, commonly called "wigglers," are exclusively aquatic and usually inhabit standing fresh or brackish water. However it is not uncommon to find the larvae of *Anopheles* in backwater areas of streams. Mosquito larvae have four larval instars with each instar becoming progressively larger in size. Larvae obtain atmospheric oxygen through a respiratory siphon located at the tip of their abdomen by inserting it through the surface of the water and hanging upside down in a vertical profile. *Anopheles* larvae have a respiratory opening rather than a siphon and they must lie parallel to the water surface to get a supply of oxygen. *Coquillettidia* and *Mansonia* larvae have modified respiratory siphons that they use to pierce the tissue of aquatic plants from which they obtain their air supply. Most mosquito larvae feed on microorganisms and organic matter in the water, but some genera, such as *Toxorhynchites*, are predatory on other insects, including mosquitoes.

Figure 177. Examples of mosquito larvae genera. Photo: Richard C. Russell.

Figure 178. Examples of mosquito larvae and a pupa. Photo: Richard C. Russell.

The pupal stage is a mobile but non-feeding, developmental stage that typically lasts about a week or less. Pupae actively "tumble" in the water when disturbed. Pupae are much more difficult to identify than either the adult or larval stages and they are seldom used for surveillance. However, pupae can be collected from natural habitats and placed in mosquito

breeders or cages for rearing to the adult stage. This is an excellent and passive means of conducting surveillance when pupae are found in abundance.

When the adult stage emerges from the pupal skin at the water surface, they are very vulnerable to wind and water movement, predators, and other factors until they are ready to fly. A newly emerged adult mosquito must rest on the surface of the water for a short time to allow itself to dry and all its body parts to harden. The length of each developmental stage depends on environmental conditions such as temperature and characteristics specific to a given species. However, the complete life cycle for most species generally takes about 14 days or less.

Figure 179. Emerging adult mosquito. Photo: Richard C. Russell.

Blood feeding and mating usually do not occur for a couple of days after the adults emerge from the source habitat. Only female mosquitoes require a blood meal and bite animals - warm or cold blooded – including birds, reptiles and amphibians. Stimuli that influence biting and blood feeding include a combination of carbon dioxide, temperature, moisture, smell, color, movement, and other chemical cues. Male mosquitoes do not bite, but feed on the nectar of flowers or other suitable sugar sources. Acquiring a blood meal (protein) is essential for egg production, but otherwise both male and female mosquitoes are mostly nectar feeders. Female *Toxorhynchites* do not take a bloodmeal and feed on nectar only.

Aedes and *Ochlerotatus* mosquitoes are painful and persistent biters, and many species in these two genera feed in the morning or at dusk. Some are diurnal (daytime biters), especially on cloudy days and in shaded areas, or at dawn and dusk. *Aedes*, particularly *Aedes aegypti* and *Aedes albopictus*, are best known for their ability to transmit dengue fever and yellow fever viruses in subtropical and tropical areas worldwide. Although these mosquitoes will breed in a variety of aquatic habitats, some members of each genus are container breeders and will use small amounts of water in tree holes, other natural cavities, and man-made objects as breeding sites.

Figure 180. *Aedes aegypti* larva. Photo: Richard C. Russell.

Figure 181. *Aedes aegypti* adult. Photo: Richard C. Russell.

Figure 182. *Aedes albopictus* adult. Photo: Dr. Harold J. Harlan.

Figure 183. *Aedes vigilax* adult. Photo: Stephen L. Doggett.

Figure 184. *Ochlerotatus camptorhynchus* larva. Photo: source unknown.

Anopheles mosquitoes are the only vectors of malaria, but, of the approximately 430 known species, only 30-40 can transmit malaria. Larval *Anopheles* have been found in fresh- or salt-water marshes, mangrove swamps, rice fields, grassy ditches, the edges of streams and rivers, and small, temporary rain pools. Many species prefer habitats with vegetation while others prefer habitats without vegetation. Some breed in open, sun-lit pools while others are found only in shaded breeding sites in forests. *Anopheles* larvae lack a respiratory siphon and for this reason position their bodies parallel to the surface of the water. Adult *Anopheles* can be distinguished

from other mosquitoes by the palps which are as long as the proboscis. Adult *Anopheles* can also be identified by their typical resting position where their abdomens point upwards rather than parallel to the surface on which they are resting. Adults feed exclusively at night.

Figure 185. *Anopheles* sp. larva. Photo: Richard C. Russell.

Figure 186. *Anopheles gambiae* adult. Photo: University of Minnesota.

Culex mosquitoes are relatively painful and persistent biters, and they prefer to attack at dusk and after dark. They will feed on a variety of mammals, but domestic and wild birds usually are preferred hosts. They are the primary vectors of viruses that cause a number of dangerous encephalitides. *Culex* mosquitoes are generally weak fliers and do not move far from their source habitats. They readily enter human dwellings to rest and feed. Adults may live a few weeks during the warm summer months, but those females that emerge in late summer search for sheltered areas where they "hibernate" until spring. *Culex* will breed in a broad variety of aquatic habitats, but they prefer water with a high degree of organic enrichment. Some species are even known to breed and overwinter in the sewer of large eastern cities such as New York.

Figure 187. *Culex annulirostris* adult. Photo: Richard C. Russell.

Figure 188. *Culex quinquefasciatus* adult. Photo: Richard C. Russell.

Culiseta mosquitoes are moderately aggressive biters, attacking in the evening hours or in the shade during the day. *Psorophora*, *Coquillettidia* and *Mansonia* mosquitoes are becoming more pestiferous as an ever-expanding human population invades their natural habitats. However, all

of these genera play a secondary role in disease transmission to people, and they are primarily annoyance biters.

Figure 189. *Coquillettidia* sp. larvae. Photo: Richard C. Russell.

Figure 190. *Coquillettidia linealis* adult. Photo: Richard C. Russell.

Figure 191. *Mansonia* adult. Photo: Richard C. Russell.

Immature stages of mosquitoes are best controlled with larvicides applied to the source water, and habitat management, although these may not be practical options during military operations. Adults can be controlled by applying residual insecticides to harborages, aerial application of pesticides for wide area treatment. Personal protection methods such as avoidance, treating screens, bednets, and uniforms with permethrin, and using repellents such as DEET help reduce attacks by mosquitoes.

Biting midges (Family Ceratopogonidae)

Members of the Family Ceratopogonidae are commonly known as punkies, no-see-ums, or biting midges. These small (0.08-0.12 inch, or 2-3 mm) flies can be serious annoyance pests and in some areas they present a significant threat as disease vectors. Because of their small size, they can easily pass through window screens and standard mosquito netting. Although most ceratopogonids are ectoparasistes of other insects, the females of some genera, such as *Culicoide*s (~1000 species) and *Leptoconops* (~90 species), will take a blood meal from humans. Ceratopogonids are painful biters, and they often cause localized reactions that may

develop into dermatitis and secondary infection. When their populations are high, they can disrupt military operations due to severe annoyance. *Leptoconops* typically are active during the day while *Culicoides* may be either diurnal or nocturnal. Diurnal species of both genera prefer early morning and late afternoon periods. They do not have a long flight range, so most biting activity occurs near the breeding source which may be any of a wide variety of aquatic and semi-aquatic habitats including tree holes, decaying vegetation, mud, tidal flats, and salt marshes. Larvae are difficult to find and identy beyond the family level, but adults are easily collected in biting collections and light traps. Larval stages are best controlled by habitat management, although this may not be practical during military operations, or over large areas. Adults can be controlled by applying residual insecticides to fly harborages, aerial application of pesticides for wide area treatment, and personal protection methods such as treating screens, bednets, and uniforms with permethrin, and using repellents such as DEET.

Figure 192. Ceratopogonidae larva on bottom, Chironomidae larvae on top. Photo: Microscopy-United Kingdom.

Figure 193. *Culicoides* sp. adult. Photo: Richard C. Russell.

Sand flies (Family Psychodidae, Subfamily Plebotominae)

These tiny (< 0.08 inch, or 2 mm) biting flies transmit leismaniasis from southern Texas southward throughout much of Central and South America, the Mediterranean, northern Africa, and throughout the Middle East. They also are vectors of sand fly fever in the Mediterranean region, North Africa and Middle East, and Bartonellosis in South America. The females feed on mammals such as rodents and canines, but they will also take blood from humans. Their bite is painful relative to their small size. The genera of concern include *Lutzomyia* in the Americas,

and *Phlebotomous* in the Old World. Adults can be controlled by applying residual insecticides to harborages, aerial application of pesticides for wide area treatment, and personal protection methods such as avoidance, treating screens, bednets and uniforms with permethrin, and using repellents such as DEET.

Figure 194. *Phlebotomus papatasi* adult. Photo: Ed Rowton.

Black flies (Family Simuliidae)

Also known as buffalo gnats, these small (0.12-0.16 inch or 3-4 mm) dark-colored flies have a hump-backed appearance. Only female black flies take a blood meal, and their biting-slashing mouthparts inflict painful bites. Black flies often occur in large swarms making them a serious pest of people, livestock, and wild animals. In addition to their painful bites, black flies in portions of Africa, southern Mexico, Central and South America can transmit Onchocerciasis, or river blindness, to humans. Black fly larva and pupae most often inhabit fast flowing streams where they attach themselves to the surface of rocks or large woody debris. Immature stages of some black flies, such as those in the genus *Cnephia*, inhabit slow-flowing streams and swampy areas. Black flies are widely distributed worldwide, but most species are found in temperate and boreal regions. Black flies can inflict substantial numbers of bites when they are emerging from the aquatic habitat. Feeding almost always occurs during daylight, but their feeding activity is often focused in the morning or at dusk. Black fly bites often itch for days after they are inflicted, but such itching can be managed with topical corticosteroids.

Figure 195. Black fly (*Simulium* sp.) larva. Photo: Benny Chan.

Figure 196. Black fly (*Simulium* sp.) larvae in their aquatic habitat. Flow is towards top of photo. Photo: Catskill Fly Fishing Center and Museum.

Figure 197. Adult black fly (*Simulium* sp.). Photo: Kansas State University

Tsetse flies (Family Glossinidae)

Tsetse flies, genus *Glossina*, are vectors of African sleeping sickness (African trypanosomiasis), and they can pose a significant threat to military members deploying to central Africa. Tsetse flies can be readily distinguished from other biting flies occurring in Africa by their long proboscis which projects forward approximately one-half the length of the body. Adult female tsetse flies do not lay eggs, but they carry a single larva in their abdomen. This fully developed larva is "larviposited" prior to pupation where it borrows into loose soil or sand.

Adult tsetse flies use visual cues to find their victims so bites are exclusively during daylight. Avoidance and proper wear of the uniform are the best means of avoiding tsetse fly bites. Tsetse flies are difficult to control because they are often distributed over large geographic areas and the adults are highly mobile. While it is possible to achieve eradication of tsetse in particular areas, such attempts usually fail in the long run because of immigration of tsetse-flies from other areas. Although several means of controlling these insects have been developed, only a few are applicable for use by deployed military personnel. The main control methods for local areas include remove brush and trees to eliminate shaded areas where lariposition occurs. However, this method is labor intensive, and it may not be practical during a military operation. Use of residual insecticides on resting areas, and application of non-residual aerosols to kill adult tsetse can be effective, but such applications must be repeated at regular intervals in order to kill newly emerged adults. Both ground and aerial application methods have been used with success in Africa. Trapping adult tsetse flies using a biconical trap or similar methods can be especially

effective on the local scale. These traps can be treated with residual insecticides to kill trapped flies.

Figure 198. Tsetse fly (*Glossina morsitans*), dorsal view. Photo: David Bowles and Mark Pomerinke.

Figure 199. Tsetse fly (*Glossina morsitans*), lateral view. Photo: David Bowles and Mark Pomerinke.

Stable flies and dog flies (Family Muscidae)

Stable flies are distributed worldwide in temperate and tropical environments. These flies appear similar to the house fly (*Musca domestica*), but they have biting mouthparts capable of inflicting painful bites to wild animals, livestock and people. Stable flies bite during daylight periods, and they can occur in relatively large numbers. Additionally, they are strong fliers and may fly upwards of 3 miles (5 km) from their breeding source. Larvae most often inhabit organically rich materials such as decaying straw and hay enriched with animal dung or decaying vegetation. The primary nuisance species are *Stomoxys calcitrans, Stomoxys nigra, and Stomoxys sitiens*.

Figure 200. Stable fly (*Stomoxys calcitrans*). Photo: University of Nebraska, Department of Entomology.

Although stable flies are mainly nuisance biters, they may have the potential to mechanically transmit certain disease agents to people. For example, *Stomoxys calcitrans* have been implicated as mechanical vectors of *Leishmania mexicana*. Although phlebotomine sand flies

are the natural vectors of *Leishmania*, mechanical transmission of these parasites by stable flies is considered possible via contaminated mouthparts. The mouthparts or feet of these flies can transfer parasites from a lesion to a non-leishmanial lesion under experimental conditions. However, such an occurrence is considered a rarity. Under laboratory conditions, stable flies have also been implicated as potential mechanical vectors of several species of trypanosomes.

Horse flies and deer flies (Family Tabanidae)

Horse and deer flies are distributed worldwide in tropical and temperate environments. The primary nuisance genera include *Tabanus* (horse flies) and *Chrysops* (deer flies). The predaceous larvae of tabanids are aquatic or semi-aquatic and occur in a variety of habitat types, and other species are terrestrial. Deer flies are generally smaller than horse flies, and some species in the latter group can exceed one inch in size. The eyes of many tabanids are often brightly colored with iridescent markings. Tabanids also are strong and fast fliers and they will actively pursue a potential host. Female tabanids feed on blood to nourish their eggs, and, in doing so, they can inflict painful bites with their biting-slashing mouthparts. Male tabanids feed on pollen and nectar. Feeding occurs exclusively during daylight. Although tabanids are generally considered to be an annoyance and not vectors of human disease, some species have been implicated as vectors of tularemia and anthrax in North America, and parasitic filarial worms (e.g., *Loa loa*) in Africa.

Figure 201. Deer fly (*Chrysops* sp.), North America. Photo: source unknown.

Figure 202. Deer fly (*Chrysops*), North America. Photo: source unknown.

Figure 203. Deer fly (*Chrysops* sp.), Thailand. Photo: John Moore.

Figure 204. Unknown species of horse fly, Thailand. Photo: John Moore.

Figure 205. View of *Chrysops* head showing mouthparts. Photo: John Moore

Filth flies (Families Muscidae, Calliphoridae, and Sarcophagidae)

Filth flies breed in and feed on feces, corpses and other carrion, and garbage. Because of these particular feeding habitats, filth flies can be responsible for mechanically transmitting a wide variety of gastrointestinal and other parasitic diseases to humans through contact with food and water sources. Filth flies are incredibly productive and a single food source can yield thousands of flies in a single week. The presence of large numbers of filth flies in an area of operations can be annoying, and this may cause psychological distress among some military members.

The primary filth fly groups of interest to military personnel are the muscid flies. Members of the *Musca sorbens* complex (*Musca biseta*; *Musca sorbens*, dog dung fly or bazaar fly; *Musca vetustissima*, Australian bush fly*)* are major nuisance flies because of their tendency to feed at the mouths, eyes and wounds of people. *Musca sorbens* also has been strongly implicated as a primary mechanical vector of traucoma (*Chlamydia trachomatis*) that can cause blindness in humans. Members of this group can be distinguished from the house fly in that they have two dark, broad longitudinal stripes on the thorax rather than four narrow stripes on the house fly thorax. Bottle and blow flies (Calliphoridae, ex., *Cynomopsis* spp, *Calliphora* spp., *Phaenicia spp*., *Lucilia*, *Phormia regina*), flesh flies (Sarcophagidae, *Sarcophaga* spp.) are often brightly metallic colored or shiny in appearance. The Old World latrine fly, *Chrysomya megacephala,* is a common pest in the Indo-Australian area, but it also has been introduced into the Afrotropical and Neotropical Regions.

Figure 206. House fly (*Musca domestica*). Photo: J. Kalisch.

Figure 207. Illustration of a house fly (*Musca domestica*) showing four thoracic stripes. Illustration: D. S. Kettle.

Figure 208. Illustration of the Australian bush fly (*Musca vetustissima*) showing two thoracic stripes. Illustration: D. S. Kettle.

Figure 209. Bazaar fly (*Musca sorbens*) on the face of a refugee boy. Photo: Associated Press.

Figure 210. Unknown species of blow fly (Family Calliphoridae). Photo: Dexter Sear.

Figure 211. Unknown species of blow fly (Family Calliphoridae), Thailand. Photo: John Moore.

Figure 212. Black blow fly (*Phormia regina*). Photo: Northern Kentucky University.

Fleas

Fleas (Order Siphonaptera) are wingless ectoparasites of warm-blooded vertebrate animals and they occur worldwide. In addition to the annoying and painful bites they inflict with their piercing-sucking mouthparts, some fleas can transmit serious disease to people including bubonic plague, endemic typhus, and tularemia. They can also serve as an intermediate host of certain parasitic tapeworms that can infest humans. Excessive bites may produce itching and hive-like reactions. Scratching of bite wounds inflicted by fleas can produce secondary infections that may require medical treatment. Bite wounds can be treated with corticosteroids when necessary, and antibiotics may be used to manage secondary infections.

Although most fleas have a preferred host, many of them will take a blood meal from a wide variety of animals and will readily bite man in the absence of their normal host. The cat flea (*Ctenocephalides felis*) and the dog flea (*Ctenocephalides canis*), two common species with

cosmopolitan distributions, can be very annoying pests of people. Cat fleas are typically more locally abundant and generally distributed than dog fleas. These fleas attack a wide variety of other mammals such as foxes, raccoons, and rats. When populations are large, cat and dog fleas can inflict numerous bites that may develop into dermatitis, which requires treatment with topical corticosteroids or systemic antihistamines. The female fleas lay their eggs among the hairs of these animals and the eggs drop off onto the mat or rug where the pets sleep or rest, onto carpets and overstuffed furniture, cellar floors, and similar places. Larval development usually requires at least two to three weeks, and the newly emerged fleas simply hop onto cats or dogs as they walk by. However, if people leave their homes and take their pets with them, or board their cats and dogs at an animal hospital for two to four weeks or longer, an enormous number of adult fleas may reach maturity in a vacant house or apartment. These fleas have had no opportunity for a blood meal, and when people return to their homes, they may be attacked by hundreds of hungry fleas. In the summer, cat and dog fleas will breed outdoors in vacant lots, under houses, in barns, and similar locations, particularly if there are stray dogs or cats about. The human flea (*Pulex irritans*) occasionally becomes abundant on farms, particularly in abandoned pigpens. The human flea is distributed throughout the warmer parts of the world. It is the most important species attacking man on the Pacific Coast and is often responsible for a dermatitis or allergy due to flea bites. The human flea attacks a wide variety of hosts including swine, dogs, coyotes, prairie dogs, ground squirrels, and burrowing owls. Human fleas has been experimentally infected with plague and shown to be capable of transmitting the bacteria in the laboratory. A related species, *Pulex simulans*, occurs in central and southwestern United States and in Central and South America. Some previous records of *Pulex irritans* probably refer to this second species.

Figure 213. Cat flea (*Ctenocephalides felis*). Photo: University of Bristol.

Figure 214. Cat flea larval. Photo: Marcelo de Campos Pereira.

Figure 215. Cat flea pupae. Photo: Marcelo de Campos Pereira.

Figure 216. Human flea (*Pulex irritans*). Photo: Ron Neumeyer.

Oriental rat fleas (*Xenopsylla cheopis*) normally spend most of their adult life on Norway and roof rats. However, when these rodents are killed, the fleas leave their rodent hosts and will readily bite people. The Oriental rat flea is the primary vector of plague and endemic (murine) typhus. This species has been introduced throughout the world along with its favored hosts, Norway and roof rats. The life cycle varies, but it is usually completed in as few as four to eight weeks. Adult oriental rat fleas may live for two to four weeks, depending on the temperature and relative humidity.

Figure 217. Rodent flea (*Xenopsylla* sp.). Photo: Emporia State University.

Figure 218. Line drawings showing the head and pronotum for some common fleas that affect humans. These illustrations should not be used as a definitive dianosis for identifying pest fleas, but they can be used as an initial basis for identifying a specimen. A. Sticktight flea (*Echidnophaga gallinaceus*). B. Human flea (*Pulex irritans*). C. Oriental rat flea (*Xenopsylla cheopis*). D. Ground squirrel flea (*Diamanus montanus*). E. Rat flea (*Nosopsyllus fasciatus*). F. Mouse flea (*Leptopsylla segnis*). G. Rodent flea (*Neopsylla setosa*). H. Dog flea (*Ctenocephalides canis*). I. Cat flea (*Ctenocphalides felis*). These illustrations are redrawn from United States Centers for Disease Control and Prevention, Pictorial keys to arthropods, reptiles, birds and mammals of public health significance.

Northern rat flea, *Nosopsyllus fasciatus*, is commonly found on domestic rats and house mice throughout North America and Europe. This species seems to prefer temperate climates and it is not abundant in areas having high temperatures. While this species does not radily bite people, it may be a vector in the zoonotic plague cycle.

Mouse flea, *Leptopsylla segnis*, was introduced into the United States on infested rats and mice. The mouse flea is most commonly found on domestic rats throughout the Gulf States and in some areas of California. This flea is most abundant along the east and west coasts near the original ports of entry, but it becomes relatively scarce in summer. Mouse fleas are considered to be poor vectors of fleaborne typhus, but they have been found naturally infected with the pathogen in China. They also can be infected with plague in the laboratory, but they are not known to be natural vectors.

Sticktight flea, *Echidnophaga gallinaceus,* is a small species that attaches firmly to birds often forming ulcers on the head and neck of the host. Eggs are deposited in these ulcers and, after hatching, the larvae crawl out and drop to the ground where they feed on organic matter. All life stages of this species may be found in poultry yards and adjacent buildings if not treated. This flea attacks rats, cats, dogs, rabbits, ground squirrels, horses, fowl, and many other animals including people. Sticktight fleas have been found infected with plague and can they can be infected with fleaborne typhus rickettsia. However, this sticktight flea plays only a minor role in disease transmission because the females remain permanently fastened to the host by means of their serrated mandibles. The western hen flea (*Ceratophyllus niger*) and the European hen flea (*Ceratophyllus gallinae*) occasionally become extremely abundant in chicken houses, and they

will attack people in large numbers. Wild bird nests are also a common source of these fleas attacking people.

The rabbit flea, *Cediopsylla simplex*, is a common pest on rabbits in eastern United States and is known to bite hunters and hikers or other users of the outdoors. Squirrel flea, *Orchopeas howardii*, is found commonly throughout the United States, especially wherever gray squirrels occur. It can sometimes become a serious household pest, if squirrels build their nests in the attics of homes and the fleas use humans as an alternative food source. In such cases, the fleas, which breed in nest material, attack people in the attic or invade other parts of the building. Control is obtained by removal of the nest and application of insecticides. Squirrel fleas have been implicated as reservoirs of plague bacteria in the western United States. Similarly, *Hoplopsyllus anomalus*, parasitizes California ground squirrels and rats, and it can effectively transmit plague. Ground squirrel flea, *Diamanus montanus,* is a dark brown, medium-size flea that primarily parasitizes ground squirrels (*Citellus*) in the central and western United States. They are capable of transmitting plague among wild rodents albeit less efficiently than the northern rat flea.

Tunga flea (chigoe, *Tunga penetrans*) differs from other fleas in that the female burrows into human skin, including the soles of the feet or toes. They also may include the genitalia, perianal area, and legs. However, the area most frequently attacked area is between the toes or under the toenails where the flea, engorged with blood and developing eggs, may swell to the size of a small pea resulting in excruciating pain. Once embedded in the skin, the female produces eggs and grows in size up to 0.4 inch (10 mm) with the resulting lesion being up to 0.8 inch (2 cm) in diameter. Inflammation and formation of ulcers follows, and secondary infection may result in

tetanus or gangrene. Minor surgery may be required to extract the embedded flea, and tetanus prophylaxis and antibiotic treatment may be necessary to prevent secondary infection. The female tunga flea lays eggs while embedded in the host and dies after about 2 weeks. Tungoe flea is distributed in tropical and subtropical regions in North and South America, the West Indies, and Africa.

Figure 219. Chigoes (*Tunga penetrans*) embedded in toes. Photo: Feldmeir *et al*.

Figure 220. Chigoes (*Tunga penetrans*) embedded in fingers. Photo: Feldmeir *et al*.

Occasionally, people report being bitten by tiny, dark, wingless insects popularly known as "sand fleas." In the northern United States "sand fleas" usually are cat or dog fleas found in vacant lots and associated with stray cats or dogs. In the western United States, "sand fleas" may be cat fleas or human fleas associated with deer, ground squirrels, or prairie dogs. In the southern United States "sand fleas" are sometimes sticktight fleas, but more commonly are cat or dog fleas. Along the beaches, tiny crustaceans belonging to the Order Amphipoda occurring abundantly in sea weed are often called "sand fleas," "sand hoppers," and "beach fleas", but these animals do not bite people.

Centipedes

Centipedes (Class Chilopoda) are found in a variety of temperate and tropical terrestrial habitats throughout the world. Body length of these elongate, flattened, and multi-legged animals varies greatly depending on the species. While most species are small, some tropical species can reach nearly two feet (600 mm) in length. Centipedes can be distinguished from millipedes in that they only have one pair of legs per segment rather than two pairs per segment. Although normally secretive, centipedes are very agile and can move rapidly. They typically seek shelter under

rocks, rotten logs, and loose tree bark where they prey on smaller organisms. The vast majority of the 3,000 known species of centipedes are completely harmless, but some species can inflict painful "bites" with a pair of fang-like toxicognaths that are modified for piercing and equipped with venom glands. The mandibles of centipedes are small and incapable of biting. The last pair of legs is also capable of inflicting a mild pinch but they do not have venom glands. Other species will secrete an offensive substance, but this is not harmful to people. The widely distributed scolopendrids (*Scolpopendra* spp.) are the largest and most venomous centipedes, and there are roughly 80 species in this genus distributed worldwide, particularly in subtropical and tropical habitats. The "bites" of these large centipedes can cause severe pain that may last for several hours in addition to localized swelling of tissue, redness, swollen painful lymph nodes, headache, heart palpitations, nausea and/or vomiting, and anxiety. Necrosis is uncommon and infection almost unknown. Symptoms and signs seldom persist > 48 hours. Deaths from centipede bites have been recorded, but such events are exceedingly rare. Numerous species of centipedes in the genus *Otostigmus* can exude chemical substances from glands found along the body segments that are used for defensive purposes. These secretions usually are not toxic to humans, but they may cause vesicles to form on skin upon contact. Species of *Otostigmus* are distributed worldwide in tropical and subtropical habitats.

Figure 221. Giant centipede (*Scolopendra* sp.). Photo: Jeff Barnes

Figure 222. Head of *Scolopendra* sp. showing fang-like toxicognaths. Photo: Dr. Harold J. Harlan.

Centipede bites should be treated by thoroughly cleaning the immediate area of the bite followed by topical application or injection of a local anesthetic (if necessary) and use of systemic antihistamines. Ice packs can be used to control pain in most cases.

Millipedes

Millipedes (Class Diplopoda) superficially resemble centipedes, but they have two pairs per body segment, and the body is circular in cross-section. They range in size from near microscopic to several inches in length for some tropical species. Millipedes can be found in a variety of terrestrial but usually damp, habitats, including under various ground shelters, leaf litter, soil, and rotting wood. Unlike centipedes, millipedes are sluggish in their movements. Most millipedes are completely harmless, secretive, and do not bite. However, some species, when alarmed will roll into a coil and excrete noxious chemicals from pores along the sides of the body. These chemicals vary in potency among species, but they usually have a highly offensive odor. Some tropical millipedes produce excretions that may cause burning of the eyes and skin, and they are capable of ejecting these chemicals for up to a yard (meter). Reactions may include yellow or brown staining of the skin, intense burning and itching of the skin, occasionally blistering, and, in severe cases, marked reddening of the skin, and necrosis. When the eyes are invloved, these secretions may cause severe conjunctival reactions with corneal ulceration. Symptoms usually resolve within 24 hours, but if the eyes are involved, recovery may take several days. Species known to be injurious include *Rhinocricus lethifer* (Haiti), *Rhinocricus latespagor* (Haiti), *Polyceroconas* spp. (Papua New Guinea), *Spirostreptus* spp. (Indonesia), *Iulus* spp. (Indonesia), *Spirobolus* spp. (Tanzania), *Orthoporus* spp. (Mexico), and *Tylobolus* spp. (California).

Figure 223. Millipede in a defensive coil. Photo: source unknown.

Figure 224. A tropical millipede. Photo: Easy Exotics.

Toxic secretions of millipedes should be washed from the skin with copious amounts of alcohol or soap and water. Topical corticosteroids and antibiotics should be applied if a skin reaction develops. Eye injuries require immediate irrigation and application of corticosteroid eyedrops or ointment.

Porifera

About a dozen species marine sponges distributed in eight different families are reported to have toxic properties. The species with toxic properties are primarily distributed in the warm waters of the Caribbean but others are known from the North Atlantic Ocean of North America and Europe, the Pacific Ocean of California, Mexico, and Australia. However, other potentially dangerous sponges may be located elsewhere. Reported responses associated with these sponges involve an almost immediate skin irritation and contact dermatitis similar to that observed following contact with poison ivy. Initial symptoms usually include redness at the contact area followed by stiffness in the finger joints (if handled) and localized swelling. Blisters often develop within a few hours. Diagnosis can be made by using a small part of the suspect sponge on an unaffected body part, although such testing usually is unnecessary. Treatment of the wounds with antiseptic lotions or dilute acetic acid (vinegar) will help ease the itching and burning. Antibiotic ointments may be necessary for the blisters. Toxic responses are strictly from accidental contact or handling of suspect sponges.

Figure 225. Fire sponge (*Tedania ignis*). Photo: Columbia University.

Coelenterates

The Phylum Cnidaria, or coelenterates, includes the jellyfish, corals and sea anemones, and numbers over 9,000 species. They are among the most primitive of animals and they are

distributed largely in marine systems worldwide. A few species of no medical importance occur in freshwater. They may be conveniently divided into two groups including attached or fixed forms such as coral, and free-swimming medusae or true jellyfish.

Coelenterates are carnivorous animals that have developed sophisticated envenomation mechanisms to compensate for their relatively fragile body structures. A large number of cnidarians can produce painful and dangerous stings to humans. The characteristic stinging cells or nematocysts consist of a minute capsule within which is a coiled, barbed tube. When activated, this barbed tube penetrates into the victim and acts as the conduit for the injection of venom. Millions of nematocysts maybe present on the body of a single cnidarian. Some jellyfish can be extremely dangerous and can kill a person in only a few minutes or less. The sea wasp (*Chironex fleckeri*) is considered to be among the most dangerous of marine animals. Similarly, the stings of Man-O-War (*Physalia physalia*) can produce extremely painful and debilitating stings. Symptoms associated with stinging are highly variable and can range from mild irritation and rashes to severe pain, systemic shock, and death. Other symptoms are known to include headache, abdominal pain, general discomfort and muscle cramps, chills, fever, nervousness and hysteria, diarrhea, vomiting, and cyanosis. Lesions and welts are common at the location of the sting. Although most lesins dissipate within a few hours, the skin may remain reddened for a day or so.

Figure 226. Beach sign warning of stinging creatures in the water. Source unknown.

Figure 227. Beach sign warning of dangerous jellyfish. Photo: Hawaiian Lifeguard Association.

Jellyfish

The common moon jellyfish, *Aurelia aurita*, is generally considered to be harmless. However, this species occasionally has been known to sting people in the Gulf of Mexico. Stings cause instant local pain that may last for up to 30 minutes with residual pain lasting for several days afterward. Shortly after the envenomation, hives may appear around the wound sites followed by ulceration. Encrusted lesions become obvious within a few days and post-inflammatory darkly pigmented skin may still be visible for up to two weeks after the sting.

Figure 228. Moon jellyfish (*Aurelia aurita*). Photo: Herb Segars.

Another common jellyfish known as east coast sea nettle (*Chrysaora quinquecirrha*) occurs from Cape Cod south along the U.S. East Coast and throughout the Caribbean and Gulf of Mexico, and it has been introduced to the Black Sea in Europe. It commonly occurs near the confluence of coastal tributaries and bays where salinities range from 10-20 ppt. Specimens generally are white in appearance although in some areas they have prominent maroon-colored markings. The stings of sea nettle are painful, but they are not considered to be life threatening. A related species, the west coast sea nettle, *Chrysaora fuscescens,* produces equally painful stings. This species often occurs in massive swarms, and near shore aggregations are most common during fall and winter months. West coast sea nettles have a distinctive golden-brown bell (up to 30 cm diameter). The whitish oral arms and thin maroon tentacles may trail behind these jellyfish for several meters. West coast sea nettles are common in the northern Pacific Ocean, but they are broadly distributed from British Columbia to Mexico. Black sea nettle, *Chrysaora achlyos*, similarly produces painful stings. This species has a distinctive purplish-colored bell and pinkish tentacles. It is distributed from southern Baja California to Monterey Bay, California.

Figure 229. East coast sea nettle (*Chrysaora quinquecirrha*). Photo: Mary Hollinger.

Figure 230. West coast sea nettle (*Chrysaora fusescens*). Photo: Scott Messmore.

The sea wasp or box jellyfish, *Chironex fleckeri*, is distributed throughout the Indo-Pacific ocean. This jellyfish has been described as the most venomous creature on the planet and it has been implicated in the death of over 70 victims throughout its range, although primarily around Australia. Children are particularly vulnerable to the sting of this species. The months of November to May are generally considered unsafe for swimming in tropical Pacific waters due to the presence of this jellyfish and also the Irukandji (see below). Despite claims to the contrary, the introduction of "stinger nets" in an attempt to provide safe swimming areas has not been satisfactory and several cases of stings occur each year from within netted enclosures. *Chironex* prefer calm waters and tend to congregate near estuaries. They are restricted to within 1.2 miles (2 km) of the shore and are almost never found in open waters. Most stings occur on humid days when the water is calm. On windy days, they drift down to calmer and deeper waters below the choppy surface where unsuspecting swimmers can tread on them.

Figure 231. Box jellyfish (*Chironex fleckeri*). Photo: source unknown.

Severe pain is a predominant feature of a *Chironex* sting peakin in intensity at 15 minutes but persisting for up to 12 hours. Rapid heartbeat and high blood pressure that begin at the onset of envenomation are superseded by an unusually slow heartbeat, other heart anomalies, pulmonary edema, and shock resulting from the failure of the heart to pump an adequate amount of blood. Also, neuromuscular paralysis may lead to respiratory arrest. Loss of consciousness may ensue rapidly and death may occur within a few minutes of being stung. The skin characteristically shows a beaded or ladder pattern of red, purple or brown whiplash lesions with a frosty

appearance reflecting the pattern of nematocysts on the tentacles. Among survivors, these skin lesions subsequently progress over several days until they develop into ulcers and widespread tissue necrosis which heal slowly over several months, often with significant residual pigmentation and scarring.

Figure 232. Scarring caused by the sting of the box jellyfish (*Chironex fleckeri*). Photo: J. Barnes.

Management of stinging victims must commence as soon as possible following envenomizaion. Vinegar should be poured liberally over the affected part in order to inactivate nematocysts. Several other substances have been tried including tea, urine, cola drinks and aluminum sulphate (Stingose®, Parke Davis-Welcome, Carringbah, NSW, Australia). However, none of these remedies have been shown to be effective and indeed they may make the situation worse by activating undischarged nematocysts. Freshwater or alcohol must never be poured onto the affected part. Tentacles adhering to the patient should be removed manually and with caution to prevent further stinging, including the care provider. Basic life support measures, including cardiopulmonary resuscitation (CPR) may be required.

Following first aid measures, hospitalization is usually required and may involve advanced life support measures such as intubation and ventilation. Irregular heartbeat should be treated with appropriate agents and large doses of intravenous narcotic analgesics are generally required to control pain. Skin and tissue lesions are treated conventionally but may subsequently require surgical debridement and grafting.

Carukia barnesi is a small box jellyfish widely distributed in the southern Pacific and it is commonly known in Australia as Irukandji, the name of an Aboriginal tribe. This species is commonly found in both open and coastal waters. The bell of this diminutive species is only about 0.78 inch (20 mm) in diameter and there are four long tentacles. The clinical presentation of their stings is characteristic and is known as the Irukandji syndrome. An initial stinging sensation that diminishes after a few minutes may remain unnoticed by the victim but on other occasions may be quite severe. The subsequent development of local pain in the affected limb is also variable. The area around the sting site becomes reddened with small lesions appearing like gooseflesh. There may be an associated reaction where the skin is dry initially followed by excessive localized sweating. Systemic symptoms usually commence about 30-40 min after the initial sting, but they may last from 4-96 hours although around 12 hours is more typical. Widespread pain is predominant, especially in the abdomen, large muscle groups in the back, and joints. Headache is often severe. Other symptoms may develop including high blood pressure, rapid and irregular heartbeat, sweating, agitation, nausea and vomiting. In severe cases, the symptoms may progress to low blood pressure, pulmonary edema, shock and heart failure. Heart attacks may occur, even in the absence of recognized risk factors. Although no deaths have been conclusively attributed to this jellyfish, Irukandji syndrome can be severe and it is quite possible deaths have occurred historically. Other box jellyfish belonging to the same family as *Carukia* also can inflict envenomations with similar symptoms. They include several species box jellyfish in the genus *Carybdea* that are widely distributed in the southern Pacific Ocean.

Figure 233. Irukandji (*Carukia barnesi*). Photo: Lisa Ann Gershwin.

Figure 234. Box jellyfish (*Carybdea* sp.). Photo: Lisa Ann Gershwin.

Field treatment can include dousing the affected site with vinegar because it has been suggested that it may inactivate any undischarged nematocysts that may be present. However, the benefits of this old remedy may be of little value. Similarly, the application of a compression bandage and limb immobilization is recommended by life savers and ambulance officers, but there is no evidence that it modifies the subsequent clinical course. Appropriate pain suppressants should be administered while transporting the victim to hospital. Treatment is mainly supportive and intravenous narcotics normally are required to alleviate pain. Some patients respond better to morphine and opiate infusions which may have to be given several times before the pain subsides. In the most serious cases, a condition known as the sympathomimetic syndrome may develop that generally is characterized by a broad suite of symptoms including delusions, paranoia, rapid or slow heartbeat, irregular heartbeat, high or low blood pressure, high fever, sweating, bristling of hairs, dilated pupils, overactive physiological responses, and seizures. This condition is extremely dangerous for the patient and emergency medical care should be provided at earliest opportunity. Severe cases may require ventilatory support with continuous positive airway pressure or tracheal intubation.

The Indo-Pacific jellyfish, *Chiropsalmus quadrigatus*, has been implicated in many serious stinging attacks and caused at least one death, although little specific information is available for this species. This species also is commonly known as the box jellyfish, but it should not be confused with *Chironex fleckeri*. It is assigned the common name of false box jellyfish here to avoid confusion.

Figure 235. The "false box jellyfish" (*Chiropsalmus quadrigatus*). This species should not be confused with the other, more dangerous, box jellyfish (*Chironex fleckeri*). Photo: K. Gillet.

The pink jellyfish, *Pelagia noctiluca*, is distributed worldwide and cases of severe cutaneous envenomation by this species are a common but periodic occurrence. This species has cyclic population dynamics and it appears in abundance about every 10 to 12 years. During these proliferations, swarms of medusae congregate near beaches resulting in significant numbers of envenomations. The stings usually produce minor cutaneous reactions such as reddened, inflamed, and itchy eruptions, but some produce lesions are more dramatic and may present as a burn-like response. Many stinging victims have post inflammatory pigmentation that may last several months but this condition eventually resolves spontaneously.

Figure 236. Pink jellyfish (*Pelagia noctiluca*). Photo: George Reclos.

The thimble jellyfish, *Linuche unguiculata*, is *a* small (~0.78 inch or 20 mm diameter) species widely distributed in the Caribbean. They have a distinct appearance and appear dark brown internally. Thimble jellyfish often occur in swarms of several thousand specimens, but isolated individuals are occasionally seen as well. They are distributed throughout the Caribbean and where they breed throughout the summer although populations tend to peak in May. Initial contact with thimble jellyfish is generally noted by a sensation of contact followed by mild irritation. Within a few days, the stings develop into an itchy, reddened rash on exposed areas of the body. Symptoms generally self-resolve and itching can be aided with antihistamines.

Figure 237. Thimble jellyfish (*Linuche unguiculata*). Photo: Jim Christensen.

The lion's mane jellyfish, *Cyanea capillata*, is a large species distributed in the North Atlantic Ocean and Artic Sea that can deliver a powerfully painful sting. This jellyfish can grow up to 6.5 feet (2 meters) in diameter and they have long stinging tentacles. Their sting causes severe burning and blistering. Prolonged stinging events can cause muscle cramps and respiratory distress, and can be fatal in some cases.

Figure 238. Lion's mane jellyfish (*Cyanea capillata*). Photo: New York Aquarium.

Portuguese Man O'War

Portuguese Man O'War (*Physalia physalis*), is a large hydroid jellyfish characterized by a large bluish gas filled sac (pneumatophore) that acts like a sail to drive the animals though the water and often towards shore. Their long tentacles reach up to 10m in length and are responsible for stings causing severe pain followed by a dull ache that involves the joints. The sting site develops a red line with white lesions that may resemble a ladder-like pattern, and small wheals may develop that resemble a string of beads. A systemic syndrome lasts for up to 24 hours and comprises hypotension (sometimes shock), abnormally fast heart beat, chills, muscle cramps, nausea and vomiting, irritability and confusion. Deaths have been reported from respiratory failure. Treatment is mainly supportive but may require advanced life support measures in some cases. Local corticosteroid creams may reduce inflammation. Patients should be hospitalized and possibly admitted to intensive care depending on the severity of the systemic syndrome.

Figure 239. Portuguese Man O'War (*Physalia physalis*). Photo: NOAA.

Sea Anemones

The stings of some sea anemones can be dangerous, causing pain and incapacity. Fortunately most sea anemones have nematocysts that are too weak to penetrate human skin. Initial symptoms vary from a prickly sensation to severe pain. The afflicted area can become red, swollen, and blistered. Stings by the more dangerous anemones can cause shock and respiratory distress. Balloon corallimorphs, *Amplexidiscus fenestrafer*, a colonial mushroom anemone, produce stinging threads capable of penetrating wetsuits of unsuspecting divers causing significant stinging. In some victims, such stings have been known to cause long-term neurological damage. Treatment for sea anemone stings is the same as for jellyfish.

Figure 240. Balloon corallimorph (*Amplexideiscus fenestrafer*). Photo: source unknown.

Figure 241. Balloon corallimorph (*Amplexideiscus fenestrafer*), showing "balloons." Photo: Shane Patterson.

Figure 242. Unidentified sea anemone. Photo: James Edmonds.

Sea Ferns

A few sessile hydroid colonies are capable of inflicting dangerous stings to people. Among the more common sessile hydroid colonies are the Cypress Sea Fern, *Aglaophenia cupressina*, and the White-Stinging Sea Fern, *Lytocarpus philippinus*, of the central and southern Pacific Ocean. These animals have delicate fronds with rows of tiny polyps along each "limb". Despite their delicate appearance, the slightest brush against one of these hydroid colonies causes immediate pain. The stinging begins as a patchy area of reddened skin and can develop into wheals within 30 minutes. The affected area may take up to a month to heal. Local anesthetic ointment is effective as a pain reliever.

Figure 243. White-stinging sea fern (*Lytocarpus philippinus*). Photo: Theresa Zubi.

Figure 244. Unidentified sea fan, Africa. Photo: Democratic Republic of Congo.

Corals

Corals are a diverse group of marine sessile coelenterates who secrete calcareous, rock-like shelters that can occur in such densities as to create islands and atolls. The Great Barrier Reef of Australia is composed of the calcareous limestone deposits of dead and living corals. Wherever corals occur they can pose two potential threats to people. Many corals both dead and alive are very sharp and can produce serious cuts to unprotected areas of the body. These types of corals are especially dangerous in tropical regions of the Pacific Ocean. Precaution should be taken in areas where these corals occur and signs posted on beaches warning of dangerous corals should be taken seriously. The other type of dangerous corals produce stings when accidentally contacted. Such stings feel like burns and generally produce reddened inflamed patches on the skin where the contact occurred. Local anesthetic ointment is effective as a pain reliever, but victims may require additional medical treatment in severe cases. One of the most common fire corals distributed in warm oceans around the world is *Millepora complanata*.

Figure 245. Beach sign warning of sharp coral. Photo: Hawaiian Lifeguard Association.

Figure 246. Fire coral (*Millepora complanata*). Photo: Henderson State University.

Bryozoans

Bryozoans (Phylum Ectoprocta) are colonial animals found in both freshwater and marine habitats. A single marine species, *Alcyonidium gelatinosum* (Family Alcyonidiidae), widely distributed in both Atlantic and Pacific oceans, can produce irritating erythematous dermatitis (Dogger's Bank itch) when contacted. This species occurs commonly among European coastal

fishermen, especially those in Denmark, England and France where it occurs in about 10% of the fishermen who contact the bryozoan. The allergic response typically follows repeated exposures to these animals and not one time encounters. Topical antihistamine treatments are recommended for treatment.

Figure 247. A marine Bryozoan (*Alcyonidium gelatinosum*). Photo: Ulster Museum.

Figure 248. Dogger's Bank itch rash on the arm of a fisherman. Photo: John Chappell.

Echinoderms

Various members of the marine Phylum Echinodermata (sea stars, brittle stars, and sea urchins) have been shown to have toxic properties that can harm people who contact them.

Sea Stars and Brittle Stars

Most species of sea stars (Class Asteroidea) are harmless, but a common tropical Indo-Pacific species, *Acanthaster planci* (crown of thorns starfish) has venomous spines capable of causing extremely painful wounds. This species can grow to more than 1 foot (300 mm) in diameter, and is distint from most starfish in having more than a dozen spiny arms. Contact with the venomous spines of this creature causes severe pain, swelling, profuse and frequent vomiting, numbness and occasionally paralysis. In some victims, pain has been known to last for several days. The sharp spines are capable of penetrating gloves, boots and wetsuits. Immersing the afflicted body part in hot water can reduce the pain, but this may not be practical in some situations. Medical attention is usually required for severe envenomations.

Figure 249. Crown of thorns starfish (*Acanthaster planci*). Photo: Linda Pitkin.

Figure 250. Crown of thorns starfish (*Acanthaster planci*). Photo: World College of Southeast Asia.

The Mosaic Sea Star, *Plectaster decanus* can cause a skin rash if handled with bare hands, and the Chain-Link Brittle Star, *Ophiomastix annufosa*, (Class Ophiuroidea) has been reported to have caused deaths in small animals. Contact with this species or its body fluids should be avoided.

Figure 251. An unidentified brittle star. Photo: NOAA.

Sea Urchins

Sea urchins are found in oceans worldwide. Similar to the starfishes, some species of sea urchins (Class Echinoidea) have toxic spines and/or minute stalked appendages (pedicellariae), both of which can cause envenomation. The spines also are brittle and can break-off into the skin, resulting in additional physical trauma. The toxin injected by some sea urchins can cause intense pain. Symptoms associated with stinging include general discomfort, nausea, vomiting, and diarrhea, and headaches. Species in the urchin Family Toxopneusidae have short thick spines that project outward through a display of flower-like pedicellariae. These structures have hook-like jaws that can deliver venom resulting in severe pain, respiratory distress, paralysis, and occasionally death. A common treatment for sea urchin envenomation is to immerse the punctured area in water heated to a temperature barely tolerable to the touch. Local anesthesia also can be used to alleviate pain. Spines and pedicellariae should be removed from the wound as soon as possible because they continue to release venom until they are removed, and surgical

exploration of the wounds may be necessary in severe cases. Local antibiotic therapy after removal of the spines reduces chances of secondary infection.

Figure 252. Unidentified sea urchin. Photo: Olof Aldin.

Figure 253. Sea urchin (*Strongylocentrotus purpuratus*). Photo: Humbolt State University

Sea Cucumbers

The final echinoderm group known to be dangerous to people is the sea cucumbers (Class Holothuroidea), although dangerous encounters with these animals are rare. Most problems associated with sea cucumbers are due to consuming the flesh of poisonous species that may result in death. However, some species when threatened or handled will eviscerate their intestines and white sticky threads used for defensive purposes. These threads and excreted mucus contain a toxin known as holothurin which can cause skin and eye irritation. Reported reactions to the toxin include burning, inflammation, redness, intense pain, and damage to the eyes sometimes causing blindness. Some species of sea cucumbers also ingest other stinging animals and incorporate and excrete those toxins for their own defense.

Figure 254. An unidentified sea cucumber. Photo: Kieran Boyce.

Figure 255. A sea cucumber (*Parastichopus californicus*). Photo: John Harvey.

Annelid Worms

Leeches

Leeches belong to the Phylum Annelida which also includes the earthworms. All leeches have 34 body segments although their form and structure varies widely. Some land leeches can grow to nearly 8 inches (200 mm) in length. The majority of several hundred known species of

leeches occur in a broad variety of standing freshwater habitats throughout the world. Other species are marine while others occur in moist temperate and tropical terrestrial environments. Although some leeches attach to vertebrate hosts to take a blood meal, most species are free-living scavengers or predators and pose no threat to people. Representative blood-sucking aquatic leaches occur in temperate and tropical aquatic habitats worldwide. Some common blood-feeding leeches include the European medicinal leech (*Hirudo medicinalis*), Asian medicinal leech (*Hirudinaria manillensis*) and the Amazon leech (*Haementeria ghilianii*). Also of particular interest in Southeast Asia area are the land leeches (*Haemadipsa* spp.) all of which are blood feeders. Blood-sucking terrestrial and aquatic leeches occur throughout East and Southeast Asia and in some areas constitute a real annoyance for military personnel forced to wade or crawl through swamps or travel in leech infested jungle. In Asia, leeches have been reported from the sinuses of people who swam in infested water, and, in such circumstances, the offending leech may have to be surgically extracted.

Figure 256. Amazon leech (*Haementeria ghilianii*). Photo: Mark Siddall.

Figure 257. Land leech (*Haemadipsa* sp.). Photo: Stanley Bender.

When a person enters leech-infested habitats, the leeches quickly swim towards the source of water disturbance. Upon reaching the host, a leech will immediately adhere with one of the suckers, then begin "exploring" in "measuring- worm" style over the skin surface. This may continue for 20 or 30 seconds or the leech may release its grip and swim around to another site and repeat the exploring action until a suitable attachment point has been selected. At this time the shin of the host is quickly perforated with the three cutting plates with minute teeth which are protruded into the cavity of the anterior sucker. As soon as the skin is perforated, suction begins

and continues until the leech is engorged. During engorgement a leech may take up several times its own weight in blood. The speed of engorgement varies, although leeches can ingest a surprising amount of blood in only a few minutes. Because blood-feeding leeches often ingest several times their body weight in blood at a single feeding and they digest their food slowly, they may go months between blood meals.

Blood ingested by leeches is mixed with salivary fluid containing an anticoagulant known as hirudin or hemetin depending on the group of leeches involved. These compounds prevent blood from clotting thus allowing the leech to freely feed. When the leech either drops from the host or is pulled loose, blood continues to flow from the attachment site for up to an hour and the wound may ooze for up to 5 hours. Also, there may be delayed irritation and itching associated with the wound. Secondary infections associated with the bite site can occur and such areas should be washed and treated with an alcohol or similar disinfectant solution after a leech is removed or falls off following feeding. However, the most significant threat posed by leeches arguably is one of a psychological disturbance.

Land leeches are quickly aroused when vegetation is moved or when a person walks through an area. Body odor of the host, movement, respiratory carbon dioxide, and perhaps other factors attract leeches to their hosts. Aroused land leeches "stand up" in a characteristic reaching attitude and sway in different directions when a host animal is close by. Upon the slightest contact with a host, they will attach the anterior sucker, and then commence exploring for a suitable attachment point. In doing this they may enter any opening in clothing and have been known to go through eyelets of boots or through the fabric in loosely woven cloth. They may

crawl between the boot and sock and feed by penetrating the sock mesh. In such instances the bite may go unnoticed until the wearer takes off the boot or finds that a "wet" feeling inside the boot is actually his own blood.

Polychaetes (bristle worms)

Certain free-living marine worms know as fire worms (Class Polychaeta, *Hermodice carrunculata, Eurythoë complanata)* have hollow, toxin-filled setae that cause painful stings when they break human skin. The retractable setae can be extended by the worm when they are threatened. Reactions to the venom may include a long-lasting burning sensation and associated inflammation, itching, and numbness, in addition to the possibility of secondary infection. The burning sensation typically last several hours but can last several days in some cases. Remedies for the burning include removing the offending setae from the skin using a pair of forceps or sticky tape, and gently soaking the affected area with isopropyl alcohol, vinegar, or diluted (10%) ammonia. Topical benzocaine can relieve pain, and antibiotic ointment should be applied to the wound to minimize the possibility of a secondary infection. Prior to removing the offending setae, the skin should not be rubbed as this only aggravates the stinging.

Figure 258. Fire worm (*Hermodice carunculata*). Photo: University of Vienna.

Figure 259. Fire worm (*Eurythoe camplanata*). Photo: David J. Elliott.

Another group of marine polychaetes do not sting with their setae but they inflict painful bites with a pair of fangs located at the tip of an eversible proboscis. Worms belonging to this group include *Eunice aphroditois*, *Onuphis teres*, and *Glycera* spp. The fangs of *Glycera* spp. are equipped with venom glands and their bites are reportedly similar to that of a wasp sting.

Symptoms generally include pain, swelling, redness and itching that may last several days. Small lesions may appearr at the bite location. Recovery is otherwise uneventful.

Figure 260. Polychete worm (*Glycera* sp.). Photo: David Remsen.

Figure 261. Mouthparts of the polychete worm *Glycera* sp. Photo: source unknown.

Mollusks

There are over 70,000 described species in the Phylum Mollusca that are distributed worldwide in terrestrial and aquatic habitats. However, only a few species can cause injury and potential death to people through envenomation or as a host of certain parasites. All of these mollusks are aquatic and occur in marine or freshwater habitats.

Several members of the Class Cephalapoda (squids, octopuses, cuttlefishes) are capable of inflicting painful and potentially dangerous bites with their hardened tooth-like beaks. The salivary glands associated with the beaks are used to kill or immobilize prey items, and they will inflict painful bites to people when threatened or handled. Symptoms stemming from envenomation include pain, stinging and burning sensations and swelling related to the original bite, as well as nausea, vomiting, diarrhea, fever, headache, and chills. Some victims have reported blurred vision, difficulty talking, and loss of feeling in the extremities. Other victims may develop convulsions, respiratory distress, and paralysis. Death can occur, but mortality rates attributed to cephalopods is generally less than one percent. Recovery normally is complete within 2 days. Cephalopods occur exclusively in marine habitats but they are distributed in oceans worldwide. The blue-ringed octopus (*Octopus maculosus*) of Australia has

been widely identified as capable of inflicting lethal bites to humans but such occurrences are extremely rare, and the species is not aggressive.

Figure 262. Bue-ringed octopus (*Octopus maculosus*). Photo: source unknown.

Most potentially harmful mollusks belong to the Class Gastropoda which includes the marine cone snails, pteropods, nudibranchs, and several genera of freshwater snails. Cone shells are the most dangerous gastropods to humans because they are capable of stinging humans with painful and potentially fatal results. Several species in genus *Conus* are capable of inflicting severe envenomations to people. Cone shells are widely distributed in the southern Pacific and Indian Oceans but the species most dangerous to people are found in the western and southwestern Pacific from Japan to Australia. Cone shells are predatory on fish and other creatures that they attack with a detachable, sharp tooth equipped with a venom gland. This dart-like tooth can be operated more rapidly that a person can react so cone shells should never be picked-up or held with an unprotected hand. Stings by cone shells results in only a very small puncture mark and, in most cases, they occur on the hand when they are picked-up. At onset the sting produces immediate sharp, burning pain. Some victims may report no such pain initially, and the initial symptoms only manifest as numbness that extends rapidly up the arm. Other symptoms may include a rapidly developing flaccid paralysis along with difficulty in speech and blurred vision. Most patients do not experience any respiratory difficulty. Loss of sensation and complete absence of reflexes may accompany paralysis. Swelling and skin discoloration has been recorded among some victims. In non-fatal cases most symptoms disappear within 24 hours. In fatal cases, death typically occurs in less than 12 hours and usually in 6 hours or less.

Recovery may take from hours to weeks depending on the species and amount of venom delivered. Serious and sometimes lethal stings have been reported for at least 14 species of *Conus*. However, the geography cone (*Conus geographicus*) is most commonly implicated in severe stinging cases among people. Incidences of cone shell stings have been reported from Japan, the Loyalty Islands, the New Hebrides, New Britain, the Seychelles, New Caledonia, New Guinea, the Paumotou Islands, and Australia.

Figure 263. Cone shell (*Conus geographicus*). Photo: Paul Kersten.

Figure 264. Cone shell (*Conus catus*). Photo: source unknown.

Figure 265. Cone shell (*Conus* sp.). Photo: David Bowles and Mark Pomerinke.

Pteropods (ex. *Creseis acicula*), or sea butterflies, are small snails occurring in oceans worldwide. They can inflict irritating stings causing a raised (maculopaplar) rash, but generally this self-resolves and there are no more serious symptoms. They primarily are a nuisance and not a significant medical threat.

Figure 266. A sea butterfly (*Creseis acicula*). Photo: Rudolph Scheltema.

Nudibranchs, or sea slugs, particularly the genera *Aeolidia*, *Glaucus*, and *Hermissenda*, feed on various coelenterates and then incorporate the stinging nematocysts into their own bodies for defensive purposes. A sting from one of these nudibranchs is not unlike that of the coelenterate itself. Nudibranchs often are brightly colored animals but specific identification is difficult and therefore contact with any of these animals should be avoided.

Figure 267. A nudibranch (*Aeolida papillosa*). Photo: Steve Gardner.

Figure 268. A nudibranch (*Chromodoris magnifica*). Photo: Great Barrier Reef Park Authority.

Figure 269. A nudibranch (*Flabellina rubrolineata*). Photo: Great Barrier Reef Park Authority.

Figure 270. A nudibranch (*Glaucus atlanticus*). Photo: Gary Cobb.

Figure 271. A nudibranch (*Hermissendra crassicornis*). Photo: David W. Behrens.

Figure 272. An unidentified nudibranch. Photo: Stanford University.

Figure 273. An unidentified nudibranch, Honduras. Photo: Joe Fries.

Several genera of freshwater snails serve as the intermediate hosts of parasitic flukes *Schistosoma* spp. which can cause potentially fatal schistosomiasis in humans. These host snails include the genera *Bulinus*, *Biomphalaria*, and *Oncomelania*. However, because these snails can be quite difficult to identify, all freshwater snails within the range of schistosomiasis should be considered as suspect. *Bulinus* spp. occur in the Africa, Middle East, Madagascar, Mauritius, India. *Australorbis* spp. (*Biomphalaria* spp.) also is a widely distributed genus occurring in Africa, Middle East, Madagascar, South America, and some Caribbean Islands. This genus also occurs in the southern United States southward through Central America but it is not known to serve as a schistosome host in these latter areas. Members of the genus *Oncolmelania* are distributed widely throughout Asia including China, Japan, the Philippines, and Sulawesi (Celebes). *Oncomelania* snails are amphibious and readily climb on vegetation and moist soils near the water source.

Figure 274. *Biomphalaria* sp. Photo: University of Hamburg.

Figure 275. *Bulinus globosus*. Photo: Eric Genevelle.

Figure 276. *Oncomelania hupensis*. Photo: P. R. Hubai.

Swimmer's itch (schistosome cercarial dermatitis)- In temperate regions worldwide, certain larval flukes (cercariae) that normally infect wading birds will sometimes infect humans that come in contact with infested water. Such infestations do not have any long-term consequences nor do they pose a threat of disease. However, the area of skin where the larval flukes burrow into the host becomes irritated resulting in formation of pustules which causes the victim to experience intense itching in that area. The larval flukes that cause swimmers itch are contacted in slow moving or stagnant water and such habitats should be avoided or not waded without a properly worn uniform.

Figure 277. Fluke cercaria that causes swimmer's itch. Photo: source unknown.

Figure 278. Swimmer's itch rash. Photo: Friedrich Alexander Universitat, Germany

Acknowledgements

We thank all those who generously gave us assistance with development of text, reviews and editing, photography assistance, and other support. We particularly thank all Air Force Medical Entomologists both past and present who, in one way or another, have greatly benefited the development of this field guide.

Bibliography

Akre, R. D., A. Greene, J. F. MacDonald, P. J. Landolt, and H. G. Davis. 1980. Yellowjackets of America North of Mexico. U.S. Department of Agriculture, Agriculture Handbook No. 552.

Biery, T. L. Not dated. Venomous arthropod handbook, envenomation, symptoms/treatment, identification biology and control. Air Force Pamphlet 161-43.

Borror, D. J., C. A. Triplehorn, and N. F. Johnson. 1989. An introduction to the study of insects, sixth edition. Saunders College Publishing, New York.

Bücherl, W. and E. E. Buckley (editors). 1971. Venomous animals and their venoms. Volume III. Venomous invertebrates. Academic Press, New York.

Bush, S. P., King, B.O., Norris, R.L., Stockwell,S.A. 2001: Centipede envenomation. Wilderness Environmental Medicine 12: 93-99.

Dzelalija, B., and A. Medic. 2003. *Latrodectus* bites in Northern Dalmatia, Croatia: clinical, laboratory, epidemiological, and therapeutical aspects. Croatian Medical Journal 44:135-138.

Feldmeir, H., M. Eisle, R. C. Saböia-Moura, and Jörg Heukelbach. 2003. Severe tungiasis in underprivileged communities: a case series from Brazil. Eemerging Infectious Diseases 9:1-7.

Goddard, J. 1989. Ticks and tickborne diseases affecting military personnel. USAF School of Aerospace Medicine, USAFSAM-SR-89-2, Brooks AFB, TX

Goddard, J. 1993. Physicians guide to arthropods of medical importance. CRC Press, London.

Goddard, J. 1994. Direct injury from Arthropods. Laboratory Medicine 25:365-371.

Goddard, J. 2000. Infectious diseases and arthropods. Humana Press, Totowa, New Jersey.

Gorham, J. R., and T. B. Rheney. 1968. Envenomation by the spiders *Chiracanthium inclusium* and *Argiope aurantia*. Journal of the American Medical Association 206:1958-1962.

Halstead, B. W. 1965. Poisonous and venomous marine animals of the world. Volume one—invertebrates. United States Government Printing Office, Washington, D.C.

Halstead, B. W. 1995. Dangerous marine animals that bite, sting, shock, or are non-edible, third edition. Cornell Maritime Press, Centerville, Maryland.

Hölldobler, B., and E. O. Wilson. 1990. The Ants. Belknap Press of Harvard University Press, Cambridge, Massachusetts.

James, W. D. (editor). 1994. Textbook of military medicine, part III, disease and the environment, military dermatology. Office of the Surgeon General, Walter Reed Army Medical Center, Washington, DC.

Kettle, D. S. 1995. Medical and veterinary entomology, 2nd edition. CABI Publishing, Oxon, United Kingdom.

Lago, P. K., and J. Goddard. 1994. Identification of medically important arthropods. Laboratory Medicine 25:298-305.

McHugh, C. P. 1994. Arthropods: vectors of disease agents. Laboratory Medicine 25:429-437.

Norris, R. Centipede envenomations. eMedicine Journal 3.

Smith, R. L. 1982. Venomous animals of Arizona. Cooperative Extension Service, University of Arizona, Tucson, Arizona.

United States Centers for Disease Control and Prevention. Not dated. Pictorial keys to arthropods, reptiles, birds and mammals of public health significance. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Atlanta, Georgia.

United States Air Force. 2002. Guide to surveillance of medically important vectors and pests. USAF Force Protection Battlelab, Lackland AFB, TX

Zumpt, F. 1965. Myiasis in Man and Animals in the Old World. Butterworths, London, England.

Appendix 1. Medically important and venomous invertebrates of the world. Following the scientific name is the common name, if known, and the geographic distribution.

SPIDERS

Banana Spiders (Family Ctenidae)

Phoneutria fera: South America

P. ochracea: South America

Black Widows (Family Theriidae)

Latrodectus antheratus: Paraguay, Argentina

L. apicalis: Galapagos Islands

L. atritus: New Zealand

L. bishopi (red widow): Southeastern United States

L. cinctus: Cape Verde Island, South Africa

L. corallinus: Argentina

L. curacaviensis (Brazlian black widow): Lesser Antilles, Americas

L. dahli: Southern Europe, Northern Africa, Middle East

L. diaguita: Argentina

L. erythromelas: Sri Lanka

L. geometricus (brown widow): Southern United States , South Africa, Japan, Southeast Asia

L. hasselti (redback): Southeast Asia, Australia, New Zealand, Japan, Marianas, Philippines, Timor, many other regional islands, New Guinea, Southeast Asia

L. hesperus (western black widow): Western North America, Israel, Singapore?

L. hystrix: Southern Europe, Northern Africa, Middle East

L. indistinctus: Namibia, South Africa

L. karrooensis: South Africa

L. katipo: New Zealand

L. lilianae: Spain

L. mactans (southern black widow): Southern North America, South Africa

L. menavodi: Madagascar, Comoro Island

L. mirabilis: Argentina

L. obscurior: Cape Verde Islands, Madagascar

L. pallidus: Cape Verde Islands, Libya, Europe, Russia, Iran, Africa, Middle East, Turkey

L. quartus: Argentina

L. renivulvatus: Africa

L. reviensis: Israel

L. rhodesiensis: South Africa

L. tadzhicus: Tajikstan

L. tredecimguttatus: Medditerranean, Saudi Arabia, Ethiopa, South Africa, Central Asia

L. variegates: Chile, Argentina

L. variolus (northern black widow): Northern North America

Brown recluses (Family Siciariidae)

Loxosceles laeta: South America

L. parrami: South Africa

L. reclusa (brown recluse): North America east of the Rocky Mountains

L. rufescens: Mediterranean, Australia

L. rufipes: Australia

L. spinulosa (jr. syn is *spiniceps*) (savanna violin spider): Africa

L. speluncarum: South Africa

Loxosceles unicolor: California

Funnelweb spiders (Family Hexathelidae)

Atrax robustus (Sydney funnel web spider): Australia

Atrax formidabilis: Australia

Hadronyche cerberea: Australia

H. infensa: Australia

H. modesta: Australia

H. versuta: Australia

Hobo spider (family Agelenidae)

Tegenaria agrestis: Europe, United States (Pacific Northwest, including Europe)

Megalomorph spiders (Family Theraphosidae)

Harpactirella lightfooti: South Africa

Six-eyed sand/crab spiders (Family Siciariidae)

Sicarius spp.: Zimbabwe, southern Africa, Central and South America, and the Galapagos Islands.

Wandering spiders (Family Heteropodidae)

Palystes natalius: South Africa

White-tailed spider (Family Lamponidae)

Lampona cylindrata: Australia

L. murina: Australia

Yellow sac spiders (Family Miturgidae)

Cheiracanthium brevicalcaratum: Australia
C. fulcatum: South Africa
C. inclusum: United States, southwestern Canada
C. japonicum: Japan
C. mildei: Mediterranean, United States
C. mordax: Australia, Central and Southwestern Pacific, and some parts of the United States (including Hawaii)
C. punctorium: Europe

Other Spiders of Potential Concern

Argiope spp. (Family Araneidae, garden spiders): worldwide

Phidippus spp. (Family Salticidae, jumping spiders): worldwide

Lycosa raptoria (Family Lycosidae, wolf spider): South America

SCORPIONS (Specific states are indicated in parentheses where appropriate)

Family Buthidae

Androctonus amoreuxi: North Africa

A. australis (fat-tailed scorpion): Middle East, North Africa

A. bicolor (black fat-tailed scorpion): North Africa

A. crassicauda : Middle East

Buthus occitanus (yellow thick-tailed scorpion): Mediterranean, North Africa

Centruroides elegans: Mexico (Jalisco)

C. exilicauda (Arizona bark scorpion*)*: United States (Arizona, California, Utah), Mexico (Baja & Sonora)

C. limpidus: Western Mexico

C. noxius: Mexico (Nayarit)

C. suffusus: Mexico (Durango)

Compsobuthus acuticarinatus : Egypt

Hottentata saulcyi: Iran

Leiurus quinquestriatus (yellow scorpion or "death stalker"): Southwest Africa, Middle East

Mesobuthus eupeus: Iran

M. tamulus (red scorpion): India

Odontobuthus doriae: Iran

Palamneits swammerdami: India

Parabuthus granulatus: Southern Africa

P. transvalicus (fat-tailed scorpion): Southern Africa

Tityus bahiensis: Brazil

T. serrulatus (Brazilian yellow scorpion): Brazil

T. trinitatis: Trinidad

Family Hemiscorpiidae

Hemiscorpius lepturus: Iran

Family Scorpionidae

Opistophthalmus glabifrons (yellow creeping leg scorpion): Southern Africa

MITES

Chigger Mites (Family Trombiculidae)

Leptotrombidium spp.: Asia, Indonesia, Australia, Philippines

Eutrombicula (EuEutrombicula) alfreddugesi (chigger): Southern North America

T. autumnalis: Europe

T. splendens: Southern North America

Scabies Mites (Family Sarcoptidae)

Sarcoptes scabei (scabies): Worldwide

Dust Mites (Family Pyroglyphidae)

Dermatophagoides farinae (dust mite): Worldwide

D. pteronyssinus (European house dust mite): Worldwide?

Chicken Mite (Family Cheyletiellidae)

Dermanyssus gallinae (chicken mite): Worldwide

Bird and Fowl Mites (Family Macronyssidae)

*Ornithon*yssus *bacoti* (tropical rat mite): Worldwide

O. bursa (tropical fowl mite): Worldwide

O. salvarium (northern fowl mite): Temperate areas worldwide

Spiny Rat Mite (Family Laelapidae)

Laelaps echidnina (spiny rat mite): Worldwide

House Mouse Mite (Family Dermanyssidae)

Liponyssides sanquineus (house mouse mite): Worldwide

Straw Itch Mite (Family Pyemotidae)

Pyemotes tritici (straw itch mite): Temperate regions worldwide

Grain and Flour Mite (Family Acaridae)

Acarus siro (grain or flour mite): Worldwide

TICKS

Hard Ticks (Family Ixodidae)

Amblyomma americanum (lone star tick): Central and eastern United States, Mexico

A. cajennense (cayenne tick): Southern United States, Mexico, Central & South America

A. hebraeum (bont tick): Central & southern Africa

Boophilus spp. (cattle ticks): Worldwide

Dermacentor andersoni (Rocky Mountain wood tick): Western United States, Canada

D. marginatus: Europe, western Asia

D. nuttalli: Eastern Europe, northern Asia

D. occientalis (Pacific Coast tick): Western United States (California), Mexico (Sonora)

D. silvarum: Europe, northern Asia

D. variablis (American dog tick): United States, Mexico

Haemaphysalis concinna: Europe, Asia

H. leachi: Africa, Asia, [eastern Australia?]

H. spinigera: India, southeast Asia, Indonesia

Hyalomma asiaticum (Asiatic Hyalomma): Asia

H. anatolicum (Anatolian Hyalomma): Europe, Asia, India, Africa

H. marginatum: Africa, Asia, Europe, India

Ixodes holocyclus (Australian paralysis tick): Australia, Papua New Guinea

I. pacificus (western black-legged tick): Western United States, Mexico

I. persulcatus (Taiga tick): Central and Eastern Europe, northern Asia

I. ricinus (European castor bean tick): Northern Africa, Europe, Northern Asia

Ixodes scapularis (black-legged tick): Central and eastern United States, Mexico

Rhipicephalus appendiculatus (brown ear tick): Central and Southern Africa

R. sanguineus (brown dog tick): Worldwide

Soft Ticks (Family Argasidae)

Ornithodoros coriaceus (Parjaroella tick): Western United States, Mexico

O. hermsi: Western USA and Canada

O. moubata (eyeless Tampan): Africa

O. rudis: Central and South America

O. talaje: Southern and western United States, Mexico, Central and South America

O. turicata (relapsing fever tick): Central, southern and western United States, Mexico

INSECTS

Collembola (springtails): Worldwide

Phthiraptera (human lice)

Family Pediculidae

Pediculus humanus capitas (head louse): Worldwide

P. humanus corporis (body louse): Worldwide

Family Phthiridae

Phthirus pubis (pubic louse): Worldwide

Blattodea (Cockroaches)

Family Blattidae

Blatta orientalis (Oriental cockroach)- Worldwide

Periplaneta americana (American cockroach)- Americas

P. fuliginosa (smoky brown cockroach)- Americas

Family Blattellidae

Blatella asahinae (Asian cockroach)- Worldwide

B. germanica (German cockroach): Worldwide

Supella longipalpa (brown-banded cockroach)- Worldwide

Hemiptera (true bugs)

Bed Bugs (Family Cimicidae)

Cimex hemiperous- Tropical areas worldwide

C. lecturlaris (bed bug): Worldwide

Assassin and Kissing Bugs (Family Reduviidae)

Arilus cristatus (wheel bug): Americas

Arilus spp: Americas

Panstrongylus spp: Central and South America

Reduvius personatus (Masked hunter): Americas

Rhodnius spp.: Central and South America

Triatoma spp.: Southwestern United States, Mexico, Central America, South America

Water Boatmen (Family Corixidae): Worldwide

Giant Water Bugs (Family Belasomatidae): Worldwide

Backswimmers (Family Notonectidae): Worldwide

Hymenoptera (ants, bees, wasps, hornets)

Ants (Family Formicidae)

Myrmecia pilosa (jumper ant): Australia

M. gulosa (bull-dog ant): Australia, Tasmania, New Caldonia

M. pyriformis (bull-dog ant): Australia, Tasmania, New Caldonia

Pachycondyla sennaarensis (samsun ant): Middle East

Paraponera clavata (bullet ant): Central and South America

Pogonomyrmex spp. (harvester ants): Southwestern United States, Mexico, Central and South America

Solenopsis invicta (red-imported fire ant): Southern United States, Mexico, Central and South America

S. richteri (black-imported fire ant): Southern United States, Mexico, Central and South America

Tetramorium caespitum (pavement ant): Europe

Wasps, Hornets and Yellow Jackets (Family Vespidae): Worldwide

Dolichovespula maculata (bald-faced hornet): North America

Vespa crabo (European hornet, sand hornet, brown hornet, German hornet): Europe, North America

Vespula maculifrons (yellow jacket): Americas

V. squamosa (yellow jacket): Americas

Velvet Ants (Family Mutillidae): Worldwide

Honey and bumble bees (Family Apidae)

Apis mellifera (honey bee): Worldwide

Bombus spp. (bumble bees): Worldwide

Carpenter bees (Family Anthophoridae)

Xylocopa spp. (carpenter bees): Worldwide

Lepidoptera (butterfies and moths)

Family Limacodidae

Calcarifera spp.: Australia

Doratifera spp. (cup moths): Australia

Euclea spp.: North America

Isa textula (crowned slug): North America

Latoia consocia: Asia

Parasa indetermina (stinging rose caterpillar): North America

Parasa spp.: Americas, Japan, Asia, New Zealand

Phobetron pithecium (hagmoth/monkey slug): Americas

Sabine stimulea (saddle-back capterpillar): North America

Family Lymantriidae

Euproctis chrysorrhoea (browntail moth): Europe

E. flava (Oriental tussock Moth): Japan

E. pseudoconspersa (tea tussock moth): Asia, Japan, Australia

E. silimis (yellowtail moth): Japan

Family Megalopygidae

Megalopyge opercularis (Puss caterpillar/flannel moth): North America

Megalopyge spp.: Americas

Family Saturniidae

Adeloneivia spp.: Central and South America

Automeris io (Io moth): Americas

Automeris spp: Americas

Cerodirphia spp.: South America

Dirphia spp.: Central and South America

Hemileuca maia (buck moth): eastern United States

Hemilueca spp.: southwestern United States, Mexico

Hylesia alinda: Cozemel, Mexico, Venezuela, Peru

H. iola: South America

H. lineate: South America

H. metabus: Venezuela

H. urticans: South America

Hyperchiria spp.: Mexico to South America

Leucanella spp.: Central and South America

Lonomia achelous: Venezuela

L. obliqua: Brazil

Molippa spp.: Mexico to South America

Family Thaumetopoeidae

Anaphae venata: Africa

A. panda: Africa

Coleoptera (beetles)

Family Meloidae

Epicauta spp.: Americas

Lytta spp.*:* Australia, Eurasia, North America

Mylabris spp.: Asia, Australia, Europe, Middle East, New Zealand

Family Staphylinidae

Paederus fusceps (rove beetle): Asia

Family Dermestidae

Trooderma granarium (Khapra beetle): Worldwide

Diptera (flies)

Black Flies (Family Simuliidae)

Simulium spp.: Worldwide

Cnephia spp.: Temperate areas worldwide

Blow and Bottle Flies (Family Calliphoridae)

Auchmeromyia senegalensis (Congo floor maggot): Africa

Chrysomyia bezziana (Old World screwworm): Africa, southern Asia

C. chloropyga: South Africa

C. megacephala (Old World latrine fly): Indo-Australian, Afrotropical

Chrysomyia spp: Asia, Australia, Indonesia

Cochliomyia hominovorax (New World screw worm): Central and South America

Cordylobia anthropophaga (Tumbu fly): Central and tropical Africa

C. rodhaini (Lund's fly): Central and tropical Africa

Cosmina bicolor: Asia

Lucilia (=*Phaenicia*) *cuprina* (sheep blow fly): Asia, Australia

Lucilia (=Phaenicia) sericata (green-bottle fly): Worldwide

Phormia regina (black blow fly): Worldwide

Flesh flies (Family Sarcophagidae)

Wohlfahtria magnifica: South-eastern Europe, southern and Asiatic Russia, Middle East, North Africa

Horse and Deer Flies (Family Tabanidae)

Chrysops spp. (deer flies): Temperate and tropical areas worldwide

Tabanus spp. (horse flies): Temperate and tropical areas worldwide

Human Bot Fly (Family Cuterbridae)

Dermatobia hominis (human bot fly): Mexico, Central and South America

Humpbacked flies (Family Phoridae)

Megaselia scalaris: Worldwide

Midges, Noseeums, Punkies (Family Ceratopogonidae)

Culicoides spp.: Worldwide

Leptoconops spp.: Worldwide

Mosquitoes (Family Culicidae)

Aedes: Worldwide

Anopheles: Worldwide

Culex: Worldwide

Psorophora: Worldwide

Haemagogus: Worldwide

Mansonia: Worldwide

Muscid Flies (Family Muscidae)

Fannia scalaris: Asia

Haematobia exigua: Asia

Lispe orientalis: Asia

Musca biseta: Africa

M. conducens: Asia

M. crassirostris: Asia

M. domestica (house fly): Worldwide

M. fasciata: Asia

Musca lucens: Asia

M. sorbens (dog dung fly, bazaar fly): Afrotropical, Oriental, regions, Australia, introduced elsewhere including Hawaii

M. ventrosa: Asia

M. vetustissima (Australian bush fly): Australia

Muscina stabulans: Asia

Stomoxys calcitrans (stable fly): Worldwide

S. niger: Afrotropical Region

S. sitiens: Afrotropical, Oriental regions

S. uruma: Asia

Sand Flies (Family Psychodidae)

Lutzomyia spp.: Southwestern United Status, Mexico, Central, South America

Phlebotomous spp.: Africa, Asia, Banladesh, Europe, India, Middle East, Pakistan

Tse Tse Flies (Family Glossinidae)

Glossina spp. (tse tse fly): Africa

Warble and Bot Flies (Family Oestridae)

Oestris ovis (sheep bot fly): Middle East, Cyprus

Siphonaptera (fleas)

Family Ceratophyllidae

Ceratophyllus gallinae (European chicken flea): Temperate regions worldwide

C. niger (western chicken flea): Western North America

Dasypsyllus gallinulae (bird flea): Worldwide

Diamanus montanus (ground squirrel flea): Western North America

Leptopsylla segnis (European mouse flea): worldwide

Nosopsyllus faciatus (northern rat flea): North America and Europe

Orchopeas howardii (squirrel flea): North America

Family Hystrichopsyllidae

Neopsylla setosa (rodent flea): Eurasia

Family Pulicidae

Cediopsylla simplex (rabbit flea): North America

Ctenocephalides canis (dog flea): Worldwide

Ctenocephalides felis (cat flea): Worldwide

Echidnophaga gallinaceus (sticktight flea): Worldwide

Hoplopsyllus anomalus (rodent flea): North America

Pulex irritans (human flea): Temperate and tropical regions worldwide

Tunga penetrans (chigoe): Tropical areas in Americas

Xenospsylla cheopsis (Oriental rat flea): Worldwide

X. vexabilis (Australian rat flea): Australia

CENTIPEDES

Family Scolopendridae

Scolopendra spp.: Worldwide (subtropical-tropical)

Family Otostigmidae

Otostigmus spp.: Worldwide (tropical)

MILLIPEDES

Family Rhinocrichidae

Rhinocricus lethifer: Haiti

Rhinocricus latespagor: Haiti

Family Spirobolidae

Iulus spp.: Indonesia

Spirobolus spp.: Tanzania

Tylobolus spp.: California

Family Spirostreptidae

Orthoporus spp.: Mexico, Central and South America

Polyceroconas spp.: Papua New Guinea

Spirostreptus spp.: Indonesia

PORIFERA (sponges)

Family Mycalidae

Neofibularia nolitangere (touch-me-not sponge): Temperate to tropical oceans worldwide

Family Tedaniidae

Tedania ignis (fire sponge): Temperate to tropical oceans worldwide

Tedania spp. (fire sponges): Temperate to tropical oceans worldwide

COELENTERATES (jelly fish, sea anemones, sea fans, coral)

Family Cyanidae

Cyanea capillata (lion's mane jellyfish): North Atlantic Ocean, Artic Sea

Family Pelagidae

Chrysaora achlyos (black sea nettle): Pacific Ocean; Baja California, southern California

C. fuscescens (west coast sea nettle): Pacific Ocean; British Columbia, Mexico

C. quinquecirrha (east coast sea nettle): Atlantic Ocean, Gulf of Mexico, Black Sea

Pelagia noctiluca (pink jellyfish): Oceans worldwide, Mediterranean Sea

Families Ulmaridae

Aurelia aurita (moon jellyfish): Gulf of Mexic, Atlantic Ocean

Family Plumularidae

Aglaophenia cupressina (cypress sea fern): Indo-West pacific

Lytocarpus philippinus (white-stinging sea fern): Indo-West pacific

Family Physaliidae

Physalia physalis (Portugese man o' war): Oceans worldwide

Family Chirodropidae

Chiropsalmus quadrigatus (box jellyfish): Indo-Pacific Ocean

Chironex fleckeri (box jellyfish, sea wasp): Indo-Pacific Ocean

Family Carybdeidae

Carybdea alata (box jellyfish): Southern Pacific Ocean

Carybdea rastonii (box jellyfish): Southern Pacific Ocean

Carukia barnesi (box jellyfish): Southern Pacific Ocean

Family Linuchidae

Linuche unguiculata (thimble jellyfish): Atlantic Ocean (Carribbean)

Family Discosomatidae

Amplexidiscus fenestrafer (balloon corallimorph anemone): Western Pacific

Lytocarpus philippinus (white-stinging sea fern**)**: Indo-West pacific

Family Milleporidae

Millepora alcicornis (fire coral): Warm oceans worldwide

Millepora complanata (fire coral): Warm oceans worldwide

Millepora spp. (fire corals): Warm oceans worldwide

BRYOZOANS

Family Alcyonidiidae

Alcyonidium gelatinosum: North Atlantic Ocean

ECHINODERMS (sea stars and brittle stars)

Family Acanthasteridae

Acanthaster planci (crown of thorns starfish): Coral reefs worldwide

Family Echinasteridae

Plectaster decanus (Mosaic sea star): Indo-Pacific Ocean

Family Ophiodermatidae

Ophiomastix annufosa (Chain-link brittle star): Indo-Pacific Ocean

ANNELID WORMS (leeches, polychaetes, nudibranchs)

Leeches

Family Glossophoniidae

Haementeria depressa: South America

H. ghilianii (Amazon leech): South America

H. officinalis: Central America

Family Haemadipsidae (land leeches)

Haemadipsa spp. (land leech): Asia

Family Hirudinidae

Hirudo medicinalis (European medicinal leech): Europe

Hirudo nipponia: Asia

Hirudinaria manillensis (Asian medicinal leech): Southern Asia, Philippines

Macrobdella decora: North America

Polychetes

Family Amphinomidae

Eurythoë complanata (bristle worm): Southern Pacific Ocean

Hermodice carrunculata (Caribbean fireworm): Caribbean

Family Goniadidae

Glycera spp. (blood worm): Temperate and tropical oceans worldwide

Family Eunicidae

Eunice aphroditois: Australia

Family Ohuphidae

Onuphis teres (beach worm): Australia

Nudibranchs and Sea Slugs

Family Aeolidiidae

Aeolidia spp.: Oceans worldwide

Family Glaucidae

Glaucus spp.: Oceans worldwide

Family Facelinidae

Hermissenda: Pacific Ocean

Family Creseidae

Creseis acicula (sea slug): Warm seas worldwide

MOLLUSKS (bivalves, squid, octopus snails, cones)

Family Octopodidae

Octupus maculata (blue-ringed octopus): Austral-Asia

Family Conidae

Conus aulicus (cone shell): Southern Pacific Ocean

C. catus (cone shell): Southern Pacific Ocean

C. geographus (geography cone): Southern Pacific Ocean

C. imperialis (cone shell): Southern Pacific Ocean

C. lividus (cone shell): Southern Pacific Ocean

C. marmoreus (cone shell): Southern Pacific Ocean

C. nanus (cone shell): Southern Pacific Ocean

C. obscurus (cone shell): Southern Pacific Ocean

C. omaria (cone shell): Southern Pacific Ocean

C. striatus (cone shell): Southern Pacific Ocean

C. textile (cone shell): Southern Pacific Ocean

C. tulipa (cone shell): Southern Pacific Ocean

Family Bulimidae

Oncomelania spp.: Asia and Asian Pacific Islands

Family Planorbidae

Biomphalaria (*Australorbis*) *spp*.: Africa, Middle East, Madagascar, Central and South America, Southwestern United States, and certain Caribbean Islands

Bulinus spp.: Africa, Middle East, Madagascar, Mauritius, India

Appendix 2. Vectorborne diseases and the vectors that transmit them.

Glossary

anaphylaxis- an increased sensitivity to a foreign compound so that a second exposure brings about a severe reaction sufficient to induce shock and death

arthralgia- pain in joints (ankles, knees, elbows, wrists, shoulders)

conjunctivitis- inflammation of the mucous membranes lining the eyelids and covering the anterior surface of the eyeball

cutaneous- referring to the skin

cyanosis- bluish, slatelike, or dark purple skin color due to excessive concentration of reduced hemoglobin in the blood

cytotoxic- poisoning of cells

debridement- the surgical removal of lacerated, devitalized, or contaminated tissue

delirium- a temporary disorientation, usually accompanied by illusions and hallucinations

dermatitis- inflammation of the skin

dialysis- a medical procedures to remove wastes or toxins from the blood and adjust fluid and electrolyte imbalances by utilizing rates at which substances diffuse through a semipermeable membrane

disseminated intravascular coagulation- a complex and controversial systemic thrombohemorrhagic disorder involving the generation of intravascular fibrin and the consumption of procoagulants and platelets

dysuria- pain during urination

ecchymosis- a hemorrhagic, non-elevated, irregularly formed discolored area of skin caused by the seepage of blood beneath the epidermis

envenomation- injection of venom into the body through either bites and/or stings

erythema- unusual redness of the skin caused by capillary congestion, resulting from inflammation, as in heat or sunburn

eschar- a sloughing or crusting which forms on the skin after the tissue dies

entomophobia- an irrational fear of insects and their relatives, or the damage or diseases they are capable of inflicting

facultative parasite- exhibiting an indicated lifestyle under some environmental conditions but not under others

hematoma- a swelling of blood which occurs in an organ or tissue resulting from ruptured blood vessels

hematotoxic- toxic or poisonous to blood, blood-producing bone marrow, or tissues (i.e., necrosis)

hypertension- persistently high arterial blood pressure

hypotension- abnormally low blood pressure

induration- a specific area of hardened tissue

larviparous- depositing living larvae, instead of eggs

maculopapular- a patch of skin that is altered in color and usually elevated that is a characteristic feature of various diseases

myiasis- invasion of the tissue of man or animals with the larvae (maggots) of certain flies (Diptera) that consume flesh or body fluids for sustenance

neurotoxic- toxins that primarily affect the nervous system of an animal

necrosis- death of cells, tissue, or bone by enzymatic degradation surrounding tissues which are healthy

necrotising arachnidism syndrome- a response to necrotic venom where living tissue is rapidly destroyed around the bite site.

obligative parasite- a parasite completely dependent on its host

occular- referring to the eyes

papules- a small elevated lesion of the skin

paresthesia- an abnormal tactile sensation, often described as creeping, burning, tingling, or numbness

parasitosis- infestation with or disease caused by parasites

perianal- the anus and surrounding area

piloerection- involuntary erection or bristling of hairs due to a sympathetic reflex usually triggered by cold, shock, or fright or due to a sympathomimetic agent

pruritis- intense, chronic itching

pseudomyiasis- accidental infestations with fly larvae such as when they are inhaled or swallowed inadvertently with food

pulmonary edema- swelling of the lung tissue due to an excessive accumulation of fluid

sympathomimetic syndrome- a condition generally characterized by a broad suite of symptoms including delusions, paranoia, tachycardia or bradycardia, hypertension, hyperpyrexia, diaphoresis (sweating), piloerection, mydriasis, hyperreflexia, seizures, hypotension and arrhythmias may occur in serious cases

tachycardia- an abnormal rapid heart, usually between 160-190 beats per minute

urticaria- itchy hives or wheals that are redder or paler than the surrounding area often attended by itching

urtication- a physiological response to contact with certain invertebrate body parts resulting a painful burning and itchy skin eruption, or hives, at the point of contact.

urogenital- relating to organs or functions of excretion and reproduction

vectorborne- carried or transmitted by vectors such as insects or other pests