enHEALTH AUSTRALIA

ARTHROPOD PESTS

OF PUBLIC HEALTH SIGNIFICANCE IN AUSTRALIA

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Preface

Humans have shown great ingenuity in adapting to life in every corner of the globe, which has, in turn, been of great benefit to many arthropod pests. These creatures have taken advantage of us, either exclusively or on an 'as need be' basis, for both food and shelter. Whether it is feeding on our blood, food, homes or garbage, many arthropods have adapted to a life in close contact with humans. For our part, we have moved our homes, businesses and holiday activities into areas that arthropods call home and it should come as no surprise that contact between people and pests will continue to increase as our population grows.

In Australia, we are fortunate to be free of some of the nastiest arthropod pests and the disease-causing microorganisms (pathogens) they transmit, particularly potentially fatal mosquito, tick and louse-borne diseases. However, we still boast an impressive list of insects, ticks, mites and spiders that can bite, sting and irritate us in our homes, workplaces and while we are enjoying the great outdoors. Besides nuisance biting and irritation, Australia also has pathogens that, while rarely causing fatalities, can be seriously debilitating and a significant cost on the local community and economy.

Climate change and globalisation represent new and potentially significant influences on the activity of arthropod pests and vector-borne disease. The predicted rises in temperature and rainfall in some regions may seem ideal for increased insect populations. However, predicting population change in our local pest populations and the activity of arthropod-borne disease is extremely difficult, with a wide range of biological, ecological, economic and sociological factors all playing a part in determining risks to public health. The rapid movement of people and their belongings around the world, facilitated by quick and affordable air travel, represents an equally important factor in future public health risks associated with local and exotic arthropods.

Sometimes it is not the insects that spread disease or that are present in large numbers that cause the greatest concern. The occasional cockroach scuttling along the kitchen floor or the tiny spider up in the corner of the bedroom can be a significant psychological threat to many self-confessed

Image TBA

entomophobes. For those who suffer a fear of insects and other arthropods, access to the worldwide web has opened up a new world of myths and misinformation that does little to alleviate these fears, and probably does a lot more to intensify them.

Whether alleviating the fears of entomophobes or addressing the risks of arthropod-borne disease in Australia, the key to success is knowledge. Along with correctly identifying the pests, knowledge of their biology, ecology and association with disease will go a long way towards achieving effective control in a timely manner.

This document is designed to provide up-to-date information on the most important arthropod pests of public health concern in Australia. The content has been updated and expanded from the 1999 version, *Guidelines for the Control of Public Health Pests — Lice, Fleas, Scabies, Bird Mites, Bedbugs and Ticks*, and now represents a key resource for those agencies and other groups, workplaces and individuals dealing with infestations of arthropod pests.

Dr Cameron E Webb

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PART I–**BACKGROUND**

Introduction

Scope

This document provides an overview of Australia's major arthropod pests of public health importance, focussing on their relative public health significance, recommendations for first aid, personal protection measures, and pest management. The term 'arthropod' refers to a wide classification of animals which includes insects, mites and ticks, arachnids (spiders) and crustaceans (such as lobsters, crabs and prawns). Many arthropod pests have complicated biological and ecological requirements and, for example, the conditions that trigger pest infestations in southern areas of the country may be different to those that trigger infestations in tropical regions.

This document is not designed to be a comprehensive guide to the biology, ecology or control of arthropod pests, or as a primary source of first aid information. It does not present an exhaustive list of arthropods with nuisance potential. There will always be situations where a unique combination of environmental and climatic conditions combines with human activity to allow a seemingly innocuous arthropod to rise to pest status. The key to solving pest problems is to correctly identify the pest causing the problems.

How to use this document

For each pest, the following series of subtitles highlight the key issues surrounding each arthropod:

+ *Description* — introductory information on the pest, including a brief description of its physical appearance to help identification and other relevant background on its current pest status.

+ *Biology and ecology* — a brief overview of the life cycle, and key biological and ecological traits that may help to avoid or manage the pest. The habitats of the pest and its host preference are discussed where appropriate. Some pests listed may have a diverse range of species and detailed information on each species is beyond the scope of this document.

+ *Public health importance* — information on the public health risks, if any, posed by the pest. These risks may include skin irritation, nuisance biting, poisoning (toxicosis) or the transmission of disease-causing microorganisms (pathogens).

+ *First aid* — basic information on treating the clinical symptoms of bites, stings, irritation or infestation. If any adverse reaction develops, or if people are concerned about a possible arthropod bite or sting, they should seek medical advice and not rely solely on the information in this document.

+ *Personal protection* — strategies for people to avoid contact with the specific pest. These may apply to potential exposure indoors, outdoors, or from existing infestations or infested individuals. Strategies can include physical or chemical barriers, changing behaviour to avoid the pest, or modifying buildings and property to minimise the risk of exposure to the pest.

+ *Managing the pest and its impacts* — strategies to control pests or minimise their effects. Specific information on insecticides and methods of application are not included. Only products registered by the Australian Pesticides and Veterinary Medicines Authority (APVMA) can be used to control infestations and a professional pest manager may be needed to eradicate the pest.

+ *References* — some pest-specific references are included. This is not intended to be a comprehensive list of references relating to the individual pests. Relevant general resources (i.e. books covering a wide range of pests) are listed in 'Further reading and resources' at the end of this document.

Public health risks associated with arthropods

Although only a very small proportion of Australia's arthropods pose a public health risk, those risks can often be very serious. Risks vary between arthropods, but may include nuisance biting, allergic reactions, skin infestations, the transmission of diseases, stings, envenoming bites and food contamination.

Nuisance biting

Humans can often be a target for bloodsucking insects and even a single insect bite can be enough to cause pain. Besides allergic reactions or the transmission of diseases, many insect bites can cause serious discomfort and annoyance. Nuisance biting can have indirect impacts on human behaviour, such as limiting outdoor activity. Sleep patterns can be disrupted and general anxiety about the risk of insect bites can cause psychological trauma. Many insects need the protein from a blood meal to complete their life cycle and, although humans are not always the specific target, our proximity when pests invade houses, backyards and urban areas means people can be affected by nuisance biting.

Allergic reactions

Humans can have various allergic reactions to arthropods from exposure to their bite, inhalation of airborne materials or physical contact. These reactions can sometimes be severe and occasionally result in anaphylactic shock or death. Some arthropods, especially dust mites, can trigger asthmatic reactions. A person's sensitivity and the severity of their reaction will vary with exposure to different pests and can often change over time with repeated exposure to particular pests. In some cases, repeated exposure may lead to desensitisation, but it can also result in extreme sensitivity in some people.

Skin infestations

Very few arthropods actively invade human tissue, but those that do can cause serious pain or discomfort. In Australia, scabies mite is the main pest in this category, and attachment of ticks to human skin can also cause serious discomfort.

Infectious diseases

The transmission of pathogens is a serious public health concern. Viruses, bacteria, rickettsia, protozoa and nematode parasites are all known to be transmitted to humans via arthropods (known as vectors) in various parts of the world. The public health risks associated with these pathogens and the severity of the diseases they cause can vary greatly, depending on the interactions between the specific arthropod vector, the pathogen, the natural hosts and the environment. Arthropods typically transmit pathogens either biologically or mechanically. The most common mode of transmission is biological, where the vector picks up the pathogen from an infected host (human or other animal), the pathogen undergoes some form of growth within the vector and is then transmitted to a human via the infected arthropod's bite. Mechanical transmission is less common and involves pathogens moving from infected to uninfected hosts through the contamination of the arthropod's body, typically the external mouthparts.

Stings and envenoming bites

Some arthropods inject venom when they bite or sting, which may lead to more severe reactions compared to a nonvenomous insect bite. The symptoms of an envenoming bite can vary greatly, ranging from mild irritation to severe pain to potentially life-threatening reactions. Venom is most commonly injected via an arthropod's sting, but some can excrete toxins in their bodily fluid or through body hairs.

Image TBA

Food contamination

Just as arthropods can transmit pathogens directly through their bites, many can pass on diseases by spreading contaminants from unhygienic areas to food storage or preparation areas. Insects that feed on contaminated material may either regurgitate, defecate or physically transfer pathogens to foodstuffs. In addition, when pest populations are high, arthropods or their body parts may contaminate stored products and be accidentally consumed, leading to allergic reactions or other human illness.

General annoyance

Under favourable conditions, many arthropods can reproduce to exceptionally large numbers. Even if these pests do not directly affect humans through biting or irritation, the sheer number of insects can cause annoyance in daily activity. In some cases, infestation of a home or property can result in severe psychological reactions, where anxiety and panic may be triggered by the perceived health risks or social stigmas associated with some pests. Some people have a strong fear of insects, known as entomophobia.

Personal protection strategies

Avoidance

One of the most reliable ways to minimise the risk of exposure to pest arthropods is to avoid their natural habitats (e.g. known mosquito or tick habitats) or limit their ability to infest a house or workplace (e.g. bed bugs or bird mites). This relies on knowledge of the pest, their natural habitats and environmental triggers for activity or population increases. For many pests, these factors may change depending on their geographic distribution across Australia.

Insect repellents

Insect repellents are usually applied to the skin to stop biting insects identifying the person as a potential blood meal. Repellents are often used against biting midges, mosquitoes and ticks, although they can sometimes be used against other blood-feeding arthropods (e.g. bed bugs, bird mites). Although the specific mode of action for many repellents is not fully understood, they usually stop the arthropod from biting by either blocking the cues that identify the host as a potential blood meal or providing an odour that overrides that of the host. There is a wide range of repellents available, classified as either synthetic or botanical in nature.

Synthetic repellents

This term generally applies to chemically produced or synthesised repellents. The most effective and widely used repellent internationally is DEET (diethyltoluamide). Developed by the United States Army in the 1950s, DEET is now used by many millions of people around the world and is available in a wide range of application formulations (e.g. roll-ons, lotions, aerosols, pump-sprays and wipes) and concentrations. Generally, repellents containing less than 10% DEET will offer up to two hours' protection from biting arthropods and are suitable for general use. Repellents that contain up to 80% DEET are more suitable for long periods of exposure to biting arthropods in areas of endemic vector-borne disease.

Picaridin is another widely available active ingredient found in commercial insect repellents in Australia. This product was developed more recently, is generally thought to have a more pleasant scent than DEET and has lower toxicity to humans (making it more appropriate for use on children). Scientific studies have shown that this product is equally effective at preventing insect bites as DEET.

Botanical repellents

There are a large number of plants whose essential oils or extracts may provide protection against biting insects. The most common products come from strongly aromatic plants, such as eucalypts or tea-tree, and commercial products often contain a blend of extracts. Many scientific studies have compared botanical and synthetic repellents and, although botanical products may provide some protection, products such as DEET and picaridin provide substantially greater and longer term protection, even at low concentrations. Some natural products offer protection for only a few minutes, leaving users unprotected and exposed to disease-carrying vectors. However, research on repellents with botanical-based active ingredients is continuing and these products may be useful under some circumstances.

Coils, sticks and other gadgets

Burning plant material to repel biting insects has been used by many cultures for thousands of years. Today, the tradition continues in the form of mosquito coils and sticks. The mosquito coil is the most popular form of personal protection from biting insects over the past 100 years. These devices are made of materials impregnated with insecticide (e.g. synthetic pyrethroids, such as allethrin) that burn slowly (some coils burn for up to eight hours) and may provide up to 80% protection. Some formulations are also available with botanical active ingredients, but these are generally less effective. Coils are cheap to produce and easy to operate, although the smoke produced may present a health risk when used indoors. There is also a number of electronic units available (for both indoor and outdoor use) that release insecticides from slow-release mats or liquids. These units can be very effective, as the pyrethroids kill mosquitoes rather than simply repelling them.

A wide range of products claim to repel biting insects in formulations other than topical repellents. Products containing synthetic or botanical active ingredients can include patches and wrist bands that claim to provide a degree of protection. However, scientific studies have shown that these products offer substantially less protection than topical repellents.

Repellent safety

All repellents used in Australia, whether synthetic or botanical, must by law be registered with the APVMA and the approval number must be listed on the label.

There is often a perception that synthetic repellents, such as DEET, are unsafe. However, despite the widespread use of DEET-based products internationally, there are very few cases of adverse reactions. Most of these cases involve serious misuse, most commonly applying too much of the product (especially on young children), eating it or exposing the eyes to the product. Botanical-based products can also cause irritation. The risk of an adverse reaction from using a repellent is very low and failing to use repellents in some locations will almost certainly result in insect bites and the real possibility of acquiring an infectious disease.

Regardless of the active ingredient, all repellents should be applied according to the instructions on the label.

Insecticides

All insecticides must be registered with the APVMA for use in Australia. Detailed discussion of the most suitable products for controlling specific pests is beyond the scope of this document and professional pest managers may be needed to treat serious infestations. However, in many cases, household insecticides (either knockdown aerosols or long-lasting residual surface sprays) may be a cost-effective solution to lessen the short-term effects of some biting arthropods. The one notable exception to this is for bed bugs, as household products are generally ineffective and can cause the infestation to spread, making eradication more difficult and expensive.

Barriers

Physical and chemical barriers against pests are often very effective. Screened windows, doorways and balconies, and bed nets provide protection from flying insects, and insecticide applications to the building or surrounding vegetation may provide further protection. Some vertebrate animals, such as bandicoots, rodents and birds can carry arthropod pests; barriers that stop these animals from entering properties are often the best way to minimise the risks of exposure to these arthropods.

Electronic devices

Many electronic (e.g. ultrasonic) devices are available that claim to repel invertebrate and vertebrate pests, but these have repeatedly been shown to be ineffective. These devices continue to be adapted to new technologies with options available for mobile phones, portable music players and other digital devices but, unfortunately, no new advances in their actual repellent properties have been made.

Traps and lures

A wide variety of traps and lures are designed to control arthropod pests. These traps and lures vary greatly, not only in their design and mode of action (e.g. electrocuting lights, carbon dioxide-baited suction traps, sticky paper, shelter providers), but also in their effectiveness in controlling pests. Although many of these devices collect pest arthropods, few offer complete protection from pest effects, long-term population control or eradication. However, they may be an important component of integrated pest management strategies and can be a useful tool in monitoring pest populations.

Knowledge

One of the most effective tools to assist personal protection is knowledge. Information about locally important pests and their biology, ecology and potential health impacts will allow the individual to better avoid exposure to the pests' bites, stings and disease-causing microorganisms. It is hoped that this document will go some way towards improving the availability of knowledge on many of Australia's most important arthropod pests.

Further reading

Antwi FB, Shama LM and Peterson RKD 2008. Risk assessments for the insect repellents DEET and Picaridin. *Regulatory Toxicology and Pharmacology* 51:31–36.

Barnard DR 1999. Repellency of essential oils to mosquitoes (Diptera: Culicidae). *Journal of Medical Entomology* 36:625–629.

Curtis C 1986. Fact and fiction in mosquito attraction and repulsion. *Parasitology Today* 2:316–318.

Fradin MS 1998. Mosquitoes and mosquito repellents: a clinician's guide. *Annals of Internal Medicine* 128:931–940.

Fradin MS and Day JF 2002. Comparative efficacy of insect repellents against mosquito bites. *New England Journal of Medicine* 347:13–18.

Frances SP and Cooper R D 2007. Personal protective measures against mosquitoes: insecticide-treated uniforms, bednets and tents. *ADF Health* 8:50–56.

Greive KA, Staton JA, Miller PF, Peters BA and Oppenheim VMJ 2010. Development of Melaleuca oils as effective natural-based personal insect repellents. *Australian Journal of Entomology* 49:40–48.

Maguranyi SK, Webb CE, Mansfield S and Russell RC 2009. Are commercially available essential oils from Australian native plants repellent to mosquitoes? *Journal of the American Mosquito Control Association* 25:292–300.

Novak RJ and Gerberg EJ 2005. Natural-based repellent products: efficacy for military and general public uses. *Journal of the American Mosquito Control Association* 21:7–11.

Strickman D, Frances SP and Debboun M 2009. *Prevention of Bug Bites, Stings and Disease,* Oxford University Press, New York.

How do I know what pest it is?

Identify the pest

The first step in controlling any arthropod pest is to determine which pest is causing the problem. This may seem like an easy task, but it can often be difficult and require the assistance of a medical entomologist or other specialist with expert knowledge in identification.

Unfortunately, it is extremely difficult — in fact, usually impossible — to identify a pest based on a bite reaction, as individuals can react differently to exposure to a particular arthropod. In some cases, there may be clues as to the identity of the pest by considering the location where individuals are bitten (e.g. bites received in the bedroom may indicate bed bugs are the culprits, but mosquitoes and bird mites may also be to blame) or the area of the body attacked (e.g. fleas tend to bite on the legs); however, the only reliable method to identify the pest responsible is to have a specimen collected and identified.

Many arthropods present in our homes, workplaces and backyards pose absolutely no public health threat at all. If you are looking for the biting pest, it is easy to find many other crawling and flying insects. However, even if these arthropods may superficially resemble some of the pests listed in this document, it is important that specimens are sent to a local expert for confirmation.

Finding an expert

Before setting out to catch the pest or collect evidence of an infestation, it is advisable to contact a local expert who can identify the specimens. In some states of Australia, medical entomology laboratories may provide an identification service or a local pest control company could be contacted. In most cases, a fee will be charged for the service. However, there are other organisations that may be able to offer free assistance, such as museums, universities or local entomological societies.

Methods for collecting specimens

Live specimens

Live specimens can be collected in small containers reasonably easily; however, remember that trying to collect biting and stinging arthropods can often result in further bites and irritation, so take care. When live arthropods are collected, they can be killed by placing them in the freezer overnight before seeking identification.

Sticky trap sampling

Traps comprised of cardboard lined with a sticky substance can be used as a passive trap to collect arthropods. These traps generally do not attract the pest, but — given that many problematic pest infestations can involve many hundreds of insects — these traps are likely to collect enough evidence to identify potential pests. Traps should be set in areas where pest effects are greatest, such as under beds and furniture, or in kitchen cupboards.

Sticky tape collections

If the pest is causing a crawling or biting sensation, collect specimens by placing a piece of broad, clear sticky tape over the site of irritation (e.g. arm or leg) and transferring the tape to a piece of clean white paper. Any arthropod present is likely to be stuck and, although the specimen may be killed or damaged in the process, there is likely to be enough of it to make a positive identification, or at least indicate that a more thorough investigation is needed.

Vacuuming

For many arthropod pest infestations, especially mites, there is often evidence of their presence amongst dust and debris on the floor. Vacuuming with a clean bag in the machine can collect a sample of arthropod body parts. A small sample can be taken from the corners of rooms where the pest impacts are greatest and the sample can be processed by an entomologist to identify any medically important arthropods.

Pest control companies

Pest control companies can play an important role in identifying arthropod pest infestations. Before any insecticide treatment is undertaken, a thorough pest inspection should be carried out, including in the roof cavity, subfloor areas and outdoor areas. Reputable companies have experience in identifying the likely pest and their location from the residents' descriptions. No treatment should be carried out unless a pest is identified.

Medical professionals

In some cases, a medical professional can help to identify the problem. They may need to take skin scrapings to identify scabies infestation, and can also offer advice on biting or stinging sensations, rashes or other symptoms that may be caused by other synthetic or environmental allergens or irritants — and not arthropod pests.

Managing expectations

Once a specimen has been collected and sent to an expert, the sender often expects that an arthropod will be identified as the source of the pest impacts. However, the specimens collected may be a nonpest species or, in some cases, may not actually contain any entomological material. This can often be confusing and frustrating for people who are convinced of a pest infestation. In some cases, a highly specialised entomologist is needed to identify the specimen. In these situations, identification of the pest to species level may be a costly process and may not be possible if the specimen is damaged. However, this does not necessarily mean that effective control is impossible.

PART II–**PEST DESCRIPTIONS**

Bed Bugs

The common bed bug, *Cimex lectularius*

Description

Bed bugs are parasites belonging to the order Hemiptera. The two species that bite humans are the common bed bug (*Cimex lectularius*) and the tropical bed bug (*C. hemipterus*). Bed bugs are wingless, flattened insects, roughly oval in shape and 4–6 mm long.

Description (continued)

They are usually a rust-brown colour, although they may appear darker following a blood meal. *C. lectularius* has a broader section behind the head (prothorax) than *C. hemipterus*. Bed bugs have dramatically increased over the past ten years and both species are now widespread in Australia. The common bed bug mainly occurs in the southern half of the country (i.e. south of the latitude of the New South Wales–Queensland border), while the tropical bed bug occurs to the north of this line.

Biology and ecology

Bed bugs must feed on blood at all stages of their life cycle and humans are their only hosts. Their mouthparts are specially adapted for piercing skin and sucking blood. Like most bloodsucking insects, the saliva they inject during feeding thins the blood — this helps the insect feed, but also causes an allergic reaction in humans. Bed bugs respond to warmth and carbon dioxide, and will seek out humans for a blood meal. However, they do not live on people or burrow into their skin. Bed bugs seek shelter during the day and come out at night to bite their sleeping target.

Bed bugs shelter in a variety of dark locations, including under and within the seams of mattresses and ensemble bases; on bed frames and other furniture; under floorboards and carpets; behind paintings, skirting boards and loose wallpaper; and in cracks and crevices of walls. They often stay in close contact with each other and blood spotting is a telltale sign of an infestation. Bed bug infestations can be accompanied by a distinctive, acrid 'buggy' smell, but this tends to be noticeable only if the infestation is extremely heavy or insect control is underway.

Each adult female lays 2–3 eggs a day throughout her lifespan. The cream-coloured eggs (approximately 1 mm in length) are cemented onto the rough surfaces of cracks and crevices in dwellings. The length of the life cycle depends on the ambient temperature; at 22°C, eggs take 10–12 days to hatch. There are five juvenile stages, known as nymphs, with each stage requiring at least one blood meal to moult to the next stage. The entire nymph stage takes 6–8 weeks at 22°C, after which the adults can live for up to six months. There are reports of bed bugs living for almost two years, but these are in cold climates without heating, which are not typical of Australian conditions.

Public health importance

Bed bug bites are usually painless, but can cause general discomfort or disturbed sleep. As with any insect bite, the severity of allergic reactions varies and some people will not have a substantial reaction. Reactions can also change with increased exposure — some people develop more severe reactions with continual bites, while others can be desensitised over prolonged infestations. People with cognitive impairment may be unaware that bed bugs are present, even if they receive many thousands of bites daily.

The arms and shoulders are the most commonly affected areas and bites are often arranged in an irregular linear pattern. Reactions to the bites may not appear until several days after being bitten. Common allergic reactions include large wheals (often bigger than one centimetre in diameter), itching and inflammation. The wheals usually subside to red spots, but can last for several days. Blistering can also occur. Anaphylaxis is rare, but may occur in people with severe allergies or those exposed to large numbers of bed bugs.

Bed bugs take a very large blood meal and there are reports of people suffering from anaemia associated with heavy infestations. Bed bugs can also trigger asthmatic reactions like those caused by dust mites, but these cases are rare.

Bed bugs do not transmit disease-causing microorganisms. However, nuisance biting during heavy infestations has significant physical, emotional and psychological effects. The high cost of removing bed bug infestations can also cause considerable emotional trauma.

First aid

There is no specific treatment for bed bug bites. As with other insect bites, use cold compresses, antiseptic lotions or antihistamine creams to reduce the itchiness and swelling. Take oral antihistamines for severe reactions. Take care to avoid secondary infection of the bite site.

Personal protection

Protecting homes from bed bug infestations requires cleanliness and good hygiene. However, regardless of how 'clean' the home, bed bugs can be introduced by homeowners or visitors who have travelled domestically or abroad. The two most common routes of bed bug introduction are via luggage and second-hand furniture. Wash infested clothing in hot water and dry it on the hot cycle of the clothes drier, or place delicate materials in the freezer for at least 48 hours.

When travelling, take care to thoroughly inspect the bed for signs of bed bugs, whether it is a five-star hotel or backpacker hostel. The most common evidence of infestation is blood spots on the bedding, particularly in the folds at the edges of mattresses. Avoiding exposure to bed bug infestations reduces the risk of having irritating bites and transferring the insects to the next destination. Insect repellents or insecticide-treated bed nets may protect against bites when staying in places suspected of having bed bug infestations.

Managing the pest and its impacts

Bed bugs are one of the most difficult pests to eradicate because they have a high level of insecticide resistance. A code of practice for controlling bed bugs has been developed by a working party of the Australian Environmental Pest Managers Association, the peak industry body for professional pest managers. The code contains detailed information on bed bug prevention and management, and can be downloaded free from the internet[1].

If an infestation is suspected, consult a licensed pest manager, preferably one with specific training in bed bug control based on the code of practice. Many insect pests only need their populations to be reduced to lessen pest effects, but bed bugs need complete eradication. Carry out a careful inspection of the infested room and all adjoining rooms to identify all likely sources of the insects. Insecticides with some long-acting activity are ideal and a range of products are currently registered for use against bed bugs.

[1] www.bedbug.org.au

Nonchemical control includes vacuuming and steaming; however, these approaches alone will not eradicate the insects and they need to be used in conjunction with insecticides. It is also hard to eradicate them with one treatment because bed bugs hide in places that are hard to reach and insecticides do not kill their eggs. A post-control treatment evaluation and retreatment approximately 10–12 days after the initial treatment is therefore essential. In some cases, more than two evaluations and treatments may be necessary.

Further reading

Doggett SL 2005. Bed bug ecology and control. In: *Pests of Disease & Unease: Synopsis of Papers*, the Synopsis of the Symposium on the Biology and Management of Arthropods of Medical Importance in Australia, Westmead Hospital, 22 April 2005, Department of Medical Entomology and Centre for Entomological Research and Insecticide Technology, Sydney.

Doggett SL 2009. Australian Environmental Pest Managers Association Bed Bug Workshop course notes. Department of Medical Entomology, Westmead Hospital, Sydney.

Doggett SL 2009. Emerging challenges in bed bug management. In: *Emerging Pest Management Challenges Symposium course notes*. Department of Medical Entomology, Westmead Hospital, Sydney.

Doggett SL 2009. *A Code of Practice for the Control of Bed Bug Infestations in Australia*, 3rd edition, Institute for Clinical Pathology and Medical Research, Westmead Hospital and the Australian Environmental Pest Managers Association, Sydney. http://medent.usyd.edu.au/bedbug/cop_3ed_final.pdf (Accessed 3 August 2010)

Doggett SL and Russell RC 2008. The resurgence of bed bugs, *Cimex* spp. (Hemiptera: Cimicidae) in Australia. In: *Proceedings of the Sixth International Conference on Urban Pests*, Robinson WH and Bajomi D (eds), OOK-Press, Budapest, Hungary, 13–16 July, 407–425.

Doggett SL and Russell RC 2009. Bed bugs: what the GP needs to know. *Australian Family Physician* 38(11):880–884.

Goddard J 2003. Do bed bugs carry disease? *Pest Control Technology* 31(11):38–40.

Goddard J and deShazo R 2009. Bed bugs (*Cimex lectularius*) and clinical consequences of their bites. *Journal of the American Medical Association* 301(13):1358–1366.

Krinsky WL 2002. True bugs (Hemiptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Pritchard MJ and Hwang SW 2009. Severe anemia from bedbugs. *Canadian Medical Association Journal* 181(5):287–288.

Romero A, Potter FM, Potter DA and Haynes KF 2007. Insecticide resistance in the bed bug: a factor in the pest's sudden resurgence? *Journal of Medical Entomology* 44(2):175–178.

Biting Midges

Biting midges are often associated with estuarine wetlands

Description

Biting midges are a group of biting flies that belong to the family Ceratopogonidae. The most significant pest species in Australia are *Culicoides ornatus* and *C. molestus*, although other species can become pests when environmental conditions are favourable. Adult biting midges are typically very small (usually less than 4 mm long) and a dark colour. They are characteristically stocky and the pest species often have a distinctive pattern on their wings. Many species are not pests of humans, but some can transmit infectious diseases to cattle and sheep, and are of veterinary importance.

Biting midges are commonly called 'sand flies' but, strictly speaking, sand flies are a group of biting insects in the subfamily Phlebotominae. Sand flies are significant pests and vectors of human disease in other countries, but not in Australia.

Biology and ecology

Immature midges develop in moist conditions, including wet soil or organic detritus (e.g. leaf litter), feeding on organic material. Their life cycle takes up to 10 weeks, depending on the climate, and the adults of some species can fly far from their larval habitats. Adult females require a blood meal for egg development.

As a group, biting midges can live in a range of aquatic and semi-aquatic habitats, from estuarine environments to freshwater conditions. The major pest species typically live within the tidal zone and sandy foreshores of rivers and estuaries, and generations of midges are often associated with tide cycles. Coastal developments, such as canal estates, provide favourable conditions for biting midges, but they can sometimes reach pest levels in other coastal and inland environments as well.

Public health importance

Biting midges do not transmit disease-causing microorganisms to humans. However, the nuisance biting of these tiny insects can be severe, especially in areas near coastal lagoons, estuaries and wetlands. Anecdotally, biting midges cause more severe skin irritation than other common biting pests, such as mosquitoes. Reactions to midge bites vary in severity, but there is usually swelling at the bite site, with redness extending a centimetre or more around a central blister. The bites can be extremely itchy and may persist for some days. People living in areas where biting midges are common may become desensitised, so the severity of reactions to bites can decrease over time.

A common myth associated with biting midges is that their urine causes the skin irritation. However, like other bloodsucking insects, midges inject their saliva into the host during blood feeding and this causes an allergic reaction in humans.

First aid

There is no specific treatment for biting midge bites. As for other insect bites, a cold compress and soothing lotions or creams will reduce mild reactions. Antihistamines may be required for severe reactions. Take care to avoid secondary infection after scratching the bites.

Personal protection

Personal insect repellents can offer some protection against biting midges. However, in areas with high midge populations, long-sleeved shirts, long pants and head nets provide the most effective protection, especially if they are impregnated with insecticides (e.g. permethrin). Biting midges are most active at dawn and dusk, so avoiding known midge habitats at these times will minimise exposure. In areas where estuarine biting midge species are present, biting is likely to be greatest close to mangroves and in sheltered areas within 2 km of mangroves.

To reduce the number of midges in homes, ensure that buildings have adequate screens on doors and windows. The mesh of the screens must be small enough to exclude these tiny insects (normal fly or mosquito mesh may not be small enough) or the screen should be treated with a long-lasting residual insecticide. Properties with dense vegetation, especially shrubs, are more likely to be affected by biting midges, as the plants provide some refuge and shelter for the midges. Generally, biting midge effects are greatest at ground level and the severity of nuisance biting decreases at higher levels of a building.

Managing the pest and its impacts

Unfortunately, there are very few cost-effective and environmentally friendly options to control biting midges. As the main larval habitats of the most common pest species are in environmentally sensitive estuarine habitats, local authorities cannot apply insecticide or modify the habitat to carry out large-scale control. In most areas of Australia, larvicides are used in canal estates or other habitats close to houses that may not have a high environmental conservation value.

Barrier treatments that protect residential properties close to biting midge habitats are common. These treatments involve applying a residual insecticide to the outside of houses or surrounding vegetation. While this does reduce local biting midge populations, the nontarget impacts should also be considered, such as effects on bees, moths, butterflies and other insects that may contact treated surfaces, as well as on aquatic vertebrates and invertebrates, should the insecticides run into waterways.

Further reading

Dyce AL, Bellis GA and Muller MJ 2007. *Pictorial Atlas of Australasian Culicoides Wings (Diptera: Ceratopogonidae)*, Australian Biological Resources Study, Canberra.

Muller M 2007. *Culicoides ornatus*, an invader from the north. *Mosquito Bites* 2:34–39.

Queensland Health 2002. *Guidelines to Minimise Mosquito and Biting Midge Problems in New Development Areas*, Queensland Government, Queensland.

Ratnayake J, Dale PE, Sipe NG and Daniels P 2006. Impact of biting midges on residential property values in Hervey Bay, Queensland, Australia. *Journal of the American Mosquito Control Association* 22:131–134.

Reye EJ 1964. The problems of biting midges (Diptera: Ceratapogonidae) in Queensland. *Australian Journal of Entomology* 3(1):1–6

Tweed Shire Council 2005. Mosquitoes and biting midges (sandflies) in the Tweed Shire. Factsheet, Tweed Shire Council, New South Wales.

Caterpillars

White stem gum moth caterpillar

Description

Moths and butterflies belong to the order Lepidoptera, a diverse order in Australia with over 20 000 species of moth and around 400 species of butterfly. Caterpillars (the juvenile stage of moths and butterflies) may seem unlikely pests of public health concern, but some species are of serious medical concern worldwide as they can sting, cause irritation or deliver a painful stab.

Biology and ecology

The biology and ecology of each species varies, but moths and butterflies generally have similar life cycles. Eggs are typically laid on vegetation and, when they hatch, the immature stages (i.e. caterpillars) feed on the plants, developing quickly before the pupal stage. Moth larvae spin silken cocoons or take refuge in excavated recesses in the soil, while butterfly larvae transform into a chrysalis that typically hangs from the underside of leaves or branches. Many species are associated with particular plant species and an understanding of these plant–caterpillar relationships can help to identify and control problematic caterpillar populations.

Public health importance

Several caterpillar species are armed with either stinging (envenoming) hairs or fragile spikes (nonenvenoming hairs). Contact with these specially equipped caterpillars can cause severe irritation and inflammation, often referred to as lepidopterism or caterpillar dermatitis. Envenoming hairs are tubular or porous spines that hold venom or an irritant. Cup moths in the family Limacodidae have these hairs. Nonenvenoming hairs cause mechanical irritation on contact. They are fragile and easily dislodged from the caterpillar — they can pierce skin when the caterpillar is touched, or become airborne and, on settling, easily fragment and penetrate clothing or skin.

Lepidopterism is most often associated with the species *Euproctis edwardsii* (mistletoe browntail moth), which is widespread from southern Queensland to south-eastern South Australia. Species in the family Lymantriidae (tussock moths) are also known to cause irritation. These include *Acyphas leucomelas*, *Euproctis stenomorpha*, *E. lutea*, *Leptocneria reducta* and *Teia anartoides*. Some species in the families Arctiidae, Anthelidae, Eupteridae, Notodontidae, Nolidae and Limacodidae are of medical importance in Australia, as their larvae can sting, pierce the skin and cause irritation.

The intensity of the irritation from either type of hair depends on the species of caterpillar and the sensitivity of the person. Symptoms include wheals, widespread rashes, burning sensations, pain, itching and swelling of the infected area. Inflammation can persist for days, but in most cases the symptoms do not last long. Detached caterpillar hairs can also be inhaled, making breathing difficult. Eye injuries from caterpillar hairs can cause inflammation or even permanent damage to the cornea. It is possible that caterpillars and their hairs can transmit pathogens to humans, but there are no documented cases of this.

First aid

To treat irritation caused by caterpillar hairs, remove all clothing that may have the hairs in it. To remove small and thin hairs from the skin, place a piece of sticky tape on the affected areas and pull the tape off immediately. This will remove some of the small hairs and irritants, and reduce the irritation. Washing the site with soap and water can also help remove any toxins, but leave it to dry naturally (or with a warm hair dryer) and do not rub it with a towel. Use cold compresses or ice packs, analgesics, creams, antihistamines and lotions with steroids to help relieve the symptoms. Larger spines are better left embedded in the skin and treated with ice packs and antihistamines until they fall out naturally.

Personal protection

Direct contact with caterpillars can happen in several ways. Handling or accidentally disturbing old larval skins and spent cocoons (usually found under leaf litter, bark, wood piles, timber or any other material that caterpillars have had contact with) can cause irritation. Large numbers of school-age children have been affected by caterpillars after sitting under infested trees, or by disturbing leaf litter and bark at the base of trees where caterpillars are or have been present. Avoid handling any hairy caterpillars or material they have been in contact with. Always wear protective clothing, including eyewear and gloves, when handling these insects or infested material. Take special care when working below infested trees — even if caterpillars are not present, their hairs and spines can build-up in leaf litter and other debris on the ground.

Caterpillar belonging to the family Anthelidae

Managing the pest and its impacts

Most caterpillar infestations are short lived and the insects should be left undisturbed, unless they are causing a serious problem. Insecticides may kill the caterpillars and the bodies can be removed, but be careful not to contaminate the area with hairs or spines. Many infestations will die out naturally after predation by birds or when the caterpillars have exhausted their food sources, but some areas below infested trees may need to be cordoned off while the caterpillars are active. Preventative control measures include managing or removing plant species associated with certain caterpillars, such as mistletoe, and planting tree species that do not attract infestations.

Further reading

Balit CR, Geary MJ, Russell RC and Isbister GK 2003. Prospective study of definite caterpillar exposures. *Toxicon* 42(6):657–662.

Balit CR, Geary MJ, Russell RC and Isbister GK 2004. Clinical effects of exposure to the white-stemmed gum moth (*Chelepteryx collesi*). *Emergency Medicine Australasia* 16(1):74–81.

Balit CR, Ptolemy HC, Geary MJ, Russell RC and Isbister GK 2001. Outbreak of caterpillar dermatitis caused by airborne hairs of the mistletoe browntail moth (*Euproctis edwardsi*). *Medical Journal of Australia* 175(3):641–643.

Common I 1993. *Moths of Australia*, Melbourne University Press, Melbourne.

Diaz JH 2005. The evolving global epidemiology, syndromic classification, management and prevention of caterpillar envenoming. *American Journal of Tropical Medicine and Hygiene* 72(3):347–357.

Isbister GK and Whelan PI 2000. Envenomation by the billygoat plum stinging caterpillar (*Thosea penthima*). *Medical Journal of Australia* 173(4):654–655.

Mullen GR 2002. Moths and butterflies (Lepidoptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Zborowski P and Edwards T 2007. *A Guide to Australian Moths.* CSIRO Publishing, Collingwood, Australia.

Cockroaches

There are thousands of different species of cockroaches worldwide, but less than a dozen are closely associated with human habitation. In Australia, the native cockroach (*Periplanta australasiae*) is occasionally encountered, especially in warmer regions, but native species pose no serious pest risk.

Description

The most common pest cockroach species in Australia are the German cockroach (*Blattella germanica*), the American cockroach (*P. americana*) and the smoky brown cockroach (*P. fuliginosa*, closely related to the American cockroach). German cockroaches are relatively small (12–15 mm long) and a light amber-brown colour with a distinctive pale stripe on the section behind the head (prothorax). American cockroaches are much larger (35–40 mm long) and a darker reddish brown colour with pale edge to their prothorax. Smoky brown cockroaches are a similar size to the American cockroach and are a uniform dark-brown colour.

Biology and ecology

German cockroaches have an adult lifespan of 4–6 months. Each female lays 5–8 egg cases in her lifetime, with each case containing up to 40 eggs. This species is typically found in buildings, mostly in kitchens beneath appliances and cupboards, and they do not fly.

American cockroaches live a little longer (around 6–12 months) and may fly in warm weather. Females lay 10–50 egg cases in their lifetime, each containing up to 16 eggs. American cockroaches are common within the walls and voids of buildings, and in industrial areas, sewers, grease traps and garbage rooms.

Smoky brown cockroaches live in gardens and underfloor areas, and can often be found in the home. They can fly in warm weather.

Public health importance

Cockroaches may spread microorganisms that cause disease (e.g. bacteria) on their bodies (mechanical transmission). Scientists are not fully agreed on the extent to which this happens, but over 30 different disease-causing bacteria, as well as several parasites and other pathogens, have been isolated from on and within cockroaches and their faeces. The key issue is the cockroaches' ability to move and spread contaminants from unsanitary areas of a building to food storage or food preparation areas. In most cases, the disease risk is low.

There is growing concern about cockroach allergens as a significant indoor public health risk. People with asthma can have allergic reactions to cockroaches that are second only to their reactions to dust mites, with symptoms including sneezing, runny nose, skin reactions and, in severe cases, breathing difficulties and anaphylactic shock. However, such severe reactions are extremely rare.

For many people, annoyance and repulsion by the presence of cockroaches is the biggest problem. Many people are frightened, not only of the insects themselves, but also the perception that they are only associated with 'dirty' homes.

First aid

There is no specific treatment for cockroach-related health effects. People with cockroach allergies should take precautions to minimise their exposure to cockroaches.

Personal protection

There is no specific personal protection against cockroaches other than to avoid creating favourable conditions for them in the home (see 'Managing the pest and its impacts', below).

Managing the pest and its impacts

Cockroaches in a home do not necessarily indicate unsanitary conditions, but maintaining a high standard of cleanliness will limit the opportunities for cockroach populations to establish. Keeping food preparation and storage areas clean is important, especially minimising the build-up of food scraps and household garbage. This includes newspapers, magazines and cardboard, which may provide refuge and egg-laying sites.

Cockroaches actively move between dwellings in unit blocks and adjoining buildings. Regardless of the cleanliness and treatment of individual homes, cockroaches can still appear if there is a problem in a nearby dwelling.

Before starting cockroach control measures, carefully inspect the building to identify areas where cockroaches are most active, such as areas they can shelter in or travel routes. Sticky traps can be used as a monitoring as well as a control device to identify changes in cockroach populations and areas of activity. Call a licensed pest manager to deal with major infestations or ongoing problems.

Many options are available for chemical control of cockroaches, including long-acting surface sprays, dusts, gels, traps and baits. Many of these products are available to the general public, but their effectiveness depends on how they are used (e.g. choosing the best places to lay traps or apply insecticides, or both). The most effective products today are the cockroach gels, but these can only be purchased by a licensed pest manager. If using a spray, it may be necessary to re-treat at a later date if egg cases are not exposed to sufficient levels of insecticide. The time frame for re-treatment varies with the species and may be more than one month.

Further reading

Berle D 2007. Graded exposure therapy for long-standing disgust-related cockroach avoidance in an older male. *Clinical Case Studies* 6:339–347.

Brenner RJ 2002. Cockroaches (Blattaria). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*, NSW Department of Health, Sydney.

Rivault C, Cloarec A and Le Guyader A 1993. Bacterial load of cockroaches in relation to urban environment. *Epidemiology and Infection* 110(2):317–325.

Rosenstreich DL, Eggleston P, Kattan M, Baker D, Slavin RG, Gergen P, Mitchell H, McNiff-Mortimer K, Lynn H, Ownby D and Malveaux F 1997. The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. *New England Journal of Medicine* 336(19):1356–1363.

Fleas

The cat flea, *Ctenocephalides felis*

Cat fleas

Description

Fleas are small parasitic insects that belong to the order Siphonaptera. There are almost 100 flea species in Australia, but the cat flea, *Ctenocephalides felis*, is the most common. Cat fleas are found in close association with domestic animals, such as dogs and cats. They are small, wingless, flattened, oval-shaped insects, generally less than 4 mm long and a brownish colour. They have powerful hind legs that allow them to jump almost 30 cm between hosts.

Biology and ecology

Fleas live either on their host or in the host's usual resting or sleeping places, and both male and female adult fleas feed on blood. In their ideal conditions, female fleas can lay up to 25 eggs per day for a month, and their fertility is higher when they are feeding on cats compared to humans or other animals. The eggs are laid on the host, but usually fall off — large numbers of eggs can be found where hosts spend most of their time, such as their sleeping and eating areas. Eggs can also be laid in cracks and crevices on the floor, or in floor coverings, such as carpets or rugs.

Flea larvae do not feed on blood; they eat small pieces of organic material that have built up on the floor or in the host's bedding. Dried regurgitated blood meals from adult fleas provide extra nutrition. The larval stage normally lasts for around two weeks, but can last several months in unfavourable environments (e.g. dry or cool conditions). When larvae have developed, they spin a cocoon and pupate for between one week and one year, depending on environmental conditions and the availability of a host. The cocoons are often difficult to find as their sticky surfaces are covered with dust, dirt and other small debris. Adult fleas often emerge from their cocoons in response to host triggers, such as body heat, vibration and changes

in light intensity. Because of this, it is common for people to enter a house that has been closed for some time and suddenly find themselves being attacked by large numbers of fleas.

Public health importance

Certain flea species (particularly the rat flea, *Xenopsylla cheopis*) transmit significant human diseases, such as the bubonic plague. Plague was once present in Australia, although the last cases occurred here in the early 1920s. In modern Australia, the major effect of cat fleas is nuisance biting. This can be severe where there is a heavy flea infestation and large numbers of bites can cause hives (an allergic skin reaction) in some people. Bites usually occur between the ankle and knee, with or without associated swelling, and a small red mark is often visible. The severity of reaction varies among different people; wheals generally appear within 30 minutes of bites, but rarely last for more than a few days. The incidence of cat fleas as a pest has decreased in recent years because of the widespread use of at-home antiflea products on pets.

Cat fleas can carry dog and cat tapeworm (*Dipylidium caninum*), which is easily transmitted to humans. This can be a problem when young children play with family pets and accidentally eat infected fleas.

Cat fleas are not usually associated with pathogen transmission. The only flea-borne disease that occurs in Australia is murine (or endemic) typhus, but this is rare. The disease is caused by a bacteria-like organism (*Rickettsia*) and can cause mild fever. Rodent fleas (usually of the genus *Xenopsylla*) carry the bacteria and transmit it to humans via their faeces or their crushed bodies when the bite site is scratched.

First aid

There are no specific treatments for flea bite. Cold compresses will reduce swelling and anti-itching medication will ease itchiness. Take care to avoid secondary infection when scratching the bites.

Personal protection

The best strategy to avoid flea bites is to ensure the home is free of fleas. Where a flea infestation is present, wearing long pants and insect repellents will provide some protection until the source of the fleas is identified and treated.

Managing the pest and its impacts

In the home, the risk of problematic flea populations can be minimised by keeping animals outdoors or regularly treating them for fleas. A veterinarian can advise on the best flea control options for pets. Minimising the pet's contact with fleas also reduces the risk of infestation. Ensure a good level of cleanliness by regularly vacuuming or washing floors and furniture, especially where pets sleep or rest. If flea control is carried out in a building, all pets should also be treated at the same time to prevent reinfestation.

A wide range of products is available for flea control, including insecticides and insect-growth regulators. Pretreatment vacuuming and cleaning can help to reduce flea populations, but it is important to properly dispose of the contents of the vacuum cleaner or treat the contents to kill the collected fleas. Antiflea treatments can offer control for a few months if the area is treated extensively — when treating, pay particular attention to the surface and underneath of rugs, and to carpets, furniture and anywhere animals rest or sleep. In some cases, the subfloor area and outdoor areas where pets rest may need to be treated as well.

Further reading

Durden LA and Traub R 2002. Fleas (Siphonaptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden LA (eds), Academic Press, New York.

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*. NSW Department of Health, Sydney.

Stickfast fleas

Description

'Stickfast flea' or 'sticktight flea' is the common name of the species *Echidnophaga gallinacea*, a parasite of poultry around the world. They are small, reddish brown insects with a sharply angled, squarish head. As their name suggests, these fleas stay attached to their host and do not move around as readily as other fleas. They were introduced into Australia in the 1940s and are an emerging problem where chickens are kept near homes, increasing the likely contact of the fleas with humans.

Biology and ecology

The average life cycle of this species is approximately 4–5 weeks and adult fleas live for up to six weeks. They lay up to 12 eggs each night, which fall to the ground and hatch into larvae. In unfavourable environmental conditions, the eggs may remain dormant for months before hatching. The larvae feed on organic material for up to four weeks before burrowing into the ground and forming a cocoon. Adults emerge after 2–3 weeks and must quickly find a host.

Stickfast fleas are commonly associated with poultry, especially chickens. They usually attach to the head region, particularly the wattles, and also under the wings and on the breast. The fleas' feeding can significantly affect the birds, causing ulcerations that may become infected. The adult flea can stay attached to the host for up to 19 days and cannot survive for more than a week without a host. While chickens are the preferred host, the fleas can also infest other birds and mammals.

Public health importance

Stickfast fleas are mainly an agricultural pest, but they can bite and attach to humans. Poultry farms were once considered high flea-exposure areas, but the change to concrete flooring in these farms means that the fleas can no longer burrow into the ground to complete their life cycle, and their populations have decreased. However, the risk of exposure to this flea in Australia has increased with the rising popularity of chickens in residential areas. Young children are the most at risk, as they often treat the chickens as pets and have close contact with infested parts of the birds. The fleas can also attach to cats and dogs, and then be transferred to humans. The flea's attachment site can cause mild skin irritation, but there are no documented cases of pathogens being transmitted to humans via stickfast fleas in Australia.

First aid

Quickly remove the flea, if possible. This is best done with fine-point forceps, holding the flea as close to the skin as possible to minimise the risk of mouthparts remaining embedded in the skin. The flea can be killed before removal with a permethrin-based cream.

Personal protection

Minimising contact between infested animals and humans, especially young children, is the best form of protection.

Managing the pest and its impacts

There is a two-stage process to managing infestations: treat infested animals to kill the adult fleas and modify the animals' housing to break the fleas' life cycle. To treat the animals, spray infested birds and their holding sheds or bedding with an insecticide, and remove and treat all flooring material. Repeat the treatment after two weeks to kill newly emerged fleas. To break the fleas' life cycle, install a concrete or other impervious floor in the animals' overnight housing. As the fleas usually lay their eggs at night, this will prevent the larvae from burrowing into the ground and emerging as adult fleas.

Further reading

Boughton RK, Atwell JW and Schoech SJ 2006. An introduced generalist parasite, the sticktight flea (*Echidnophaga gallinacea*), and its pathology in the threatened Florida scrub-jay (*Aphelocoma coerulescens*). *Journal of Parasitology* 92(5):941–948.

Carlson JC and Fox MS 2009. A sticktight flea removed from the cheek of a two-year-old boy from Los Angeles. *Dermatology Online Journal* 15(1):4.

Kabay M 2006. *Farm Note 2/97 — Stickfast Fleas: Control and Eradication*, Department of Agriculture and Food, Perth, Western Australia.

Schloderer D, Owen H, Clark P, Stenos J and Fenwick SG 2006. *Rickettsia felis* in fleas, Western Australia. *Emerging Infectious Diseases* 12(5):841–843.

Small L 2004. *Agnote 498: Fleas on Dogs and Cats*. Department of Primary Industry, Darwin, Northern Territory.

Flies

The common house fly, *Musca domestica*

Houseflies

Description

The housefly (*Musca domestica*) is one of the most common nuisance indoor flying pests and is widespread throughout Australia. Houseflies are 4–8 mm long and grey coloured, with four dark stripes on the thorax. Like all flies, this species has a single pair of wings and six legs.

Biology and ecology

Houseflies usually appear in spring and persist through summer into autumn. In spring, they represent a small proportion of the overall nuisance fly population, but in late autumn their relative importance increases as other nuisance fly populations decrease. The females lay up to 100 eggs on moist organic material, such as manure, food scraps or compost, and the eggs hatch into larvae (maggots) within 24 hours. Larvae feed for around a week then move to a drier area to pupate for another week. Adult flies can live for up to four weeks and are generally more active during daylight hours.

Houseflies have sucking mouthparts and feed on liquids, but they can also regurgitate saliva onto solid materials and feed on the dissolved material.

Public health importance

Houseflies can be a serious annoyance during the warmer months. They do not bite humans, but they are a potentially important pest of public health concern. The main risk is the mechanical transmission of pathogens on flies' bodies as they move between contaminated material (e.g. decaying organic and faecal material) and food preparation areas, including foodstuffs and utensils. Flies can carry bacteria in their digestive tract and contaminate surfaces when they regurgitate digestive fluids during feeding. They can potentially transmit a wide range of disease-causing microorganisms, including bacteria (such as *Salmonella* and *E. coli*), viruses and parasites. However, increased insecticide use and improved hygiene in the home have reduced this risk.

First aid

There is rarely a need to give first aid to people exposed to houseflies.

Personal protection

Some personal insect repellents claim to repel flies, but they may not be effective against houseflies. Strongly scented vegetation may offer some degree of protection. To reduce the number of flies entering living areas, ensure that windows and doors have appropriate screens. In industrial or commercial areas, particularly where foodstuffs are prepared, air curtains or plastic strip curtains on doorways provide effective barriers against fly movement.

Managing the pest and its impacts

Maintaining good hygiene standards, and minimising potential feeding and egg-laying sites reduces housefly populations around the home. Insecticides will only be effective if suitable fly breeding areas are removed. Thoroughly inspect the property to determine the most likely location of egg-laying and larval habitats. In areas where these habitats cannot be moved (e.g. garbage areas), consider techniques to minimise fly access to organic material, such as sealing food scraps in plastic bags, regularly cleaning bins and ensuring bins have tight-fitting lids. Compost heaps should be covered, screened or dug into the ground.

Adult flies in the home are mainly controlled with widely available insecticides, especially aerosol sprays. Automatic spray systems are available that attach to the wall and periodically release small quantities of insecticides (e.g. synthetic pyrethroids), but these are more appropriate for commercial premises. A variety of fly traps use ultraviolet light to attract flies, then either electrocute them or trap them on glue boards. Other products contain an insecticide (dichlorvos) that can be placed in bins to prevent flies from breeding. Some control of adult fly populations associated with livestock has also been achieved through biological control, using insects that parasitise the immature stages of houseflies.

Further reading

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Graczyk TK, Knight R, Gilman RH and Cranfield MR 2001. The role of non-biting flies in the epidemiology of human infectious diseases. *Microbes and Infection* 3(3):231–235.

Hall RD and Gerhardt RR 2002. Flies (Diptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Orton C 2008. The role of biology in the management of flies, Safety and Pest Biology Symposium course notes, Department of Medical Entomology, Westmead Hospital, Sydney.

The bush fly, *Musca vetustissima*

Bush flies

Description

The bush fly (*Musca vetustissima*) is one of the most common outdoor nonbiting flying pests in Australia. Adult flies are 5–6 mm long and a greyish colour, with two darker bands extending lengthways on the thorax.

Biology and ecology

Bush flies are a predominantly outdoor species associated with large vertebrate animals, particularly cattle, and are common in rural regions. However, following strong, warm north-westerly winds in summer, cities along the eastern seaboard may also be inundated with bush flies. The complete life cycle

of the insect can take up to five weeks. Eggs are laid in faecal material and hatch after 24 hours, with immature stages lasting up to two weeks until adults emerge from pupae. Adult flies can survive on a variety of organic material, especially animal waste. Unlike many flies that simply become inactive during the cooler months, bush flies actually migrate to warm climates. They are most active in open, sunny areas and tend to avoid cooler areas that may be shaded, such as inside buildings.

Public health importance

Bush flies are attracted to human sweat, tears and saliva, and can remain on and around a person for long periods, creating a serious nuisance. The flies do not have biting mouthparts but they may transmit eye infections (leading to conjunctivitis) and enteric disease in people.

First aid

There is rarely a need to give first aid to people exposed to bush flies.

Personal protection

Some personal insect repellents claim to repel flies and can vary in their effectiveness against bush flies.

Managing the pest and its impacts

Control of adult bush flies is difficult and the most effective control is directed towards larvae. Management of animal waste in rural and semirural regions provides some control and larvicides, especially water-based surface sprays, can be used if larval habitats can be identified. However, it is often impractical to treat large areas. The longer animal waste remains moist, the longer it will be available as larval habitat for flies. In some circumstances, bush fly populations can decrease in the presence of dung beetle (*Onthophagus* species) populations. The dung beetles break up and bury dung, making it unavailable for the flies, but their effectiveness as a biological control agent is limited.

Further reading

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Hall RD and Gerhardt RR 2002. Flies (Diptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Quarles W 2007. Repellents for nuisance and biting flies. *The IPM Practitioner* July/August:1–8.

Ridsdill-Smith TJ and Matthiessen JN 1988. Bush fly, *Musca vetustissima* Walker (Diptera: Muscidae), control in relation to seasonal abundance of scarabaeine dung beetles (Coleoptera: Scarabaeidae) in south-western Australia. *Bulletin of Entomological Research* 78:633–639.

The march fly, or horsefly, belong to a group of flies commonly known asTabanids

March flies

Description

The terms ‘march fly’ or ‘horsefly’ refer to a group of biting flies that belong to the family Tabanidae (these flies may also be known as Tabanids), with over 200 species in Australia. The distribution of species varies across the country, but potential pest species occur in many different habitats, from the wet tropics to alpine regions. They range in size from less than 10 mm to up to 20 mm long, and all are stockily built with relatively large eyes.

Biology and ecology

The biology and ecology of each species varies and their preferred larval habitat ranges from muddy environments to floating aquatic vegetation. These flies are most common in rural areas, particularly properties where livestock is kept close to waterways and dams.

Public health importance

The main impact from these flies is their painful nuisance biting, but severe skin ulceration can be associated with some species. In northern Western Australia, a small brown species (*Mesomyia tryphera*) produces serious reactions in some people, including hives, fever, wheezing and anaphylaxis requiring hospital admission. Secondary infections can also occur.

First aid

There is rarely a need to give first aid to people exposed to march flies. Soothe irritation at the bite site with a cold compress and antiseptic cream. Severe anaphylactic situations require adrenaline injections.

Personal protection

Some personal insect repellents may be effective against march flies. In areas where adult fly populations are high, long-sleeved shirts, long pants and head nets provide the most effective protection.

Managing the pest and its impacts

Control of march fly populations is extremely difficult and, in most cases, unlikely to be practical or cost-effective.

Further reading

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Hall RD and Gerhardt RR 2002. Flies (Diptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

The Stable fly *Stomoxys calcitrans*

Stable flies

Description

Stable flies (*Stomoxys calcitrans*) are biting flies approximately 5–7 mm long that are often found near animal sheds, such as horse stables. They are generally a light grey colour with a striped thorax and darker spots on the abdomen. They are often mistaken for houseflies or bush flies, but stable flies have long, solid mouthparts, which they hold forward when at rest and fold down during biting.

Biology and ecology

Female stable flies must have a blood meal to develop their eggs. Eggs are laid in suitable organic material ranging from animal waste to garden mulch or compost, and even seaweed. While generally considered a pest of rural areas, especially intensive livestock farms, these flies can also pose a risk in urban areas where compost and animal manure used on gardens provide suitable habitat, and on beaches where seaweed has built up. The eggs hatch within a few days and the immature stages of the fly can last up to four weeks. Adult stable flies only live for a few weeks, but they are strong fliers and can move long distances from their larval habitats. Adult flies prefer to rest low to the ground on shaded sections of buildings and other structures (e.g. walls, fences, posts, gates).

Public health importance

Stable flies do not transmit pathogens, but their painful nuisance biting can have serious effects when fly populations are large. The fly's bite is similar to a medical punch biopsy — it removes a small cylinder of flesh and the fly laps at the welling blood. While primarily a livestock pest, these flies will bite humans on any exposed skin or even through clothing if it is wet with perspiration, with a preference for biting around the ankles. Stable fly bites can seriously damage pets, especially dogs' ears, often resulting in ulceration and permanent tissue damage. Fortunately, stable flies are rarely a problem indoors.

First aid

There is rarely a need to give first aid to people bitten by stable flies. Soothe irritation at the bite site with a cold compress and antiseptic cream.

Personal protection

Some personal insect repellents may be effective at repelling stable flies. However, in areas where population densities of adult flies are high, long-sleeved shirts, long pants and head nets may provide the most effective protection.

Managing the pest and its impacts

Control of established stable fly populations is extremely difficult and, in many cases, unlikely to be cost-effective. Long-lasting residual insecticides may be effective, especially as a barrier treatment. Proper management of animal waste, spoiled straw or hay, and organic materials, such as grass clippings, can help reduce fly numbers. This includes removing or covering potential breeding materials to exclude flies, and provides a more reliable long-term management option than insecticide use.

Further reading

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Hall RD and Gerhardt RR 2002. Flies (Diptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Le Messurier J 2005. Control of *Stomoxys calcitrans* in urban and rural areas. *Bulletin of the Mosquito Control Association of Australia* 17:38–47.

The blowfly, *Lucilia sericata*

Myiasis flies

Description

Myiasis flies are flies whose larvae cause a human and animal infestation known as 'myiasis', which is the invasion of living tissue by live fly larvae. Myiasis flies cover a diverse range of species that have different needs. Some species depend on myiasis to survive (known as obligatory myiasis); this occurs when tissue is infected with the larvae of truly parasitic flies that can only survive in living tissue. Some species are only occasionally or very rarely involved in this process (facultative myiasis); this occurs when tissue is infected with the larvae of species that can be either parasitic or free-living. This category includes flies that can lay eggs on, and whose larvae can take advantage of, both living and dead tissue. The flies that cause sheep blowfly strike belong to this group and include species that occasionally infest wounds on humans.

Accidental myiasis (also known as pseudomyiasis) can occur when the larvae or eggs of a normally nonparasitic fly are ingested. Although cases of accidental or facultative myiasis are occasionally reported, there are no native fly species that cause obligatory human myiasis in Australia. Every year, several cases of myiasis are reported in travellers returning to Australia from Africa and South America. Some obligatory fly species are of veterinary importance, especially various species of screw worm flies, and could cause serious economic damage if introduced into Australia.

Biology and ecology

The biology and ecology of myiasis flies vary with different species according to how much they rely on living or dead tissue for egg laying and larval development. Generally, these species of fly are simply exploiting a protein-rich resource in the form of human or animal tissue. The most common fly species responsible for accidental or facultative myiasis in Australia are those in the families Calliphoridae (blow flies) and Sarcophagidae (flesh-flies), with rare reports of myiasis in some Muscidae (the family that includes houseflies). These flies are usually associated with rotting organic matter, especially dead animals.

Public health importance

Accidental or facultative myiasis in Australia is rare in healthy individuals who maintain a reasonable level of hygiene. However, the elderly, infants and debilitated people living in unhygienic conditions are at much greater risk. Postsurgery myiasis can also occur in hospitals. Myiasis can have serious effects on healthy tissue if left untreated.

The larvae of some flies that eat dead tissue are now used in some hospitals and health care facilities to treat infected wounds that do not respond to antibiotic therapy. An ancient technique dating back many thousands of years, maggot debridement therapy (MDT) is becoming popular again in modern medicine. As a simple, cost-effective and noninvasive surgical option, MDT is increasingly used to treat ulcers and other wounds where antibiotics are ineffective or surgery is impractical. The only facility in Australia that supplies medicinal maggots for MDT is the Department of Medical Entomology at Westmead Hospital in Sydney.

First aid

For accidental or facultative myiasis, open wounds should be cleaned; the larvae can be washed off with sterile saline or picked out of the wound, which should then be covered (where appropriate) to restrict further access of flies to the open wound.

Personal protection

Good personal hygiene prevents accidental and facultative myiasis. Fly populations must be controlled to minimise the risk of myiasis, especially in hospitals and nursing homes. Properly screen windows and doors to prevent adult flies entering and avoid contact with flies. Regularly clean and cover open wounds, and treat possible infections early.

Managing the pest and its impacts

Fly populations can be reduced by minimising adult flies' access to potential egg-laying sites. These sites include exposed meat, and dead rodents or birds, especially around buildings.

Also see 'Managing the pest and its impacts' under 'Houseflies'.

Further reading

Catts EP and Mullen GR 2002. Myiasis (Muscoidea, Oestroidea). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Geary MJ and Russell RC 2004. Fly larvae for wound management: a maggot makeover. *NSW Public Health Bulletin* 15:218–219.

Geary MJ, Smith A and Russell RC 2004. Maggots down under. *Wound Practice & Research* 17(1):36–42.

Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance*, CRC Press, Boca Raton, United States.

Adult stage of the moth fly

Moth flies

Description

The small, hairy flies in the family Psychodidae are commonly known as moth flies, drain flies, sewer flies or fungus gnats. They are commonly found in buildings, especially rooms with high humidity or moisture such as bathrooms, toilets and laundries. The adult flies are less than 0.5 cm long, with a dark grey body and wide wings covered in dense, long hairs, making them look like tiny moths. The larvae are worm-like — thin and up to about 1 cm long.

Biology and ecology

The adult flies lay eggs in moist organic material, especially slime in bathroom drains or under the rims of toilets, cisterns and shower roses, and the immature stages feed off this and other organic material.

Public health importance

Moth flies are not medically important pests — they do not bite humans or transmit pathogens, and their impact is restricted to general nuisance and contamination of foodstuffs. Some people may suffer mild irritation or allergic reactions if they are predisposed to insect allergies, but this is rare. Moth fly larvae can sometimes alarm people who mistake them for intestinal parasites — larvae under toilet rims can be dislodged when the toilet is flushed and remain in the toilet bowl.

First aid

As these flies do not bite, no first aid is needed.

Personal protection

See ‘Managing the pest and its impacts’, below.

Immature stage of the moth fly

Managing the pest and its impacts

Moth flies are easily controlled with knockdown insecticides or by applying long-lasting residual insecticides to drain openings. Ensure that drains and toilets are regularly cleaned of organic material build-up to limit breeding opportunities for these flies. Various chemicals are available that can remove the slime layer in which the larvae breed.

Further reading

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Gold BL, Mathews KP, Burge HA 1985. Occupational asthma caused by sewer flies. *American Review of Respiratory Disease* 131:949–52.

Lachowsky F and Lopez M 2001. Occupational allergens. *Current Allergy and Asthma Reports* 1:587–593.

Ordman D 1946. Bronchial asthma caused by the trickling sewage filter fly (Psychoda): inhalant insect allergy. *Nature* 157:441.

A drone fly maggot with its long breathing tube

Drone flies (rat-tailed maggots)

Description

Small flies belonging to the genus *Eristalis* are commonly called drone or hover flies. They have large and unusual-looking immature stages, often known as rat-tailed maggots because of their long, tail-like structure that functions as a breathing tube.

Biology and ecology

Adult flies lay eggs on decaying organic matter, with a particular preference for faeces. The larvae feed on rotting organic material in wet environments and use their extended breathing tube to feed underwater.

Public health importance

Drone flies pose no real health risk, but the occasional presence of the immature stages in toilets can cause alarm because of their resemblance to intestinal parasites. Cases of suspected internal myiasis in humans have been reported after accidental ingestion of the eggs or immature stages of *Eristalis* species. However, scientists have not reached an agreement on this — an alternate hypothesis is that eggs are laid in the perianal region and newly hatched larvae crawl into and develop within the rectum. In most cases, very mild symptoms are reported (e.g. nonspecific abdominal pain and mild anal discomfort) or no symptoms at all, and it is unlikely that any internal myiasis occurred.

First aid

No specific first aid is required.

Personal protection

No specific personal protection strategies are required.

Managing the pest and their impacts

No specific management is required. However, problems with drone flies may be more likely to occur under unhygienic conditions.

Further reading

Aguilera A, Cid A, Regueiro BJ, Prieto JM and Noya M 1999. Intestinal myiasis caused by *Eristalis tenax*. *Journal of Clinical Microbiology* 37(9):3082.

Catts EP and Mullen GR 2002. Myiasis (Muscoidea, Oestroidea). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Drisdelle R and Forward KR 2006. Doctor, there's a tadpole in my feces! *The Canadian Journal of Infectious Diseases & Medical Microbiology* 17(3):189–191.

Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance*, CRC Press, New York.

Whish-Wilson PB 2000. A possible case of intestinal myiasis due to *Eristalis tenax*. *Medical Journal of Australia* 173(11):652.

Lice

The head louse, *Pediculus capitis*

Head lice

Description

Human head lice (*Pediculus capitis*) are wingless insects less than 4 mm long. Their bodies are relatively flat, they have three pairs of legs and are usually a light grey colour, turning to brown after a blood meal. They have strong claws on each leg to cling onto hairs and they are found almost exclusively on the head.

Biology and ecology

Head lice are highly adapted to life in the head hair of humans and are one of the few external parasites that must live on humans, not other animals. Their highly specialised claws are ideal for clinging to and moving through hair. Head lice dry out and die within 48 hours if they are removed from the head. They cannot infest other animals, such as dogs, cats, possums or birds, or live in clothing, floor coverings or furniture.

Head lice need blood meals at all stages of their lives and adult lice feed on blood at least once per day. A female louse can lay around six eggs per day and over 100 eggs in her lifetime, attaching them to the hair shaft with a strong adhesive she secretes. The eggs hatch after a week, and immature lice develop into adults over less than two weeks. Adult head lice may live up to a month and there are usually fewer than a dozen active lice on an infested person at any time. However, there may be hundreds of living and dead eggs and larvae present on one person.

Public health importance

Head lice infestation (known as pediculosis) is a common problem throughout the world in all socioeconomic groups. However, considerable myth and misinformation surround head lice and their management, mainly due to a lack of accurate information on the biology, transmission and control of these insects.

Studies have shown that around one in four primary school-aged children in Australia have head lice and most are unaware of it. Itchiness is a common symptom, but severe irritation is relatively rare.

Although heavy infestations cause skin irritation, head lice do not transmit disease-causing microorganisms. However, while the direct public health impacts of these insects are low, the psychological trauma of parents and carers, disturbed by the societal implications of a lice infestation, can sometimes be substantial.

Using insecticides and other substances to control head lice can actually have more serious health effects than the lice themselves. Swapping between different treatments or using several different treatments at the same time can cause serious skin irritation, itchiness and other complications. Registered chemicals that kill lice are usually safe, but excessive use of other substances, such as home remedies and other insecticides, can cause irritation. If head lice are effectively removed (see 'Managing the pest and their impacts', below), any irritation should quickly resolve.

Personal protection

Head lice cannot jump or fly. Their movement within hair, and from one head to another, is usually via direct head-to-head contact. Primary school-aged children, particularly girls, are at greatest risk of exposure to head lice. There is little that can be done to stop exposure to head lice among children and, since children are rarely quarantined because of more contagious infections such as cold or flu, it makes little sense to segregate them based on the presence (or suspected presence) of head lice.

Studies show that lice are rarely transferred through clothing, hats, furniture or bedding. Lice or eggs may be attached to strands of hair left on pillows, bedding or furniture, but this is uncommon.

A range of products, both of botanical and synthetic origin, claim to repel head lice and provide protection from infestation, but few studies have been done to test this.

Managing the pest and its impacts

While the health risks are minimal, few parents or carers would happily allow children with head lice infestations to go untreated. Before starting treatment, ensure that the person is actually infested with head lice. This can only be confirmed by the presence of live adult or nymphal head lice, not just eggs (nits) or natural scalp secretions that can resemble eggs. There is no benefit to treating people because of suspected head lice and 'preventative' treatment does not provide any protection.

There are two main strategies to remove head lice — the 'wet comb' method and the pediculicide (products that contain insecticides to kill head lice) method. The wet comb method is the preferred way to detect and treat head lice — it is effective, does not contribute to insecticide resistance in head lice and presents a low risk of skin irritation. In this method, hair conditioner is applied to dry hair, which stuns the head lice (making them immobile) and makes the hair strands slippery. This makes the lice easier to remove using a good-quality fine-toothed lice comb. Weekly use of this method can prevent an infestation establishing and prevent reinfestation. It can also be used as a diagnostic tool to identify infestations that might benefit from chemical treatment — if five or more adult lice are collected using this method, then consider using the pediculicide method. The wet comb method is outlined below:

+ *Equipment needed* — light-coloured hair conditioner, standard comb, good-quality lice comb (preferably metal, as plastic prongs can deform, allowing lice to escape), light-coloured paper towel or tissue.

+ *Apply conditioner to dry hair* — apply a large amount of conditioner, as each hair strand must be covered. The conditioner can be easily spread through the hair using a normal comb. Head lice are more common close to the scalp, so take care to ensure these areas are well covered.

+ *Remove the lice* — use the normal comb to part the hair into small sections, working from the nape of the neck towards the crown of the head. For each small section, carefully inspect the hair and work through with the lice comb from scalp to tip of hair. Lice or eggs may be difficult to see but wiping the lice comb on paper towel or tissue makes them easier to see. Continue combing each section of hair until no further lice or eggs are detected.

+ *Retreatment* — while a good quality lice comb will remove eggs, sometimes live eggs can survive the initial treatment. Retreatment after seven days will ensure that any immature head lice that have hatched since the initial treatment will be removed before they can lay more eggs.

The wet comb method can be time-consuming and needs dedication from parents or carers, as well as cooperation from children, to be effective.

The pediculicide method involves applying a product that contains an insecticide (such as a synthetic pyrethroid or active botanical ingredients) to the head and hair of people with head lice. A number of products are available that kill adult head lice and eggs, although they are generally more effective for controlling adult lice. Therefore, the treatment needs to be repeated after seven days to kill any newly emerged lice. Some treatments take less than 20 minutes and these are preferable to longer (e.g. overnight) treatments. These products can be very effective, but resistance to these chemicals is contributing to the growing problem of head lice around the world. Always follow the instructions on the label of pediculicide products.

A combination of these two methods may be the most effective way to manage head lice.

Further reading

Burgess IF 2004. Human lice and their control. *Annual Review of Entomology* 49:457–481.

Canyon DV and Speare R 2007. A comparison of botanical and synthetic substances commonly used to prevent head lice (*Pediculus humanus* var. *capitis*) infestation. *International Journal of Dermatology* 46(4):422–426.

Durden LA 2002. Lice (Phthiraptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Leo NP and Barker SC 2005. Unravelling the evolution of the head lice and body lice of humans. *Parasitology Research* 98(1):44–47.

Leo NP, Hughes JM, Yang X, Poudel SKS, Brogdon WG and Barker SC 2005. The head and body lice of humans are genetically distinct (Insecta: Phiraptera, Pediculidae): evidence from double infestations. *Heredity* 95:34–40.

NSW Health 2010. *Nitbusters: Head Lice in Schools Program*, NSW Health. www.health.nsw.gov.au/publichealth/environment/headlice/nitbusters.asp

Silva L, Alencar R de A, Madeira NG 2008. Survey assessment of parental perceptions regarding head lice. *International Journal of Dermatology* 47(3):249–255.

Speare R and Buettner PG 1999. Head lice in pupils of a primary school in Australia and implications for control. *International Journal of Dermatology* 38(4):285–290.

Speare R 2007. *Head Lice Information Sheet*, Department of Public Health and Tropical Medicine, James Cook University, Queensland.

The pubic louse, *Pthirus pubis*

Pubic lice

Description

Pubic lice (*Pthirus pubis*, also known as crab lice) are parasites of humans and are closely related to head lice and body lice. They are found throughout the world. Research shows that pubic lice were once parasites of gorillas before transferring to humans millions of years ago. The lice are light-brown insects, less than 2 mm long, and relatively flat and round. They resemble small crabs because of their robust claws, which are designed to grasp the coarser hair of the pubic region.

Biology and ecology

Pubic lice are perfectly adapted to life on the human body. They readily feed on human blood, but cannot burrow into or live within human skin. They are best adapted to relatively thick, coarse hair and are most commonly found in hair in the pubic and perianal regions. These lice are also occasionally found in other areas including the beard, moustache, eyelashes and armpits, as well as hair on the chest and abdomen. The hair on the scalp is usually unsuitable because of its fine texture and closeness of the hair shafts. On children, public lice tend only to attach to the eyebrows and eyelashes; this usually indicates that the child has had close contact with an infested parent.

The life span of adult pubic lice is less than a month. A mature female louse lays up to three eggs a day for around 10 days. The eggs are smaller than those of other human lice and are a darkish brown with an opalescent sheen. Each egg is firmly attached to the shaft of coarse hair and will hatch within 6–8 days at skin temperature. Pubic lice cannot infest rooms or carpets, and if the lice are removed from the host they will die within a few hours.

Pubic lice are usually transmitted by sexual contact, and although this is the most common method, it is not the only means of transmission. Shared bath towels and clothing, discarded clothing hanging in overcrowded locker rooms, children sleeping with an infested parent, or bedding that has recently been vacated by an infected individual can cause new infestations. Pubic lice cannot be transmitted from animals.

Public health importance

In many countries today, pubic lice are considered a sexually transmitted infection (STI) and their presence may indicate the presence of a more serious STI. In fact, pubic lice are one of the most contagious of all STIs. The bites of public lice can produce small, round, grey-blue spots that may be intensely itchy, and therefore prone to secondary infection. A study during the late 1980s reported that approximately 1.5% of people visiting a sexually transmitted disease clinic had pubic lice. The incidence of pubic lice infestation increased markedly following the 'sexual revolution' of the 1960s, but the incidence rates have declined in some countries over the past decade, despite other STIs increasing. One possible explanation for this phenomenon is the trend towards extensive pubic hair removal among sexually active people. No disease-causing organism has been transmitted by pubic lice in Australia.

First aid

An infestation of pubic lice is diagnosed by identifying adult lice or eggs within the hair of the infested person. Pediculicide treatments (most commonly containing permethrin) are normally used to kill the lice. Eggs need to be physically removed with a lice comb as they are strongly attached to the hair shafts. Hair removal is an effective alternative approach to insecticide use. For infestations in the eyebrows or eyelashes, apply an occlusive ointment (e.g. Vaseline) twice daily for ten days if the lice cannot be physically removed.

Personal protection

Pubic lice are a highly contagious STI and condoms do not prevent their transmission. The only personal protection strategy is complete pubic hair removal.

Managing the pest and its impacts

When someone is diagnosed with pubic lice, it is important that they inform all their sexual contacts so they can seek treatment if necessary. If one person within a family has pubic lice, all family members should be examined and treated, especially if the infested person shares a bed with other family members. Wash the infested person's underwear and bed linen in hot water, followed by hot tumble drying to ensure all lice have been killed. It is not necessary to spray rooms or beds with insecticides.

Further reading

Anderson AL and Chaney E 2009. Pubic lice (*Pthirus pubis*): history, biology and treatment vs. knowledge and beliefs of US college students. *International Journal of Environmental Research and Public Health* 6(2):592–600.

Armstrong NR and Wilson JD 2006. Did the 'Brazilian' kill the pubic louse? *Sexually Transmitted Infections* 82:265–266.

Durden LA 2002. Lice (Phthiraptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Leone PA 2007. Scabies and pediculosis: an update of treatment regimens and general review. *Clinical Infectious Diseases* 44(S3):S153–159.

Reed DL, Light JE, Allen JM and Kirchman JJ 2007. Pair of lice lost or parasites regained: the evolutionary history of arthropoid primate lice. *BMC Biology* 5:7.1–7.11.

Varela JA, Otero L, Espinosa E, Sanchez C, Junquera ML and Vazquez F 2003. *Phthirus pubis* in a sexually transmitted diseases unit. *Sexually Transmitted Diseases* 30(4):292–296.

Weiss RA 2009. Apes, lice and prehistory. *Journal of Biology* 8:20.1–20.7.

The human body louse, *Pediculus humanus*

Body lice

Description

Despite their name, human body lice (*Pediculus humanus*) are usually found in clothing and not on the body. This bloodsucking louse is a parasite of humans and is thought to have evolved from head lice (*Pediculus capitis*), migrating to the body in association with the introduction of clothing. Historically, body lice have been an ever-present companion of humans, but are now less common due to the relatively modern habit of regularly changing and washing clothes. However, problems still persist in some regions of the world, particularly parts of Africa, Asia, and Central and South America.

Body lice are small flattened insects with a slightly elongated, lobed abdomen. They have a distinct head, small eyes, a pair of short antennae and six legs, each ending in a strong claw. Each claw has a small thumb-like spine for grasping, allowing the louse to move quickly around clothes using the fibres of the fabric or body hair for support. Adult lice are 2–4 mm long and pale greyish in colour, but they redden and darken after blood feeding. The mouthparts are tube-like, armed with minute teeth and sharp spines for piercing the skin.

Biology and ecology

Body lice live their entire lives within human clothing. They only leave the clothes briefly to feed from the host's body, or they hold onto clothing fibres or body hair while blood feeding. The lice take frequent blood meals at any time, day or night, but usually when the person is at rest. They prefer to feed where the skin is soft and folded, and the clothing fabric is in close contact with the body. Female body lice lay their eggs along the seams or hems of clothes (especially underwear) that are next to the surface of the skin. Each egg is firmly glued to fibres of the clothes or, occasionally, to body hair. Adult lice may live for up to a month and can lay up to 300 eggs within their life span. The eggs are white and oval shaped. Eggs hatch within 5–10 days, but if the clothing is removed each night from the warmth of the body, the eggs may take up to two weeks to hatch. Body louse eggs can survive for up to 14 days, but the adults are extremely sensitive to changes in temperature and humidity, and can abandon a host if they die or have a fever. Without a constant source of blood, the lice die within 2–5 days. In hot weather, if several layers of infested clothing are worn, the lice may move to an outer layer where the temperature is cooler. They are very rarely seen crawling on the outside of infested clothes, but if they are, this would indicate a heavy infestation.

Public health importance

Louse-borne diseases have been significant throughout history. Body lice can transmit the potentially fatal epidemic typhus (caused by the bacteria-like organism, *Rickettsia*) and trench fever (caused by *Bartonella* bacteria), as well as relapsing fever (caused by *Borrelia* bacteria). However, as body lice populations have dramatically decreased across the world, so has the incidence of their associated diseases. Body lice are relatively rare in Australia and there is almost no risk of acquiring a louse-borne disease in this country, but they can be acquired in other countries and brought in on travellers' bodies.

Body lice bites appear as small red dots that develop into raised lesions with wheal-like inflammation. Reactions to the repeated injections of insect saliva may include headache, fatigue, loss of appetite, joint pain, high temperature, irritability, severe itchiness and rash. Secondary infections of bite sites are common, resulting from continuous scratching. In heavy infestations, inhalation of body lice faeces or parts of cast lice skins can also trigger symptoms resembling hay fever.

Heavy infestations can cause a general discolouration and thickening of the skin — a condition commonly known as vagabond or hobo disease. These names reflect the fact that, in developed countries like Australia, those at greatest risk of body lice infestation are the homeless or destitute.

First aid

If a body lice infestation is identified, remove and dispose of clothes, or wash them in hot water. Treat bites with a cold compress or soothing lotions to relieve itchiness, and an antiseptic ointment to prevent secondary infection. Other secondary symptoms should be treated by a general practitioner on a case-by-case basis.

Personal protection

In Australia, the risk of exposure to body lice is extremely low. Transmission of body lice occurs when living conditions are crowded, personal hygiene is neglected, clothes are not changed or facilities for laundering clothes are not available. Lice can spread rapidly among homeless people, or victims of war and natural disasters, when people sleep in their clothes and huddle together for warmth. Bedding and furniture can also be a source of infestations. Health and social care workers involved with these groups need to be aware of these potential risks to avoid personal exposure and to identify the early signs of body lice activity in others.

Managing the pest and its impacts

Body lice are best managed by maintaining good personal hygiene. The insects do not live in human skin, so treating infected individuals with insecticides is not necessary, unless clothing cannot be changed and treated. In most cases, clothing should changed and washed regularly in hot soapy water to kill adult lice and eggs that may be lodged within the seams and folds of clothing.

There is rarely a need to treat houses or buildings with insecticide, except in large infestations in crowded or unhygienic conditions. If a heavy infestation is identified in a group of people, remove and replace clothes and bedding material, then carefully inspect the surroundings to determine if insecticides need to be applied to floor coverings and furniture.

Further reading

Durden LA 2002. Lice (Phthiraptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

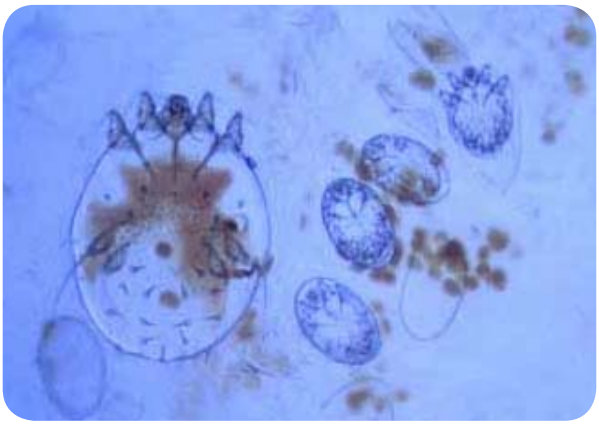
Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance.* CRC Press, Boca Raton, United States.

Leo NP and Barker SC 2005. Unravelling the evolution of the head lice and body lice of humans. *Parasitology Research* 98(1):44-47.

Leo NP, Hughes JM, Yang X, Poudel SKS, Brogdon WG and Barker SC 2005. The head and body lice of humans are genetically distinct (Insecta: Phiraptera, Pediculidae): evidence from double infestations. *Heredity* 95:34–40.

Raoult D, Foucault C and Brouqui P 2001. Infections in the homeless. *The Lancet Infectious Diseases* 1(2):77–84.

Mites



The human scabies mite, *Sarcoptes scabei*

Scabies mite

Description

The human scabies mite (*Sarcoptes scabei*, sometimes known as the human itch mite) is the only arthropod in Australia known to infest human skin and regularly cause a clinical syndrome. This mite is found worldwide and only parasitises humans. It lives under the skin, causing a condition known as scabies. The mites are very small (less than 0.5 mm long) and are best observed under a microscope, as shown above. They are wingless, straw coloured and oval shaped, with no eyes and short thick legs. All immature stages look similar to the adult mites, except the larvae have six legs and the two stages of nymphs have eight legs.

Biology and ecology

The mite burrows under the skin, making tunnels through the upper skin layers by secreting an enzyme that dissolves the skin. They do not need human blood for survival — instead, they feed on dissolved human tissue within the tunnels. Their entire life cycle occurs over 10–17 days. Mites mate on the skin surface and newly mated females burrow into the skin within an hour, using their mouthparts and claws to make a tunnel. Usually, only one mite lives in each tunnel and it rarely leaves, if ever. The mite lays individual eggs, leaving them behind her at a rate of 2–3 eggs each day. A female will lay up to 40 eggs in her lifetime. The eggs hatch within 48 hours and the immature mites dig their way to the surface, where they use hair follicles, folds of skin or very short burrows to moult to the next stage.

In most cases, infested patients have a stable mite population of less than 20 female mites. New infestations are initiated by a fertilised female mite transferring to a new host. This usually occurs shortly after the mite has mated and has not yet started burrowing, but can also happen if the mite is removed from her tunnel by scratching. Mites cannot jump or fly but they can travel quickly on skin at speeds of up to 2.5 cm per minute.

Public health importance

In the early stages, scabies infestations can be difficult to diagnose because noticeable symptoms can take up to a month to develop. Symptoms appear after the host has been sensitised and develops an allergic reaction to the mite's faeces, skin moults or saliva, or the fluids diffusing into the host tissues from the tunnels. The tunnels can appear as pale grey, threadlike marks and often follow natural creases in the skin in areas such as the hands (particularly the webbing between the fingers), wrists, elbows, genitals and breasts. Large areas of the body can be covered by a rash that is not specifically associated with the mite's burrows, but is thought to be a generalised allergic reaction or associated with immature mite activity. The patient can experience severe itching all over the body that increases in intensity at night. This mite is not associated with the transmission of pathogens.

Crusted scabies (previously known as Norwegian scabies) is a term used to describe extreme infestations of thousands of mites. Infestations become extreme if they are left untreated, especially in immobilised geriatric patients, the homeless, the cognitively impaired, AIDS patients and other patients with lowered immune systems. The patient's skin becomes thickened and crusted on the surface, particularly on the scalp, face, neck and buttocks, and the underlying layers are soft and honeycombed with tunnels. The skin that flakes off contains many mites and this form of scabies is highly contagious. Patients with crusted scabies can be a source for local epidemics in health care facilities, with fellow patients, medical staff and the patient's family all at risk.

Studies have shown that outbreaks of scabies are associated with the cooler months, perhaps as a result of human behaviour (e.g. overcrowding in houses, higher rates of shared bedding) or mite physiology (e.g. mites may survive better in cool weather or they may reduce their activity in summer in reaction to human sweat). Socioeconomic factors, especially homelessness, mental illness and poor hygiene, are risk factors for scabies infestation, with outbreaks commonly occurring in institutions such as hospitals, nursing homes, prisons, refugee camps and schools. Scabies is uncommon in the wider community.

First aid

The presence of scabies should be confirmed by consulting a general practitioner before treatment begins. Skin scrapings are usually needed to make a diagnosis — these need to be deep to the point of bleeding and are then examined under a microscope for signs of infestation. A new alternative to skin scrapings is videodermatoscopy, a noninvasive test for the presence of mites, eggs and faeces, using a camera that magnifies the skin.

Once diagnosed, most scabies infestations are easy to control using topical scabicides (insecticides registered for use on human skin). The most commonly used scabicide is permethrin (a widely used synthetic insecticide with minimal side effects) — other products contain benzyl benzoate or crotamiton. Any pharmacy will supply a topical scabicide and a prescription is not necessary. Oral ivermectin (an antiparasitic drug) has been used effectively against severe infestations in some controlled clinical cases. A prescription is necessary for ivermectin. In most cases, itching can persist for one week to one month after the treatment, but this is not necessarily a sign of treatment failure. Postscabies eczema can occur after using scabicides and this reaction should not be misdiagnosed as reinfestation with scabies, leading to retreatment and overexposure to chemicals. After the initial treatment, wash bed linen and clothing in hot water and tumble dry on a hot cycle. There is no need to use insecticides in the house or on furniture.

If crusted scabies is diagnosed, the patient should be isolated throughout their treatment, and nursing staff should wear gloves and other protective clothing. Treatment is difficult, as the thickness of the skin prevents topical scabicides from entering and treatment failures can be common. Ivermectin may need to be administered. Crusted scabies is highly contagious and close contact with infested people should be avoided.

Personal protection

Minimising direct physical contact with infested people is the only way to avoid new infestations. If a person is diagnosed with scabies, then anyone who has had physical contact with them, lives in the same household, or shares bedding, towels or clothing must be notified so that they can treat any infestation that may have occurred. Anyone else who has had significant contact with the primary patient should also be treated.

Managing the pest and its impacts

The scabies mite is usually transmitted by direct physical contact between people, particularly during sexual contact or bed sharing. New infestations can sometimes occur after exposure to infested bedding, towels and clothing. Mites may live for up to three days away from their host when environmental conditions are suitable, and it is possible that eggs laid off the host can hatch, with larvae potentially infesting new hosts via airborne particles.

Scabies can be a serious problem in remote Aboriginal and Torres Strait Islander communities in central and northern Australia, with up to 50% of people infested in some communities. Local hygiene improvements and coordinated widespread topical scabicide treatments have lowered infestation rates, but scabies activity continues in these communities.

Further reading

Henngge UR, Currie BJ, Jager G, Lupi O and Schwartz RA 2006. Scabies: a ubiquitous neglected skin disease. *Lancet Infectious Diseases* 6(12):769–779.

Heukelbach J and Feldmeier H 2004. Ectoparasites — the underestimated realm. *The Lancet* 363(9412):889–891.

Heukelbach J and Feldmeier H 2006. Scabies. *The Lancet* 367(9524):1767–1774.

Micali G, Lacarrubba F and Tedeschi A 2004. Videodermatoscopy enhances the ability to monitor efficacy of scabies treatment and allows optimal timing of drug application. *Journal of the European Academy of Dermatology & Venereology* 18(2):153–154.

Mullen GR and O'Connor BM 2002. Mites (Acari). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Otero L, Varela JA, Espinosa E, Sanchez C, Junquera ML, Valle AD and Vazquez F 2004. *Sarcoptes scabiei* in a sexually transmitted infections unit. *Sexually Transmitted Diseases* 31(12):761–764.

Russell RC 2001. The medical significance of Acari in Australia. In: *Acrarology: Proceedings of the 10th International Congress*, Halliday RB, Walter DE, Proctor HC, Norton RA and Colloff MJ (eds), CSIRO Publishing, Melbourne.

Steen CJ, Carbonaro PA and Schwartz RA 2004. Arthropods in dermatology. *Journal of the American Academy of Dermatology* 50(6):819–821.

The bird mite, *Ornithonyssus bursa*

Bird mites

Description

There are several species of bird mite, but the most common species affecting humans is *Ornithonyssus bursa*, known as the bird mite, tropical fowl mite or starling mite. The adult mite is small and oval shaped, has eight legs (the larval stage has six legs), is pale in colour and semitransparent, and has a sparse covering of short hairs. They may also appear reddish to brownish in colour, depending on the time since the last blood meal. Individual mites may be difficult to see with the naked eye, but large infestations are clearly visible due to the sheer number of mites, especially when concentrated close to their entry points to dwellings.

Biology and ecology

Bird mites rely on a bird host for survival, and populations cannot be maintained on humans or other vertebrates. The mites feed on the bird's blood and are most strongly associated with common introduced birds, such as pigeons, starlings, sparrows and Indian mynahs. They can also be found on pet birds, other wild birds and poultry.

The mites have a five-stage life cycle with a generation time of about seven days from egg hatching to adult. Although they can survive for up to three months in association with a suitable host, the mites are unlikely to live more than a few weeks away from a host. Bird mites are extremely mobile, but they do not jump or fly.

Public health importance

Bird mites do not infest the skin, hair or clothing of humans, or furniture, carpets or bedding in houses. However, mites do bite humans and cause a prickling sensation followed by irritation, rashes and itching. The irritation is caused by an allergic reaction to the mite's saliva and, as a result of severe itchiness and scratching, the bite sites are be prone to secondary infection. No disease-causing microorganisms are transmitted to humans by bird mites in Australia.

Bird mites primarily affect humans by their nuisance biting; however, the effects of very large mite populations can be significant and the problem may persist for a long time without control of the bird or mite populations.

First aid

The irritation associated with bites can be soothed with an anti-itch medication, such as crotamiton, but there is no specific treatment. Severe reactions may need to be treated with antihistamines, as for other allergic conditions. Controlling the mite infestation is the only way to stop the bites and the symptoms.

Personal protection

The most effective protection against bird mite irritation is to ensure that birds do not nest or roost in houses. If an infestation does occur, personal insect repellents will provide temporary relief until the birds can be removed and mites can be controlled using insecticides.

Managing the pest and its impacts

Bird mite infestations can be effectively controlled by following a four-step process. Bird mites should firstly be correctly identified as the pest of concen. Specimens should be collected and identified by suitably qualified personnel to avoid confusion with mites of similar appearance (e.g. rodent mites, stored product mites or mites of pets) or a noninsect cause of the irritation.

Once correctly identified, the source of the infestation (e.g. bird nests) must be located. The birds (including dead birds) and nesting material must be completely removed, taking care that mites are not accidentally transferred to other areas of the house or workplace. The mite infestation will then disappear over time and chemical control will provide the fastest relief from nuisance biting. The locations of birds or nests should be treated with an appropriate insecticide and, although treatment of the living areas of the house may not be necessary, floors and walls can be treated with a long-lasting insecticide. Treating the house without removing birds and nesting material will provide only a temporary solution. Entry points to roof cavities for birds (e.g. broken tiles) should be repaired or blocked to prevent the problem from recurring.

Further reading

Mullen GR and O'Connor BM 2002. Mites (Acari). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Webb CE, Doggett SL, Geary MJ and Russell RC (2004). The biology and control of bird mites. *Professional Pest Manager* 9:21–22.

The rodent mite, *Ornithonyssus bacoti*

Rodent mites

Description

The rodent mite (*Ornithonyssus bacoti*, also known as the rat mite or tropical rat mite) is a global species closely associated with rodent populations, such as rats and mice, and their nests. It is small, oval shaped and very similar in appearance to the bird mite. Any suspected rodent mite specimen should be identified by an entomologist experienced in mite identification. The adult mite is usually a pale colour, but may appear darker depending on the time since the last blood meal. Rodent mites are a less common problem for humans than bird mites, and tend to be associated more often with industrial buildings or warehouses than residential buildings.

Biology and ecology

The life cycle of the rodent mite takes around two weeks, and both adult and immature stages feed on rodents. If the host rodent dies or is removed, the adult mites that are left in the nesting material or on the dead host move away from the original location in search of a new host. Mites can live for up to two weeks without a blood meal and during this time they may encounter humans. They cannot complete their life cycle in association with a human, but they will bite people.

Public health importance

Rodent mites do not infest the skin, hair or clothing of humans, but they will bite humans and cause irritation and itchiness. No disease-causing microorganisms are known to be transmitted to humans by rodent mites in Australia.

First aid

The irritation associated with bites can be soothed with an anti-itch medication, such as crotamiton, but there is no specific treatment. Severe reactions may have to be treated with antihistamines, as for other serious allergic conditions.

Personal protection

The most effective protection is to ensure that there are no rodents on the premises. If an infestation occurs, personal insect repellents will provide temporary protection until rodent control measures are taken and the mites are treated using insecticides.

Managing the pest and its impacts

Rodent mite infestations can be effectively controlled by following a four-step process. Mites should firstly be correctly identified by suitably qualified professionals to avoid confusion with other mites of similar appearance (e.g. bird mites, stored product mites, or mites of pets) or a noninsect cause of the irritation.

Once correctly identified, locate the source of the infestation. Rodents must be killed or removed, along with nesting material, taking care that mites are not accidentally transferred to other areas of the house or workplace. The infestation will then disappear over time and chemical control will provide the fastest relief from nuisance biting. The locations of the rodents or nests should be treated with an appropriate insecticide and, although treatment of the living areas of the house may not be necessary, floors and walls may be treated with a long-lasting insecticide. Treating the house without removing rodents and nesting material will provide only a temporary solution. Entry points for rodents, such as floor cavities or wall voids, should be repaired or blocked to prevent the problem from recurring.

Further reading

Mullen GR and O'Connor BM 2002. Mites (Acari). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

An example of a chigger mite

Chigger mites

Description

Chigger mites (also known as scrub itch mites) belong to the family Trombiculidae and are notable as the only arthropod with a larval stage that can cause irritation to humans. The adult and nymph stages of the mites pose no public health concern. The adult mites are small, sometimes less than 1 mm long, and the problematic larval mites are tiny — less than 0.2 mm long. They tend to be light coloured if unfed and have a yellowish to dark colouring after feeding.

The species most often encountered and documented as being of potential public health importance are:

+ *Eutrombicula hirsti* and *E. samboni* (found in the eastern and south-eastern coastal areas from Queensland to South Australia)
+ *E. sarcina* (found in central Queensland)
+ *E. macropus* and *Neotrombicula mackayensis* (found in north-west Queensland and northern New South Wales)
+ *Leptotrombidium deliense* (found in the coastal north of Queensland and Western Australia).

Biology and ecology

Chigger mites are external parasites of rodents, birds and lizards. They are commonly found in disturbed habitats, especially on the fringes of rainforests, where their rodent hosts often forage. Eggs are usually laid on soil or debris, and hatch within a week. The prelarva develops into the larval stage after a week. The larvae climb onto blades of grass and await a potential host to attach themselves to for feeding. Larvae feed on the host for up to five days before dropping to the ground to continue their development through three nymphal stages and finally become an adult. The adult mite can live without a host and eats small ground-dwelling arthropods. The duration of the life cycle depends on the species of mite, and local environmental and climatic conditions.

Public health importance

Human contact with chiggers can cause localised irritation with persistent itching and there may be a red raised patch at the bite site. Multiple chigger bites and their associated symptoms are often referred to as 'scrub itch' — but note that attack by multiple larval ticks is also called scrub itch in some parts of Australia. The chiggers do not burrow into human skin, although there may be localised swelling that looks like they have embedded. The chigger larvae do not survive for more than two days on a human host. Chiggers prefer to bite areas where skin is soft and they often congregate under clothing where it is tight against skin (e.g. around the waist or underwear), as well as around the ankles and lower legs.

Chiggers can also transmit an infective agent that causes the disease known as 'scrub typhus' (previously known as 'tsutsugamushi disease'). Scrub typhus is a potentially fatal fever that is widespread through eastern and south-east Asia, and is also found in parts of northern Australia (Queensland, Northern Territory and Western Australia). It is caused by a rickettsia (*Orientia tsutsugamushi*) that naturally occurs in rodents and bandicoots, and can be transmitted to humans via the chigger *Leptotrombidium deliense.* The symptoms of scrub typhus can vary from a mildly irritated bite site to a more painful bite site that develops around 10–20 hours after the bite. The bite site can become ulcerated and a dark scab (known as an eschar) develops, along with a rash and fever.

Further symptoms can include head and muscle aches, general malaise and loss of appetite, with more severe symptoms including haemorrhaging and other blood disorders. If the infection is with a virulent strain of the microorganism, it can lead to potentially fatal damage to the kidneys, lungs and heart. Immunity after infection is short-lived and reinfection is common in areas of endemic disease activity. Scrub typhus has a high fatality rate of around 30% if left untreated, but the condition is readily treated with antibiotics.

First aid

The irritation associated with bites can be soothed with an anti-itch medication, such as crotamiton, but there is no specific treatment. Severe reactions may need to be treated with antihistamines, as for other allergic conditions. Scrub typhus is potentially fatal without proper treatment, but it can be effectively treated with antibiotics after seeking medical advice.

Personal protection

The most effective strategy to protect against chiggers is to avoid known areas of activity. Using personal insect repellents that contain DEET (which is toxic to chiggers), as well as wearing clothing impregnated with permethrin, can provide excellent protection against chiggers. After being in known areas of chigger activity, take hot soapy baths or showers to remove attached and unattached mites. Placing clothing in a hot dryer will kill any mites present.

Managing the pest and its impacts

It may be possible to reduce the naturally occurring mite population with insecticides, but this is unlikely to be effective because of the difficulty in identifying specific areas of mite activity. The distribution of mites may depend as much on the abundance of their preferred hosts as it may on particular environmental conditions. Management of the preferred hosts may be an effective strategy to reduce the potential health risks associated with chiggers.

Further reading

Domrow R and Lester LN 1985. Chiggers of Australia (Acari: Trombiculidae): an annotated checklist, keys and bibliography. *Australian Journal of Zoology Supplementary Series* 114:1–111.

Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance*, CRC Press, New York.

Lawless P 2000. Other arachnids and myriapods. In: *Wildlife of Tropical North Queensland*, Ryan M and Burwell C (eds), Queensland Museum, Queensland.

Mullen GR and O'Connor BM 2002. Mites (Acari). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

An example of a dust mite

Dust mites

Description

The term ‘dust mite’ refers to a group of mites, generally species belonging to the genus *Dermatophagoides*, as well as other mites such as *Euroglyphus maynei*, that are naturally associated with the dust and debris inside houses. The adult mites are very small, less than 0.5 mm long, and mostly white to a light tan colour.

Biology and ecology

The whole life cycle of dust mites, from egg to adult, takes approximately one month. There are five stages: the egg, the larval stage, two nymphal stages and the adult. Adult mites can live for up to two months, but this is depends on the humidity and temperature of their surrounding environment. Dust mites prefer homes in regions of high humidity and constant warm temperatures. Although there are some seasonal and geographic fluctuations in mite activity, mite populations can increase dramatically in favourable conditions. Problematic dust mite populations are less likely to occur in dry or cold environments, or air conditioned homes. Mite populations are usually concentrated in high-traffic areas in homes and on furniture, especially beds, upholstered lounges and chairs, and in carpets with long fibres. They are attracted to these areas for food and they feed on shed human skin flakes and secretions, house dust, fungal spores, pollen grains, plant fibres and insect scales. Dust mites dislike strong light and will shelter in the seams, ledges and framework of furniture. The mites do not fly, but their small size means they can become airborne and easily distributed throughout the room during activities such as bed making.

Public health importance

Dust mites can cause skin reactions, especially in infants and people with insect allergies. The most important human health risk associated with dust mites is respiratory problems caused by dust mite allergens. Mites were first identified as potential allergen components of house dust in the 1920s, and sensitisation to mites (alive or dead) and their faeces is now acknowledged as a major risk factor for developing asthma. There is no single clinical symptom that can readily identify mite-allergic asthmatic patients, making clinical diagnosis difficult. Medical conditions that can be caused by dust mites include allergic rhinitis (blocked or runny nose), asthma and childhood eczema. Dust mites do not transmit any pathogens.

First aid

For skin reactions, irritation can be soothed with an anti-itch cream, but severe reactions, although rare, may require antihistamines. For people with asthma or other respiratory irritation, a general practitioner or a specialist immunologist should be consulted to identify the specific allergens and manage the symptoms. Many allergy clinics specialise in identifying allergic responses to different materials, including dust mites, using skin prick tests. Allergies from house dust mites can be managed with ‘allergy shots’ (immunotherapy), as well as reducing the mite population in the home.

Personal protection

See ‘Managing the pest and its impacts’, next page.

Managing the pest and its impacts

Managing dust mite populations in the home can be extremely difficult. Studies show that, for particularly sensitive individuals, it may not be possible to reduce mite populations (or their allergenic products) enough to improve either asthma or allergic rhinitis. It is virtually impossible to remove all dust mites from a household, but areas where mites tend to congregate can be targeted and populations of mites can be reduced.

Insecticides can be effective in killing the mites, but this method alone is unlikely to reduce asthma symptoms immediately, as the bodies of the mites and their faeces will still be present and may become airborne. Environmental or physical methods are necessary, with or without insecticide use. Minimise carpeted areas and replace them (where possible) with smooth, hard surfaces that are easy to clean. Avoid upholstered furniture, and enclose mattresses and pillows in specially manufactured ('plastic') products that help to exclude mites. Select bedding and curtains that can be washed at least weekly. Thoroughly vacuum all soft furnishings (including all mattresses, especially their seams, and the framework of the bed) on a regular basis, with a unit that has a HEPA air filter. Reducing humidity by improving air circulation and ventilation, or with air conditioning throughout the house, will help keep mite populations at lower levels.

Further reading

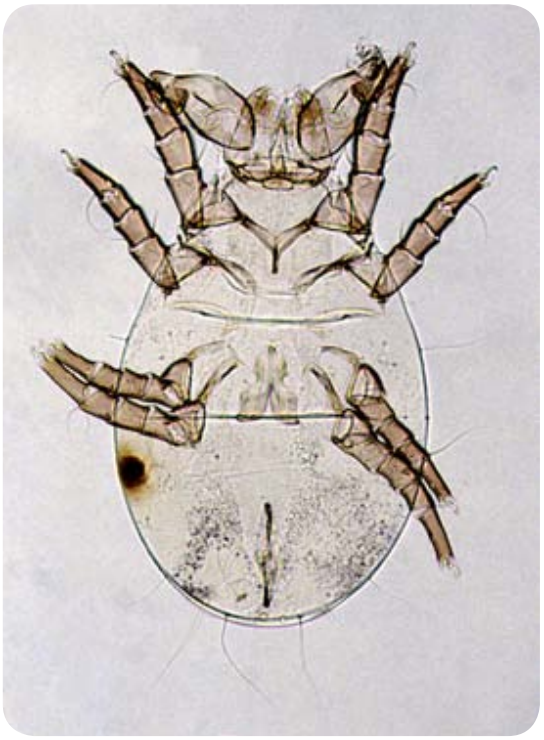
Arlian LG 1991. House dust mite allergens: a review. *Experimental & Applied Acrology* 10:167–186.

Gotzsche PC and Johansen HK 2008. House dust mite control measures for asthma: systematic review. *Allergy* 63(6):646–659.

Mullen GR and O'Connor BM 2002. Mites (Acari). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Russell RC 2001. The medical significance of Acari in Australia. In: *Acarology: Proceedings of the 10th International Congress*, Halliday RB, Walter DE, Proctor HC, Norton RA and Colloff MJ (eds), CSIRO Publishing, Melbourne.

Sheikh A and Hurwitz B 2003. House dust mite avoidance measures for perennial allergic rhinitis: a systematic review of efficacy. *British Journal of General Practice* 53(489):318–322.



A range of mite species can be associated with stored products

Stored product mites

Description

A wide range of mite species can be associated with stored food products. Large numbers of these mites can cause adverse reactions in people working with (or near) these products. The problem is greatest when dried foodstuffs (including seeds, grains, cereal products, flour and pet food, or hay and straw used as packing agents) are placed in warm, humid environments. These products can easily become infested with the larvae of storage insects, such as beetles and moths. Large populations of mites can also develop in these conditions.

The most common mite species associated with stored products is the straw itch mite, *Pyemotes ventricosus*. This species parasitises the larvae of insect species that are associated with grains and other stored food products. Other mite species (including *Acarus* species, *Aleuroglyphus* species, *Carpoglyphus* species, *Glycphagus* species and *Tyrophagus* species), which are associated with particular stored products, can all cause contact dermatitis in humans.

Biology and ecology

Stored products (including wheat, bran, flour, dried meat, fruit and vegetables) can provide favourable environments for many mite species. The stored products, along with the moulds and fungi that grow on them, provide a food source for the mites, especially if stored under humid conditions. The specific life cycle varies slightly between species, but generally takes 2–4 weeks with four developmental stages: egg, larva, nymph and adult. These mites do not actively seek out humans; irritation only occurs when humans handle materials containing mites.

Public health importance

Improvements in the storage, processing and packaging of food products have led to an overall decrease in reported cases of irritation caused by stored product mites. However, occasional cases of irritation from these mites do occur, and workers in produce stores who handle animal feed, such as hay, straw and lucerne, are especially at risk. In these cases, skin irritation tends to occur on the torso, arms and upper thighs — areas that usually come into direct contact with a bale of hay as it is carried. Some mites (e.g. *Pyemotes*) will bite, while others are so small they penetrate the upper skin layers and cause temporary itchiness. Large numbers of mites can be present and the reactions can be numerous and severe. Bite sites can be extremely itchy, usually leading to scratching and the possibility of secondary infection. Storage mites that have allergens in common with dust mite species may trigger respiratory problems in some people. There are no known human diseases spread by stored product mites.

First aid

In most cases, if contact with the stored product and the mites stops, the irritation will resolve in a matter of days. However, anti-itch cream can provide immediate relief from irritation. Severe reactions may require antihistamines.

Personal protection

Avoiding materials known to contain mites will provide effective protection. If material needs to be handled when mites are present, wear full protective clothing to avoid direct skin contact with mites or inhalation of mite material. After exposure to these materials, wash clothes to ensure any mites present are killed or removed. Personal insect repellents, especially those containing DEET, can minimise exposure to mites, but it is not clear if these products repel mites or are toxic to them. For agricultural workers with a high risk of exposure, permethrin-treated clothing may provide additional protection against the mites.

Managing the pest and its impacts

The most effective way to minimise exposure to stored product mites is to store material in well-ventilated and dry conditions that are unfavourable for mites. These conditions are also unfavourable for moulds and fungi, and the immature stages of other insects, so ensure that humidity does not build up. Also, raise the products off the floor to minimise the amount of debris that will attract insect pests. Stock should also be regularly circulated. Insecticides may be used to control mite populations, but this can be an expensive option and some mite species may not be susceptible to some commonly used insecticides, such as synthetic pyrethroids.

Further reading

Geary MJ, Knihinicki DK, Halliday RB and Russell RC 2000. Contact dermatitis associated with the brown-legged mite, *Aleuroglyphus ovatus* (Trupeau) (Acari: Acaridae), in Australia. *Australian Journal of Entomology* 39(4):351–352.

Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance*, CRC Press, New York.

Hardie D, Emry R, Adcock K and Hoffmann H 2006. Itch mites. Gardennote no. 28, Western Australian Government Department of Agriculture.

Hubert J, Stejski V, Munzbergova Z, Hajslova J and Arthur FH 2007. Toxicity and efficacy of selected pesticides and new acaricides to stored product mites (Acari: Acaridia). *Experimental and Applied Acrology* 42:283–290.

Hughes AM 1976. The mites of stored food and houses. Ministry of Agriculture, Fisheries and Food, Her Majesty's Stationery Office, London.

Mullen GR and O'Connor BM 2002. Mites (Acari). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Russell RC 2001. The medical significance of Acari in Australia. In: *Acrarology: Proceedings of the 10th International Congress*, Halliday RB, Walter DE, Proctor HC, Norton RA and Colloff MJ (eds), CSIRO Publishing, Melbourne.

Other mites

Description

Mites are common in many Australian environments and the majority of mite species rarely, if ever, cause any health concerns for humans. However, when mite populations increase in response to favourable environmental conditions, or when humans are exposed to naturally high mite populations, irritation can occur. In some instances, these mites may be of veterinary importance, either for livestock or domestic pets. Some examples of mite species associated with outdoor environments that can affect Australians include the grass itch mite (*Odontacarus australiensis*) and clover mite (*Bryobia praetiosa*). Pet dogs, cats and rabbits may have fur mites (*Cheyletiella parasitivorax*) that can cause irritation in people. All these mites are very small and, in most instances, expert entomological advice is needed to accurately identify the species.

Biology and ecology

The biology and ecology, and local seasonal and geographic distribution, varies with each species.

Public health importance

Generally, if there are any human health effects associated with these mites, they are likely to be limited to localised and raised, red or blistering skin reactions. There is unlikely to be any transmission of disease-causing microorganisms.

First aid

The irritation associated with bites can be soothed with an anti-itch cream.

Personal protection

There is no specific strategy to avoid exposure to these mites, apart from being aware of any existing mite problems and avoiding areas of mite activity, or avoiding human activity that may increase contact with naturally occurring mite populations. Appropriate treatment of infested pets (e.g. cats, dogs, rabbits) will ensure that the risk of exposure to mites is minimised.

Managing the pest and its impacts

Once the species of mite responsible for the pest problems has been identified, a specific approach can be taken. Management of mite problems can involve insecticides; removal of plants, animals or other materials sheltering the mites; or modifying human behaviour to avoid contact with areas of mite activity.

Further reading

Baker EW, Evans TM, Gould DJ, Hull WB and Keegan HL 1956. *A Manual of Parasitic Mites of Medical or Economic Importance*, National Pest Control Association, New York.

Mullen GR and O'Connor BM 2002. Mites (Acari). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

NSW Department of Health 1987. *Common pests and public health in New South Wales*. Department of Health, NSW.

Russell RC 2001. The medical significance of Acari in Australia. In: *Acrarology: Proceedings of the 10th International Congress*, Halliday RB, Walter DE, Proctor HC, Norton RA and Colloff MJ (eds), CSIRO Publishing, Melbourne.

Mosquitoes

The dengue mosquito, *Aedes aegypt i*

Many books and articles have been written on the mosquitoes of Australia and their habitats, associations with disease-causing microorganisms and control. It is beyond the scope of this document to provide detailed information on all species and all regionally specific pest and public health issues across the country.

This chapter provides an overview of the most important mosquito-related issues for Australian and exotic mosquitoes. Please refer to the further reading section for more specific information, or contact your state or territory health department for regionally specific information.

Australian mosquitoes

Description

Australia has many mosquito species, but only a small number of species are pests or a significant risk to human health. The most commonly encountered species with potential to cause problems include:

+ *Anopheles farauti* — a medium-sized mosquito with a spindly appearance and speckled grey colouring, found in northern Australia. This is a night-biting species with a biting peak in the first two hours after sunset. The larvae of this species are found in a range of habitats, including ground pools; large, open, water-holding containers; freshwater wetlands; and some brackish water habitats. This species actually includes at least three identical-looking subspecies in Australia and at least one of these can carry malaria.

+ *Aedes aegypti* — a small to medium-sized mosquito closely associated with water-holding containers in urban environments, such as rainwater tanks; drums and cans; roof guttering; pot plant bases and tyres; and in water-holding plants (e.g. bromeliads). This species is a day-biting nuisance pest that preferentially bites humans in shaded or indoor locations. It is the only species on mainland Australia that can transmit dengue viruses. This species was once widely distributed in Australia, including on the east coast and as far south as Victoria, but it is currently restricted to (mostly northern and western) Queensland.

+ *Aedes notoscriptus* — a small to medium-sized mosquito with banded legs and a thin, silver to golden lyre-shaped pattern on the thorax. This mosquito is often a severe nuisance pest, usually biting in the afternoon and around dusk, and is one of the most common pest species in urban areas. The species can transmit arboviruses, including Ross River virus, as well as dog heartworm. The larvae are usually found in water-holding containers around houses, such as tins, pots, ornamental ponds, roof guttering, rainwater tanks and tyres, as well as in water-holding plants (e.g. bromeliads) and tree holes.

+ *Aedes procax* — a small to medium-sized brownish mosquito with banded legs. The larvae of this species are found in freshwater and mildly brackish ground pools in tea-tree forest habitats. Little is known about the ecology of this species, but it may play an important role in local activity of arboviruses in coastal New South Wales and Queensland.

+ *Aedes vigilax* — a dark, medium-sized mosquito with banding on the legs. This species bites in the day in shaded locations and is also active in the morning, evenings and the early night. The larvae of this species are usually found in coastal estuarine wetlands and population increases are closely linked to high tides and rainy warm weather. The adult mosquitoes can fly many kilometres from their larval habitats. This species is a severe nuisance biting pest and can transmit arboviruses.

+ *Aedes camptoryhnchus* — a relatively large mosquito, found in salty and brackish wetlands in southern coastal areas of New South Wales, coastal and inland Murray River irrigation areas in Victoria, coastal South Australia and south-west Western Australia. This species is usually associated with estuarine marshlands, but is also common in flooded brackish water marsh and pastures immediately behind estuarine wetlands. They will bite during the day in shaded locations and are more prevalent in the mornings, evenings and early night. This species may occur in large numbers and is a serious nuisance-biting pest.
  It is a major arbovirus vector.

+ *Coquillettidia linealis* — a medium-sized, dark mosquito with golden scales on the top of the thorax. This species can be a nuisance-biting pest in southern Australia, but it is not clear if it can transmit arboviruses. This species is closely associated with permanent freshwater wetlands with abundant semi-aquatic plants.

+ *Mansonia uniformis* — a medium-sized, speckled pale and brown mosquito with a shortened tip to the abdomen. It will bite by day in shaded locations near its breeding places, as well as in the early evening and night. This species can be a severe nuisance-biting pest in northern Australia, but is not thought to transmit arboviruses. It is closely associated with permanent to seasonal freshwater wetlands with abundant semi-aquatic plants.

+ *Culex annulirostris* — a medium-sized mosquito with a white band on the proboscis (feeding tube). This species very rarely bites in the day and has a biting peak in the first two hours after sunset. This species is the major nuisance biter and vector species in inland Australia, as well as in coastal regions in the northern states. It is particularly common in the major river basins and irrigation areas of New South Wales and Victoria, and in tropical wetlands. Larvae are often found in freshwater habitats ranging from temporary flooded grasslands to permanent, well-vegetated wetlands. High populations can build in organic habitats, such as open drains, and wastewater and sewage ponds and their effluents. This mosquito is an important vector of arboviruses.

+ *Culex quinquefasciatus* — a medium-sized pale brownish mosquito and another very common pest species in urban areas, usually biting indoors at night. It does not transmit human pathogens in Australia. The larvae of this mosquito are usually associated with habitats with a high-organic content, such as plant containers, water containers (e.g. drums and tyres), drains, greywater (sullage) pits, primary sewage ponds, septic tanks, and other wastewater holding and water storage areas. They can also be found in freshwater wetlands, including water management structures — such as gross pollutant traps and drains — and the wetland itself.

+ *Verrallina funerea* — a dark, medium-sized mosquito, mainly found in the tropics and extending into northern temperate areas. The larvae of this species are found in a range of habitats, including ground pools, freshwater wetlands and some brackish water habitats. In some places, this mosquito is a nuisance-biting pest and an important arbovirus vector. Adults of this species can usually be found during the day in dense forested areas such as mangroves or tea-tree wetlands and, although it will bite readily during the day in these habitats, it will not come out of these forested areas into full sun during the day.

Biology and ecology

Mosquitoes are small, bloodsucking insects that belong to the family of flies called Culicidae (order: Diptera). There are more than 300 different species in Australia and, although each species has specific ecological associations and differs in their pest status, they generally have similar biological requirements.

Mosquitoes have a relatively short but complex life cycle consisting of eggs, four larval stages (instars) that develop in the water, a pupal stage in the water and an adult stage on land. The larvae cannot develop to the adult phase without access to water, and cannot develop in damp mud, soil or vegetation.

An adult female mosquito lays her eggs either on the water surface (usually as a floating raft) or on a surface that is often flooded with water (usually singly or in small groups). These egg-laying sites may include soil or vegetation at the edge of a wetland, soil or leaf litter where temporary pools form after rainfall, or the inside of water-holding containers (e.g. tins, tyres).

Some mosquito eggs (usually those laid by *Aedes* or *Verrallina* species) do not dry out and can remain dormant for some time before hatching, but most eggs (particularly those laid by *Culex* and *Anopheles* species) will hatch within 2–3 days. On hatching, the young larvae (commonly called wrigglers) feed continuously on particles in the water and grow through four different instars or moults. The final larval stage (fourth instar) develops into a pupa (also called a tumbler), from which the adult mosquito emerges around two days later. The length of time for larval development depends on the water temperature (and is usually shorter during the warmer months) and the availability of food, but it usually takes 1–2 weeks from when the eggs hatch to when the adults emerge.

On average, females live for approximately 2–3 weeks, males slightly less. Within their lifetime, adult male and female mosquitoes will feed on nectar and other plant sugars, but only the female will seek a blood meal. The blood meal provides protein for egg development and, while many mosquitoes are generalist feeders, some must specifically feed on humans, mammals, birds or amphibians.

The host-seeking behaviour of female mosquitoes is driven by a combination of carbon dioxide, body odours, and body heat or humidity. When she finds a suitable host, the female probes the skin for a blood capillary and injects a small amount of saliva containing chemicals that stop the blood from clotting. This is often the pathway for potential pathogens, such as viruses, to enter a host. In general, mosquitoes take three or four blood meals in their lifetime, and lay three or four batches of eggs.

Most adult mosquitoes are more active from dusk until dawn and usually seek refuge during the day in cool and humid sheltered habitats, such as in vegetation or under houses. Many mosquitoes do not travel far from their aquatic larval habitats, but some species can fly 5 km or more. A few species can fly 50 km or more downwind from their larval habitats.

Public health importance

Nuisance-biting mosquitoes can negatively affect the community, as well as having potential economic impacts on residential and recreational developments. It is difficult to measure the impacts of nuisance biting, as different people have different levels of tolerance towards mosquito bites and this can also depend on the density of the mosquito population. Geographic differences also exist — small populations of species, such as *Ae. notoscriptus*, can cause serious problems in some areas, but the effect of this species would be overshadowed by large *Ae. vigilax* populations in areas close to estuarine wetlands. Authorities and wetland managers in many areas often deal with complaints from the community regarding local nuisance-biting mosquito populations. As a general guide, most experienced mosquito workers would find a biting rate of around 60 bites per minute a pest problem.

Mosquitoes can also act as vectors for several human diseases, but the precise way that this happens varies with the mosquito species and pathogen. For example, arboviruses develop in suitable hosts (including native Australian mammals and birds). When a mosquito bites an infected animal, it takes in a small amount of blood that may contain virus. If the mosquito species is suitable for virus development, the virus will multiply and move through the mosquito's body to the salivary glands. The mosquito can then pass on the virus when it injects saliva during blood feeding.

This process of virus infection in the mosquito is called the 'incubation period' and can take 3–12 days to complete, depending on virus type, mosquito species and temperature. The mosquito cannot transmit the virus until the salivary glands are infected. The biological processes involved in the incubation period are very specific, and that is why only arboviruses are transmitted by mosquitoes. Mosquitoes do not transmit other viruses that may be taken in when blood feeding, such as influenza, measles, hepatitis and HIV — these viruses are all degraded by the mosquito's digestive system. Virus transmission from human to mosquito to human (i.e. without involving another animal) may occur with some viruses.

Arboviruses in Australia

The arboviruses that can be transmitted by mosquitoes in Australia include Ross River virus, Barmah Forest virus, Murray Valley encephalitis virus, Kunjin virus and dengue. A number of other arboviruses may be isolated from mosquitoes or may occasionally cause disease in Australia.

Ross River virus and Barmah Forest virus cause the most arbovirus diseases in Australia, with around 5000 reported cases of human disease per year. Symptoms can vary greatly between individuals and include fever and rash. Infection with either of these viruses can cause a condition known as polyarthritis, resulting in arthritic pain in the ankles, fingers, knees and wrists. Barmah Forest virus infection tends to give a more highly coloured rash, but the arthritic pain is greater and longer lasting with Ross River virus infection.

Murray Valley encephalitis virus and Kunjin virus were once grouped together and known as Australian encephalitis, but the infections are now considered separate. The seriousness of symptoms following infection by each virus is quite different.

Only a small proportion of Murray Valley encephalitis virus infections cause symptoms, but the disease affects the brain and can be fatal. Symptoms almost always include a sudden onset of fever, anorexia and headache. Vomiting, nausea, diarrhoea and dizziness may also occur, along with lethargy and irritability. Drowsiness, confusion, convulsions and neck stiffness can be experienced a few days after the onset of initial symptoms. Many who survive the brain inflammation are left with a mental or functional disability.

Fortunately, there have only been a small number of human cases since the last large epidemic in 1974. For Kunjin virus, there are fewer human cases reported, the disease is milder and there are no known deaths resulting from the infection.

Both Murray Valley encephalitis virus and Kunjin virus have a natural endemic cycle in northern Australia, involving water birds as a host and freshwater mosquitoes, especially *Culex annulirostris*, as the major vectors. Epidemic activity of the viruses in the southeast of Australia is rare and has been associated with excessive spring and summer rainfall and flooding, which increases bird and mosquito populations. It is uncertain whether the viruses are sometimes introduced to the southeast of Australia from the north, or whether either or both viruses are endemic in inland areas at undetectable levels and only become evident with periods of intense bird breeding and mosquito production.

Dengue is the term used to describe disease caused by four related viruses. It is considered one of the most important mosquito-borne diseases around the world, with an estimated 100 million people infected each year. In Australia, locally acquired cases of dengue occur only in Queensland, especially around Townsville and Cairns, where the vector mosquito (*Ae. aegypti*) is abundant in urban environments. Epidemics of dengue occurred in the late 19th century and early 20th century, with a large outbreak in Townsville in 1955. In 1981, there was a major outbreak in Far North Queensland, with an estimated 3000 infections. Almost every year since the early 1990s, there have been some cases of dengue in travellers visiting or returning to communities in the region.

The clinical symptoms of dengue range from mild fever to a severe and potentially life threatening haemorrhagic disease. The so-called classical dengue fever usually affects older children and adults, with fever, violent headache and severe pains in the muscles and joints after an incubation period of 5–8 days. The symptoms last about 4–7 days and recovery is usually long and gradual.

Other viruses in Australia

Sindbis virus occurs in all mainland states of Australia but human disease is virtually unknown. Edge Hill virus, Kokobera virus and Stratford virus can cause symptoms including muscle and joint pain, and muscle fatigue, although there have been few documented cases in Australia. Gan Gan virus and Trubanaman virus cause a mild illness with symptoms of fever, malaise, muscle pain, joint pain and inflammation, and rash. The viruses have been found in a number of mosquito species, but documented human disease is rare.

Malaria

Malaria is caused by infection with a protozoan blood parasite (one of five species of the genus *Plasmodium*) that is transmitted by *Anopheles* mosquitoes. The clinical symptoms of malaria include periodic fever, varying degrees of anaemia and enlargement of the spleen. Symptoms also include a range of syndromes resulting from the physiological and pathological involvement of certain organs, including the brain, liver and the kidneys.

Malaria was once endemic in Australia, but was eradicated in 1981. Cases reported in Australia now are usually acquired overseas or, rarely, by local transmission from imported cases. A number of local *Anopheles* species can transmit the disease. *Anopheles farauti* is a major vector of malaria in Papua New Guinea and it is the species of greatest concern in northern Australia, but this species does not occur in southern Australia. In southern Australia and the southern sections of the northern states or territories where *An. farauti* does not live, *An. annulipes* may cause occasional cases of malaria.

First aid

There is no specific treatment for mosquito bites. The allergic reaction to the saliva injected by the mosquito during blood feeding is highly variable but a cold or ice compress and soothing lotions or creams can reduce mild reactions. For severe reactions, antihistamines may be required, but this is rare for mosquito bites. Take care to avoid secondary infection following scratching of the bites.

Personal protection

There are a range of strategies to protect against biting mosquitoes. These typically involve changing human behaviour (e.g. wearing protective clothing or avoiding mosquito habitats) or using mosquito repellents. Many of the strategies used against mosquitoes can also be effectively used against other biting arthropods and have been dealt with in other chapters.

+ *Avoiding mosquito habitats* — mosquitoes will typically be most active around dawn and dusk. However, when populations of some pest species are high, biting can occur during the day in shaded areas, while some species, such as *Aedes aegypti*, are day-biting species.

+ *Clothing and bed nets* — physical barriers between people and mosquitoes can provide important protection. Bed nets are constructed from material with a mesh size small enough to exclude mosquitoes, but can provide additional protection when treated with a long-lasting insecticide such as a synthetic pyrethroid. Bed nets can be especially useful in protecting sleeping babies and young children. Wearing long-sleeved shirts and long pants when outdoors in areas where mosquitoes are active can protect against bites, and clothing can also be treated with synthetic pyrethroids. Where young children or babies are concerned, it is important for strollers to be fitted with screens or netting if outdoors when mosquitoes are active.

+ *Mosquito repellents* — personal insect repellents are available in a wide range of formulations, including aerosols, creams, lotions, and gels. The most effective active ingredients are DEET and picaridin. Active botanical ingredients, including eucalyptus, tea-tree and citronella, generally offer substantially lower protection times compared to DEET or picaridin. A range of products including coils, sticks and other 'burner' devices claim to repel mosquitoes. These products are generally impregnated with an insecticide (usually a synthetic pyrethroid) that is released when heated, either by burning (coils and sticks) or with a small electrical unit (vaporising mat). These products are designed for indoor or sheltered outdoor areas, and should be used as directed. Some products claim that sonic waves can effectively repel mosquitoes, but none of these have been scientifically proven to have any appreciable protective effect.

+ *Building design* — preventing mosquitoes entering buildings is essential, and mesh screens should be fitted to all windows and doors, where possible. A wide range of temporary and permanent screening options for windows, doors and outdoor areas are available. Ensure that there are no entry points via air conditioning ducts, ventilation structures or other connections between indoor and outdoor areas.

Managing the pest and its impacts

It is beyond the scope of this document to provide a detailed list of options for mosquito management. There are a number of local and international publications available that outline strategies for managing local mosquito populations. The most common mosquito management strategies are described below.

+ *Source reduction of backyard mosquitoes* — mosquitoes associated with backyard habitats, such as water-holding containers, can be reduced by emptying, covering or removing all containers (e.g. cans, old tyres, buckets), filling pot plant saucers with sand to absorb standing water, ensuring tarpaulins covering boats or trailers do not collect water, and routinely flushing bird baths. Large water-holding or storage structures around the house should be regularly maintained, including roof guttering, and leaves and other debris should be removed. All openings to rainwater and septic tanks should be properly screened with wire gauze to stop mosquitoes entering or exiting the structure.

+ *Mosquito traps* — commercial traps can use a combination of light, heat, carbon dioxide or a chemical attractant to catch or kill adult mosquitoes. These traps do collect mosquitoes but it is not clear if they can reduce nuisance-biting effects or public health risks in areas close to productive mosquito habitats.

+ *Control of immature mosquito populations* — the bacterium *Bacillus thuringiensis israelensis* (*Bti*) produces toxins that, when eaten, can destroy the gut wall of mosquito larvae and kill them. Along with *Bti*, the insect growth regulator, s-methoprene, is one of the most commonly used mosquito control agents in Australia. Both can be used in and around houses and urban areas, or in large-scale field applications. Neither product has significant nontarget effects, but their effectiveness depends on the target mosquito species and its habitat.

+ *Biological control of mosquito populations* — a number of organisms have been investigated for their suitability as mosquito larvae predators. These include invertebrates (e.g. fly and beetle larvae, crustaceans, aquatic bugs, dragon flies, damsel flies) and vertebrates (fish). In urban environments, fish are often used to control mosquito production in ornamental ponds and constructed wetlands, while dragon flies and copepod crustaceans have been used to control container-breeding mosquitoes.

+ *Control of adult mosquito populations* — a number of insecticides can be useful against adult mosquitoes in times of especially large populations or epidemic virus activity, but these products are not appropriate for the long-term management of mosquitoes across a large area. Long-lasting insecticides can be applied to buildings or vegetation as a barrier between residential or recreational areas and mosquito habitats. Although there are some environmental concerns about this approach, studies have shown that mosquito populations can be effectively reduced.

Further reading

Foster WA and Walker ED 2002. Mosquitoes (Culicidae). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Jacups SP, Whelan PI and Currie BJ 2008. Ross River virus and Barmah Forest virus infections: a review of history, ecology, and predictive models with implications for tropical northern Australia. *Vector-borne and Zoonotic Diseases* 8(2):1–15.

Jansen CC and Beebe NW 2010. The dengue vector *Aedes aegypti*: what comes next. *Microbes and Infection* 12(4):272–279.

Mosquito Control Association of Australia 2008. *Australian Mosquito Control Manual.* Mosquito Control Association of Australia, Gold Coast.

Russell RC 1990. *Mosquitoes and Mosquito Borne Disease in Southeastern Australia,* Department of Medical Entomology, Westmead Hospital and the University of Sydney, Sydney.

Russell RC 1998. Vectors vs. humans in Australia — who is on top down under? *Journal of Vector Ecology*23 (1):1–46.

Russell RC 2009. Mosquito-borne disease and climate change in Australia: time for a reality check. *Australian Journal of Entomology* 48(1):1–7.

Russell RC and Kay BH 2004. Medical entomology: changes in the spectrum of mosquito-borne disease in Australia and other vector threats and risks, 1972–2004. *Australian Journal of Entomology* 43(3):271–282.

Russell TL and Kay BH 2008. Biologically based insecticides for the control of immature Australian mosquitoes: a review. *Australian Journal of Entomology* 47(3):232–242.

Russell RC, Currie BJ, Lindsay MD, Mackenzie JS, Ritchie SA and Whelan PI 2009. Dengue and climate change in Australia: prediction for the future should incorporate knowledge from the past. *Medical Journal of Australia* 190(5):265–268.

Silver JB 2008. *Mosquito Ecology: Field Sampling Methods,* 3rd edition, Springer, New York.

Strickman D, Frances SP and Debboun M 2009. *Prevention of Bug Bites, Stings and Disease*, Oxford University Press, New York.

Webb CE and Russell RC (2009) *Living with Mosquitoes in the Lower Hunter and Mid-North Coast Region of NSW.* NSW Premier's Department, Newcastle.

The Asian Tiger Mosquito, *Aedes albopictus*

Exotic mosquitoes and mosquito-borne diseases

Description

Many mosquitoes found in Australia present substantial risks as nuisance-biting pests and pathogen vectors. A small number of exotic species may create an increased risk if they are introduced and become widely established in Australia. In addition, if *Ae. aegypti* spreads to south-east Queensland, or the Northern Territory and Western Australia, dengue could become much more prevalent and widespread.

Biology and ecology

Aedes albopictus is commonly known as the Asian tiger mosquito and is native to south-east Asia. Over recent decades, the species spread widely and established in the south-west Pacific, North America, South America, Africa, Europe and the Middle East. In 2005, an infestation of this species was detected in the Torres Strait and, despite intensive efforts to eradicate them, the species was reported for the first time on mainland Australia in 2009. This mosquito is strongly associated with natural and artificial water-holding containers, so it can be accidentally carried between countries with human activity. There have been many instances of this species being imported and subsequently eliminated in northern Australia. The mosquito is an aggressive day-biting species that will attack in the sun and in shade during the day, as well as the evening and early

night. It can transmit a variety of arboviruses including dengue, Ross River virus, Japanese encephalitis virus and chikungunya virus. Computer models have predicted that, since this mosquito can tolerate cooler climates, its potential distribution along the coast of Australia could reach Victoria, South Australia and southeast Western Australia.

Culex gelidus is a vector of Japanese encephalitis virus in parts of south-east Asia. It was first recognised in Australia during the 1990s and is distributed across northern Australia, from subtropical Queensland to northern Western Australia. It has also been found in southeast Queensland and computer models predict that the potential distribution of this species may spread into southern New South Wales and Western Australia, if suitable larval habitats are available. Larvae are usually found in freshwater habitats with a high organic content.

Public health importance

Arboviruses in other countries that may pose a risk in Australia are summarised below.

Japanese encephalitis virus is present in south-east Asia and the island of New Guinea. It is maintained in natural cycles between waterbirds (as well as pigs) and *Culex* mosquitoes. Worldwide, over 40 000 cases, including 10 000 deaths, occur per year. Japanese encephalitis virus infection can range from mild infections with symptoms of fever and headache, to more severe infection marked by a quick-onset headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, occasional convulsions (especially in infants) and paralysis. More severe infections can lead to fatal encephalitis. In Australia, it was first detected on Torres Strait islands in 1995 and has been found in sentinel pigs later. The major south-east Asian vector (*Culex tritaeniorhynchus*) is not found in the region, but a local species (*Culex annulirostris*) can potentially transmit the virus. This virus could be introduced to mainland Australia through human activity or windborne mosquitoes, and may spread through local mosquito vectors, and wild bird and pig populations. Surveillance will remain important to ensure this virus does not establish in Australia.

West Nile virus is widely distributed in Africa, the Middle East, Europe, India, Indonesia and Australia. It was introduced to North America in 1999, causing disease in many thousands of people and a high number of deaths over the following decade. Generally, this virus causes symptoms in 20% of infected people, including fever, headache, body aches, nausea, vomiting, swollen lymph glands, or a rash on the chest, stomach and back that may last for several weeks. In a small number of cases (mostly in patients older than 50 years) symptoms can be severe and potentially fatal, with high fever, headache, neck stiffness, convulsions, vision loss, coma or paralysis, and possibly some permanent neurological effects.

In North America, the main vectors of West Nile virus are *Culex* mosquitoes. Several Australian *Culex* species could spread the virus in Australia if the North American strain is introduced. Kunjin virus, which is endemic to Australia, is actually a less severe subtype of West Nile virus, so people who have previously had Kunjin virus may have some degree of protection against West Nile virus.

Chikungunya virus causes dengue-like symptoms, including fever, rash and severe joint pain. In the last five years, major outbreaks of chikungunya virus have occurred in several islands of the Indian Ocean, India, south-east Asia and some areas of Europe. It is thought that the virus has mutated and improved its ability to infect mosquito vectors, mainly *Ae. aegypti* and *Ae. albopictus*. In Australia, the distribution of these known vector species is limited, but other species (including *Ae. vigilax*, *Ae. procax* and *Cq. linealis*) also have potential to transmit the virus. Several cases of chikungunya virus have been reported in Australia, but all of these were in people who had travelled to endemic areas of virus activity in other countries.

Yellow fever virus occurs in equatorial Africa and Latin America. The virus can circulate among monkeys and forest mosquitoes, but it also has an epidemic form where mosquitoes associated with urban habitats and humans (such as *Ae. aegypti*) are an important vector. Initial symptoms include fever and chills, severe headache, back pain, general muscle aches, nausea, fatigue and weakness. Visible bleeding, jaundice, kidney and liver failure can also occur.

A large number of arboviruses exist in other parts of the world and over 100 arboviruses cause disease in humans. These diseases may occasionally occur in travellers but this is not considered to be a risk for virus introduction to Australia. Some of these viruses include eastern and western equine encephalitis viruses, O'nyong-nyong, Rift Valley fever virus, LaCrosse virus and St. Louis encephalitis virus.

First aid

See 'First aid' under 'Australian mosquitoes'.

Personal protection

See 'Personal protection' under 'Australian mosquitoes'.

Managing the pest and its impacts

See 'Managing the pest and its impacts' under 'Australian mosquitoes'.

Further reading

Benedict MQ, Levine RS, Hawley WA and Lounibos LP 2007. Spread of the tiger: global risk of invasion by the mosquito *Aedes albopictus*. *Vector-borne and Zoonotic Diseases* 7(1):76–85.

Kearney M, Porter WP, Williams C, Ritchie S and Hoffmann AA 2009. Integrating biophysical models and evolutionary theory to predict climatic impacts on species' ranges: the dengue mosquito *Aedes aegypti* in Australia. *Functional Ecology* doi: 10.1111/j.1365-2435.2008.01538.x

Jansen CC, Webb CE, Northill JA, Ritchie SA, Russell RC and van den Hurk AF 2008. Vector competence of Australian mosquito species for a North American strain of West Nile virus. *Vector-borne and Zoonotic Diseases* 8(6):805–811.

Johnson DF, Druce JD, Chapman S, Swaminathon A, Wolf J, Richards JS, Koman T, Birch C and Richards MJ 2008. Chikungunya virus infection in travellers to Australia. *Medical Journal of Australia* 188(1):41–43.

Johnson PH, Hall-Mendelin S, Whelan PI, Frances SP, Jansen CC, Mackenzie DO, Northhill JA and van den Hurk AF 2009. Vector competence of Australian *Culex gelidus* Theobald (Diptera: Culicidae) for endemic and exotic arboviruses. *Australian Journal of Entomology* 48(3):234–240.

Paupy C, Delatte H, Bagny L, Corbel V and Fontenille D 2009. *Aedes albopictus*: from the darkness to the light. *Microbes and Infection* 11(14–15):1177–1185.

Ritchie SA, Moore P, Carruthers M, Williams C, Montgomery B, Foley P, Ahboo S, Van Den Hurk AF, Lindsay MD, Cooper B, Beebe N and Russell RC 2006. Discovery of a widespread infestation of *Aedes albopictus* in the Torres Strait, Australia. *Journal of the American Mosquito Control Association* 22:358–365.

Russell RC 2009. Mosquito-borne disease and climate change in Australia: time for a reality check. *Australian Journal of Entomology* 48(1):1–7.

Russell RC, Currie BJ, Lindsay MD, Mackenzie JS, Ritchie SA and Whelan PI 2009. Dengue and climate change in Australia: predictions for the future should incorporate knowledge from the past. *Medical Journal of Australia* 190(5):265–268.

Russell RC, Williams CR, Sutherst RW and Ritchie SA 2005. *Aedes (Stegomyia) albopictus* – a dengue threat for southern Australia? *Communicable Diseases Intelligence* 29(3):296–298.

Tabachnick WJ 2010. Challenges in predicting climate and environmental effects on vector-borne disease episystems in a changing world. *Journal of Experimental Biology* 213(6):946–954

van den Hurk AF, Ritchie SA and Mackenzie JS 2009. Ecology and geographical expansion of Japanese encephalitis virus. *Annual Review of Entomology* 54:17–35.

Williams CR, Ritchie SA and Whelan PI 2005. Potential distribution of the Asian disease vector *Culex gelidus* Theobald (Diptera: Culicidae) in Australia and New Zealand: a prediction based on climate suitability. *Australian Journal of Entomology* 44(4):425–430.

Spiders

The funnel web spider, *Atrax robustus*

Funnel web spider

Description

There are around 30 species of funnel web spider, found mainly in eastern Australia. Of the six venomous species, the most important is the Sydney funnel web spider (*Atrax robustus*) but other species, especially those of the genus *Hadronyche,* have been responsible for many reported bites. Funnel web spiders live in the ground and are found in New South Wales around the Sydney Basin, Blue Mountains, Hunter region, central coast and south coast. It is one of the best known spiders in Australia because it is one of our most dangerous native animals. Funnel web spiders are entirely black. The females are relatively large, with a body up to 3.5 cm long, and the males are smaller — around 2.5 cm long.

Biology and ecology

The funnel web spider can be found in cracks and crevices among rocks, tree roots and other natural or human-made materials. It does not build its own tunnel, but creates a funnel-shaped web that lines the natural tunnel it lives in. The spider generally lives in isolation but, in favourable environmental conditions, spiders may be present in high densities. The spiders prefer habitats that are humid, damp and sheltered, and they can be attracted to houses with well-watered gardens. The majority of Australian spiders are secretive and shy, but the funnel web can be extremely aggressive when disturbed or threatened, rearing back and striking dramatically with its fangs. Male spiders are more mobile than females and are therefore more likely to be encountered, sometimes even entering houses. This is more likely to occur during the warmer months, especially late summer, but can also happen after a rainfall that floods the spiders' nests and sends them looking for alternative shelter. The use of outdoor insecticides can also drive them indoors. The female spiders can live for up to eight years and the males live less than a year.

Public health importance

The bite is painful and, in most cases, fang marks are present. Symptoms of funnel web venom poisoning include tingling sensations around the lips, sweating, nausea, vomiting, headache and high blood pressure and, in serious cases, fluid in the lungs and unconsciousness.

This spider bite usually does not cause serious illness or require antivenene to be given. However, in some rare, extreme cases the bite can be fatal. Antivenene is available and, if given quickly, can be life saving. Therefore, it is important to monitor the victim for up to four hours after the bite.

First aid

Seek urgent medical attention for funnel web spider bites. Apply a firm pressure bandage and immobilise the bitten limb. If it is safe, collect the spider in a jar or container so the species can be identified.

Personal protection

Although they are aggressive, funnel web spiders will not seek out humans to attack and, in most cases, contact between humans and spiders happens either by accident or by people deliberately seeking them out. Most contact with the spider will occur outdoors and bites are commonly reported on feet and hands. However, in areas where the spider is common, remember that spiders may come inside and shelter inside shoes and other household items.

Managing the pest and its impacts

Despite their status as one of Australia's most dangerous creatures, funnel webs only rarely cause problems. In these cases, it is mostly in residential areas close to bushland or where prime habitat is accidentally created on residential properties. Controlling spider populations can be very difficult and using insecticides against funnel webs is unlikely to provide effective control. Long-lasting insecticides may provide some control of spider populations, but their effectiveness is limited when used outdoors and may actually encourage the spider to move around, increasing the risk of contact with humans. In areas where funnel webs are common, the risk of populations establishing on private property or around houses can be minimised by reducing favourable habitat. Landscapes with many loosely placed rocks and logs make excellent habitat for funnel webs, and loose stones in paths and drains create space between rocks for the spiders to build their nests.

Further reading

Isbister GK and Gray MR 2002. A prospective study of 750 definite spider bites, with expert spider identification. *QJM* 95(11):723–731.

Isbister GK, Gray MR, Balit CR, Raven RJ, Stokes BJ, Porges K, Tankel AS, Turner E, White J and Fisher MM 2005. Funnel-web spider bite: a systemic review of recorded clinical cases. *Medical Journal of Australia* 182(8):407–411.

Isbister GK 2006. Spider bite: a current approach to management. *Australian Prescriber* 29(6):156–158.

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*. NSW Department of Health, Sydney.

NSW Health 2007. *Snakebite and Spiderbite Clinical Management Guidelines*, Statewide Services Development Branch, NSW Department of Health,

The redback spider, *Latrodectus hasselti*

Redback spider

Description

The redback spider (*Latrodectus hasselti*) is very common and is closely associated with human habitation. Mature female spiders are around 14 mm long, usually shiny black in colour with a distinctive red stripe running along the length of their pea-shaped abdomen. Males are substantially smaller than females.

Biology and ecology

The redback spider is very reclusive and is most often found in piles of wood and other building materials, empty drums and containers, under outdoor furniture and the rims of pot plants and bins, among overgrown vegetation, and within outdoor sheds and toilets. It prefers areas that are quiet, dark and remain undisturbed for many months at a time. The spider is not aggressive and will not actively attack humans. The bite from both male and female spiders can cause severe reactions in humans. The majority of bites are from the females.

Public health importance

Redbacks are widespread and cases of these spider bites are common, but no fatalities have been reported since antivenene was developed in the 1950s, even if the bite goes untreated. The bite can cause severe pain and medical attention may be required, although usually not urgently.

Redback spider bites occur most often in the warmer months, especially between January and April. The venom from redback spiders contains excitatory neurotoxins so, rather than causing paralysis, it stimulates the nervous system. The syndrome produced by this spider's venom is known as 'latrodectism'. After the initial bite, symptoms may be mild with nothing more than a small red mark at the bite site. In around 50–60% of cases, severe and persistent pain occurs that may last for several days. Pain radiates from the bite site to the rest of the bitten limb, trunk or local lymph nodes. In some cases, the localised pain can develop into more general symptoms, including sweating, nausea, weakness, chest pain and abdominal pain. Serious reactions occur in less than 20% of cases.

Contact with this spider most often occurs by accident. Historically, much of this contact was in outdoor toilets, with more than 50% of reported bites occurring to the buttocks or genitals. Since the decline of the outhouse, feet, hands or arms are now the most commonly bitten.

First aid

Antivenene is available and will dramatically improve symptoms in people suspected of suffering serious reactions. Studies show that antivenene treatment can prevent the persistent pain that may disrupt sleep. In cases of severe pain or systemic envenoming, antivenene is recommended, either injected into a muscle or as a slow intravenous infusion. Cold compresses and ice packs will help reduce pain. Pressure bandages should not be applied as they may make the pain worse.

Personal protection

The spider is most commonly encountered in the garden, but bites are also reported in the home, particularly when putting on shoes. When gardening (especially during backyard clean-ups where old pots, timber and other materials are being moved after long periods of being undisturbed), wear shoes, gloves and a long-sleeved shirt. Indoors, carefully check shoes, clothing or other items that have not been worn for long periods.

Managing the pest and its impacts

Reducing the available habitat for spiders will reduce the spider population. Minimise built-up rubbish and other material (especially piles of wood and timber) to reduce the available breeding sites. If it is not possible to remove this material, long-lasting insecticides can reduce local spider populations. Redback spiders rarely come indoors, but barrier treatments of insecticides around doorways and windows will provide additional control.

Further reading

Isbister GK and Gray MR 2003. Latrodectism: a prospective cohort study of bites by formally identified redback spiders. *Medical Journal of Australia* 179(2):88–91.

Isbister GK 2006. Spider bite: a current approach to management. *Australian Prescriber* 29(6):156–158.

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*, NSW Department of Health, Sydney.

NSW Health 2007. *Snakebite and Spiderbite Clinical Management Guidelines*. Statewide Services Development Branch, NSW Department of Health, North Sydney.

Simon-Brunet B 1994. *The Silken Web: A Natural History of Australian Spiders*, Reed Books, Chatswood.

The white-tailed spider, *Lampona spp.*

White-tailed spider

Description

'White-tailed spider' refers to a group of species in the genus *Lampona*. The two species most commonly reported for biting humans are *Lampona cylindrata* and *Lampona murina*. These spiders are relatively large — the females are up to 2 cm long, are dark reddish brown to black, and have a distinctive white patch at the end of their abdomen. Younger spiders lack the distinctive patch, but have a series of lighter coloured patches on the abdomen that become more pronounced with each moult until the adult stage. These spiders are found across Australia with a preference for temperate regions.

Biology and ecology

These spiders are common in urban dwellings, especially in summer, when the spiders enter buildings to shelter from hot conditions outdoors. They are also attracted to exterior lights where suitable prey gather. In nature, they are found in bushland habitats, usually hiding beneath flaking bark. The spiders are known as open-range hunters and normally prey on other spiders, but they will also eat other insects (in the home, this may include cockroaches and silverfish). They do not make traditional webs, but will often build a silken tube to hide in. The female can lay up to 90 eggs in a single egg sac and will often remain with the eggs until they hatch.

Public health importance

Most white-tailed spider bites occur indoors, usually at night, during periods of warm weather. The spider does not seek out humans to bite and most encounters happen accidentally when the spider is trapped in shoes or bedding. The bite of a white-tailed spider can be painful, but the pain generally subsides within two hours. Redness, itchiness and a small red mark at the bite site are common and may persist for up to a week after the bite. Systemic effects such as nausea, vomiting and headache occur in a very small percentage of cases.

There is a perception in the community and among many health professionals that the bite of these spiders can cause necrotic or 'flesh-eating' ulcers. There is a medical condition known as necrotising arachnidism, but this is a poorly defined clinical disorder associated with the bite from a *Loxosceles* species spider (recluse spiders), which are not native to Australia. However, since the 1980s, white-tailed spiders have been blamed for necrotic ulcers without supporting evidence that links the spider to the condition. While cases of necrotic ulcers have been reported in the scientific literature as being associated with white-tailed spider bite, there

was no definitive identification of white-tailed spiders being responsible for the bites and only circumstantial evidence (e.g. a search of the home or property many days after the initial bite) was used to link to the ulcer to the spider. Laboratory studies have shown that the active toxic components in *Loxosceles* species bites are not found in white-tailed spider venom. Many healthcare professionals in Australia continue diagnosing necrotic ulcers as white-tailed spider bites, perpetuating this association. There is significant media coverage and public interest in the topic, which is further complicated by case reports of true necrotic arachnidism from overseas circulating through local media and online communities. An Australian study of 130 definitive white-tailed spider bites did not find any cases of necrotic ulcers.

First aid

Pain management and preventing secondary infection are the primary objectives of first aid for white-tailed spider bites. A cold compress will help relieve pain, but if the pain is severe or irritation persists for more than 24 hours, seek medical attention. Secondary infections can be treated with antibiotics.

Personal protection

Most bites inside the home occur during periods of warm weather when the spiders are seeking refuge in cooler places. On hot nights, take care to avoid bites indoors by checking bedding, or piles of clothing or towels for any spiders. When gardening, always wear shoes and gloves.

Managing the pest and its impacts

There is no need for specific white-tailed spider control around the home. Given the relatively low health risks posed by the spiders, treatment with insecticides is unlikely to provide an effective control or reduce risk to exposure. However, using long-lasting insecticides around the openings to houses (e.g. doorways, windows) in the warmer months may reduce the number of spiders entering the building.

Further reading

Brunet B 1997. *Spiderwatch: A Guide to Australian Spiders*. Reed Books, Australia.

Isbister GK 2004. Necrotic arachnidism: the mythology of a modern plague. *Lancet* 364(9433):549–553.

Isbister GK 2006. Spider bite: a current approach to management. *Australian Prescriber* 29(6):156–158.

Isbister GK and Gray MR 2002. A prospective study of 750 definite spider bites, with expert spider identification. *QJM* 95(11):723–731.

Isbister GK and Gray MR 2003. White-tail spider bite: a prospective study of 130 definite bites by *Lampona* species. *Medical Journal of Australia* 179(4):199–202.

NSW Health 2007. *Snakebite and Spiderbite Clinical Management Guidelines*, Statewide Services Development Branch, NSW Department of Health, North Sydney.

Other spiders

Description

There are around 2000 species of spider in Australia and the vast majority pose no serious public health risk. With the exceptions of those species already discussed (particularly the redback spider and funnel web spider), the bite from most other spiders is unlikely to need medical treatment, with the possible exception of mouse spiders (*Missulena* species). The majority of spiders are either too small to effectively bite humans or bites to humans are scarcely reported, even if the spiders are common. Some of the most commonly encountered spiders inside and around the home include huntsman spiders (family Heteropididae) and orb-weaving spiders (family Araneidae). Black house spiders (*Ixeuticus robustus*) and daddy long-legs (*Pholcus phalangoides*) can be found in almost every Australian household from time to time.

Biology and ecology

The spiders most often encountered are those associated with urban environments that spin their webs around buildings or across walkways, or take refuge under rocks, debris and other habitats in the garden. Many spiders commonly found outdoors, especially ground-dwelling species, may sometimes come indoors if climatic or environmental factors are unfavourable (e.g. extremely hot and dry weather, or during heavy rainfall). Mouse spiders live in burrows and can be seen during gardening and garden excavations.

Public health importance

Any bite from a spider may be painful, especially if the spider is large like a huntsman spider, orb-weaving spider, mouse spider or black house spider. In very rare circumstances, reaction to the bite may be more serious than just localised pain and mild irritation.

First aid

In most cases, pain should quickly subside following a bite, but a cold compress will help relieve pain. Generally, if pain and redness at the bite site continues for more than 24 hours, seek medical attention to address any localised secondary infection that may need antibiotic treatment.

Personal protection

Spider bites most commonly occur by accident, especially while working in the garden, so always wear gloves and shoes. Some spider bites occur while getting dressed, so ensure no spiders are present in shoes, especially those that have not been worn for many weeks. Bites can also occur when people try to catch or kill spiders found in the home. Only a few species are naturally aggressive, but many will bite if provoked.

Managing the pest and its impacts

Using long-lasting insecticides around the home is generally ineffective at eliminating spiders, because of their widespread distribution throughout gardens, and in cracks and crevices in the building. Inside the home, knockdown or long-lasting insecticides may kill any spiders encountered. However, remember that most of these spiders are harmless and also do a good job of keeping numbers of other arthropod pests in check.

Further reading

Brunet B 1997. *Spiderwatch: A Guide to Australian Spiders*, Reed Books, Australia.

Isbister GK 2006. Spider bite: a current approach to management. *Australian Prescriber* 29(6):156–158.

Isbister GK and Gray MR 2002. A prospective study of 750 definite spider bites, with expert spider identification. *QJM* 95(11):723–731.

NSW Health 2007. *Snakebite and Spiderbite Clinical Management Guidelines*, Statewide Services Development Branch, NSW Department of Health, North Sydney.

Stinging Arthropods

The bull ant, *Myrmecia pyriformis*

Ants

Description

Ants are one of the most commonly encountered arthropods in Australia. Fortunately, they are more likely to pose a nuisance problem than a more serious stinging threat. There are over 2500 ant species in Australia and they can be found in a wide range of habitats.

Biology and ecology

The biology and ecology of each ant species varies depending on their ecological niche. However, generally, ants are scavenging social insects that live in colonies that may contain many thousands of ants. Each colony has at least one queen that controls the colony.

Public health importance

Given the widespread abundance of ants, relatively few serious health effects from stings or bites have been reported. However, some local ant species are venomous and there has been a small number of ant sting-related deaths in recent times. Venomous ants can either deliver a true sting or spray venom on the skin. Ants belonging to the genus *Iridomymrex* can bite and then spray secretions onto the bite site, causing irritation, but these incidents rarely cause more than mild reactions. More severe reactions can be caused by stings from ants belonging to the genus *Myrmecia*, particularly two species, *Myrmecia pyriformis* (bull ant) and *Myrmecia pilosula* (jack jumper), which are common throughout south-east Australia. In most cases, ant sting-related deaths occur in middle-aged men who have heart or lung disease, and a venom allergy. Deaths have only been recorded in Tasmania, caused by *M. pilosula*, which poses the greatest risk.

Studies show that the number of people who have allergic reactions to ant stings is comparable to the number who react to bee stings in south-eastern Australia. Because of the aggressive nature of these ants and the risk of anaphylactic reactions, susceptible people should take care to avoid being bitten.

The introduction of the exotic ant species *Solenopsis invicta* (red fire ant) to south-east Queensland presents a new risk for ant sting reactions. Besides the repeated stings and associated painful reactions, the sting of this species can cause anaphylaxis. The National Fire Ant Eradication Program has made significant progress in eradicating fire ants from Australia. Surveillance is ongoing, and treatment and containment measures are continuing in areas where the ants have been detected.

In some cases, ants have been associated with the transmission of pathogens in hospitals, but this is considered an extremely low risk.

First aid

A cold compress can reduce the pain associated with the ant sting, but seek urgent medical attention for people with a known or suspected allergy, if a rash develops, or if the stung person has breathing difficulties or collapses. People with known hypersensitivity may need to carry an EpiPen (an adrenaline injection) when in ant-prone areas in case of anaphylaxis; consult a general practitioner or specialist immunologist to manage this condition.

Personal protection

Take care in outdoor areas where stinging ants are present. People with previous exposure to stinging ants or who are known to have an ant venom allergy should take special care. New research into 'allergy shots' (immunotherapy) for individuals allergic to ants, particularly *M. pilosula*, is showing promising results.

Managing the pest and its impacts

These ants are most commonly encountered in rural or semirural settings. In fact, in areas where *M. pilosula* is endemic, avoiding the ants is difficult, as they can be very widespread. A survey in Tasmania reported that over 10% of participants were stung in the previous year, with an average of almost two stings per year. Widespread insecticide use or destroying known ant nests in the local area is unlikely to be effective.

Further reading

Brown SGA, Franks RW, Baldo BA and Heddle RJ 2003. Prevalence, severity, and natural history of jack jumper ant venom allergy in Tasmania. *Journal of Allergy and Clinical Immunology* 111(1):187–192.

Brown SGA, Wiese MD, Blackman KE and Heddle RJ 2003. Ant venom immunotherapy: a double-blind, placebo-controlled, crossover trial. *Lancet* 361(9362):1001–1006.

Douglas RG, Weiner JM, Abramson MJ and O'Hehir RE 1998. Prevalence of severe ant-venom allergy in southeastern Australia. *Journal of Allergy and Clinical Immunology* 101(1):129–131.

Henderson A, Henderson D and Sinclair J 2008. *Bugs Alive! A Guide to Keeping Australian Invertebrates*, Museum Victoria, Melbourne.

McCubbin KI and Weiner JM 2002. Fire ants in Australia: a new medical and ecological hazard. *Medical Journal of Australia* 176(11):518–519.

McGain F and Winkel KD 2002. Ant sting mortality in Australia. *Toxicon* 40(8):1095–1100.

NSW Health 2007. *Snakebite and Spiderbite Clinical Management Guidelines*, Statewide Services Development Branch, NSW Department of Health, North Sydney.

Shattuck SO 2000. *Australian Ants: Their Biology and Identification*, Monographs on Invertebrate Taxonomy Vol 3, CSIRO Publishing, Collingwood.

The European honey bee

Bees

Description

Bees are widely distributed in Australia and can be equally common in urban and rural areas. The most commonly encountered bee is the European honey bee (*Apis mellifera*), which was introduced into Australia in the 1820s. There are many Australian native bees, but the majority of these species do not sting.

Biology and ecology

Bees typically live in hives constructed in naturally occurring cavities, such as tree hollows, although people can keep honey bees in specially built hives. They can also make nests in cavities of residential or commercial buildings. Honey bee colonies include one queen bee, and a mix of drone and worker bees. New colonies are established by a swarm of bees including a mated queen and a large number of worker bees. Each colony can have up to 50 000 bees. Bees are rarely aggressive, but will sting people if disturbed, either intentionally or accidentally. Bees have a unique barbed sting that is often left embedded in human skin once the insect moves away. Although this phenomenon (known as 'sting autotomy') kills the bee, their poison gland remains attached to the sting and continues to inject venom.

Public health importance

Although the occasional sting and one fatality have been reported from native bees, the majority of stings are from *A. mellifera*. The symptoms and severity of reaction to bee stings varies between different people, depending on their sensitivity. In almost all cases, there is localised pain and swelling that is caused by the bee venom itself, and is not an allergic reaction. In people who are allergic, there can be more extensive local reactions and systemic anaphylaxis. These reactions can be severe and include skin reactions, nausea, vomiting, low blood pressure and fluid in the lungs. Deaths from bee stings are rare (around 3–4 cases per year) and usually occur in children under five or adults over 40, especially older men with heart or lung conditions. The much larger bumble bee (*Bombus* species), which was introduced into Tasmania, can also sting, and occasionally causes severe allergic reactions.

First aid

The embedded sting must be quickly removed, with care taken not to inject additional venom into the skin. The most effective way to remove the sting and attached venom sac is to wipe across the surface of the skin with the edge of a thin, flat object (e.g. credit card or thumb nail). The initial reaction to the sting is localised and only lasts a short time. A cold compress can help reduce pain. However, if pain begins to spread and intensify in the first 15 minutes, a more severe reaction should be suspected. As a caution against a possible anaphylactic reaction, people with known hypersensitivity may need to carry an EpiPen; consult a general practitioner or specialist immunologist to manage this condition.

The Australian native blue banded bee

Personal protection

Bees do not actively seek out humans to sting and are normally passive. The majority of stings occur outside during the warmer months of the year. Take care when bees are active, especially to avoid accidentally treading or sitting on bees. Bee stings to the mouth can be serious, and many of these stings occur where bees crawl into cans of soft drink that have been left unattended outdoors on hot days. Using a drinking straw can substantially reduce the risks in these situations.

Managing the pest and its impacts

If a bee hive is established around or within residential buildings, it is possible to have the colony removed by a beekeeper (apiarist), but the bees may need to be killed with insecticides. Bee control should be carried out by a pest manager experienced with this insect. Before any control activities start, it is important to identify the bee species — some species of native stingless bee (e.g. *Trigona* species) can set up hives in urban areas, but they pose no risk. Some local councils in Australia actually promote native bee hives in backyards to increase environmental awareness in the local community.

Further reading

Akre RD and Reed HC 2002. Ants, wasps and bees (Hymenoptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Liew WK, Williamson E and Tang MLK 2009. Anaphylaxis fatalities and admissions in Australia. *Journal of Allergy and Clinical Immunology* 123(2):434–442.

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*, NSW Department of Health, Sydney.

Riches KJ, Gillis D and James RA 2002. An autopsy approach to bee sting-related deaths. *Pathology* 34(3):257–262.

An example of one of Australia's centipede species

Centipedes

Description

There are an estimated 150 species of centipede in Australia and they can be found in a wide range of habitats, from arid environments to suburban backyards. They are distinctly shaped with elongated bodies and a large number of legs (ranging from 50 to more than 300). Centipedes have one pair of legs per body segment, a characteristic that distinguishes them from millipedes, which have two pairs. Centipedes have what appears to be a dangerous-looking dual spine-like structure at the end of their body, but this is actually harmless and the venom fangs are located out of sight under the head.

Biology and ecology

Centipedes can be readily found in gardens and around houses. They are active at night as they hunt for prey, typically smaller invertebrates. During the day, they hide under rocks and other debris.

Public health importance

Centipede bites are not considered a serious public health concern in Australia. Very few bites have been reported and, although centipedes are actually venomous, the bites mostly cause localised pain and minor swelling that subsides within a few hours. It is typically the large centipedes (especially those belonging to the family Scolopendridae) that can bite into human skin.

First aid

Limited information is available on the best treatment for centipede bites. Applying a cold compress, in combination with an analgesic or mild painkiller, will reduce localised pain.

Personal protection

Take care when gardening, especially when moving stones and other debris where centipedes may be hiding. If a centipede appears, do not handle it. They are very fast runners and can quickly run up sticks that may be used in an attempt to move them.

Managing the pest and its impacts

There is rarely, if ever, a need to control centipede populations. Long-lasting insecticides may be useful, but difficulty in identifying the location of centipedes will dramatically decrease their effectiveness.

Further reading

Balit CR, Harvey MS, Waldock JM and Isbister GK 2004. Prospective study of centipede bites in Australia. *Journal of Toxicology* 42:41–48.

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*, NSW Department of Health, Sydney.

NSW Health 2007. *Snakebite and Spiderbite Clinical Management Guidelines*, Statewide Services Development Branch, NSW Department of Health, North Sydney.

The marbled scorpion

Scorpions

Description

Scorpions are found all over Australia. They are very distinctive, with four pairs of legs, a pair of impressive claw-like pincers and a barbed tail. There are over 40 species of endemic scorpions and the most medically important species belong to the family Buthidae (especially *Lychas* species). These scorpions are generally small to medium sized, less than 60 mm long, and are so well camouflaged they are rarely seen.

Biology and ecology

Scorpions are nocturnal and very secretive, hiding in burrows, beneath rocks or under bark. They can live in a wide range of habitats, from arid environments to eucalypt bushland and tropical rainforests. Each species has developed specialised adaptations to these different environments.

Public health importance

Scorpions are important arthropods of medical importance around the world, especially in parts of Africa, the Middle East and South America, where scorpion stings can be potentially fatal. In Australia, no scorpion species are dangerous and stings are extremely uncommon. However, if they do occur, stings can cause localised mild to severe pain and localised

inflammation. Pain can persist for up to two hours. Most scorpion stings occur indoors at night when they are accidentally stepped on. *Urodacus* species and *Liocheles* species can be seen outdoors during the day and their stings cause short-term pain and swelling. Australian scorpions are relatively placid and will not actively sting humans.

First aid

No antivenene exists for scorpion stings in Australia, mainly because the health risks associated with the stings of native species are low. Apply a cold compress to help reduce pain, but in more severe or persistent cases, pain relieving medication may be required.

Personal protection

Take care when lifting stones and other debris in the garden, or when bushwalking, so that scorpions are not disturbed. If scorpions are encountered, minimise the risk of being stung by avoiding the temptation to handle the scorpion.

Managing the pest and its impacts

There is no specific management strategy to control scorpion populations. Scorpions are unlikely to be encountered in most backyards, except for residential properties that back onto bushland areas. Even when scorpions are present, they will rarely be seen because of their secretive, nocturnal nature.

Further reading

Chippaux JP and Goyffon M 2008. Epidemiology of scorpionism: a global appraisal. *Acta Tropica* 107(2):71–79.

Henderson A, Henderson D and Sinclair J 2008. *Bugs Alive! A Guide to Keeping Australian Invertebrates*, Museum Victoria, Melbourne.

Isbister GK, Volschenk ES, Balit CR and Harvey MS 2003. Australian scorpion stings: a prospective study of definite stings. *Toxicon* 41(7):877–883.

Isbister GK, Volschenk ES and Seymour JE 2004. Scorpion stings in Australia: five definite stings and a review. *Internal Medicine Journal* 34(7):427–430.

NSW Health. 2007. *Snakebite and Spiderbite Clinical Management Guidelines.* Statewide Services Development Branch, NSW Department of Health, North Sydney.

White J, Edmonds C and Zborowski P 1998. *Australia's Most Dangerous Spiders, Snakes and Marine Creatures: Identification and First Aid*, Australian Geographic, Terrey Hills.

There are several species of native and exotic wasps in Australia

Wasps

Description

Wasps are a group of insects closely related to bees, but include a diverse group of species. While they are generally similar in appearance, wasps are less hairy than bees and those that tend to sting are often slightly larger than bees. Wasps can be either solitary or social. The most commonly encountered species in Australia are the papernest wasps (*Polistes* and *Ropalidia* species). Exotic wasp species include the European wasp (*Vespula germanica*) and the English wasp (*Vespula vulgaris*); these two species have a limited distribution in Australia.

Other commonly encountered wasps include the mud wasps, which belong to the families Vespidae and Sphecidae. Their nests are common in urban areas, and appear as small mud or clay accumulations under eaves or on outside walls. These wasps are native Australian insects, rarely aggressive, and few stings are ever reported. The large metallic purple flower wasp (Family Scoliidae) is occasionally seen in the garden and these can inflict a painful sting, although they are mostly nonaggressive. The newly introduced Asian paper wasp species (*Polistes chinensis*) has been responsible for several attacks on people.

Biology and ecology

Some wasp species use the same nesting site year after year, although the nests themselves are usually rebuilt or extended. The native papernest wasps often build nests that hang from roof eaves, gutters, window sills and, occasionally, indoors in infrequently used structures, such as sheds or attics. The nests have a flat cone-shaped structure, hang from a short stalk and are 10–12 cm in diameter. Wasps are often seen congregating on or around the nests. The wasps feed on nectar and their 'paper' nests are actually made of wood fibres held together with saliva. In contrast, European wasps can construct massive nests, mostly in the ground, with multiple layers several metres across and containing up to four million individual compartments.

Public health importance

Wasp stings often produce a similar reaction to bee stings. Unlike bees, wasps can sting multiple times; reactions can be severe and deaths have been reported. Multiple stings from one or more wasps may result in severe envenomation and can be fatal (usually more than 20 stings are required). Allergic reactions to wasp stings can also be fatal.

Native papernest wasps mainly have a painful sting, which may be multiplied by many stings from the same or other insects. Anaphylactic reactions have been reported. European wasps are far more aggressive and their stinging can create a serious pest issue. They often sting multiple times and their stings are extremely painful. Deaths resulting from wasp stings are rare, with only seven deaths from allergic reactions recorded during the 1980s and 1990s. Although there was no formal identification of the wasps responsible, they were likely to be either *Polistes* or *Ropalida* species, as all cases were outside the range of the European wasp. Deaths have been attributed to the sting of European wasps overseas, but not in Australia.

First aid

The initial reaction to the sting is localised and only persists for a short time. Cold compresses can help reduce pain. However, if pain begins to spread and intensify in the first 15 minutes, a more severe reaction should be suspected and medical attention should be sought.

Personal protection

For the most part, wasps do not actively seek out humans to sting, but European wasps can be aggressive. The majority of stings occur outside during the warmer months. Take care when wasps are active and, as they can be attracted to soft drinks left unattended outdoors on hot days, use a drinking straw to reduce the risk of stings to the mouth. Do not disturb wasp nests.

Managing the pest and its impacts

Wasp control is best achieved by removing the nest. Killing individual wasps will not cause a significant reduction in wasp numbers unless the nest was recently established. The control of papernest wasps is most easily done at night when the wasps are inactive. Wear protective clothing and eyewear, and use a strong plastic bag or plastic sheeting to cover the nest while removing it from the building. Shortly after the European wasp was introduced to mainland Australia, attempts were made to eradicate the species. Unfortunately, these attempts failed and the insect is now widely distributed across the south-eastern states. European wasp nests should only be removed by experienced pest managers.

Further reading

Akre RD and Reed HC 2002. Ants, wasps and bees (Hymenoptera). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Horwood MA, Toffolon RB and Brown GR 1993. Establishment and spread of Vespula germanica (F.) (Hymenoptera: Vespidae) in New South Wales and the influence of rainfall on its abundance. *Journal of the Australian Entomological Society* 32(3):241–248.

McGain F, Harrison J and Winkel KD 2000. Wasp sting mortality in Australia. *Medical Journal of Australia* 173:198–200.

NSW Health 2007. *Snakebite and Spiderbite Clinical Management Guidelines*, Statewide Services Development Branch, NSW Department of Health, North Sydney.

Ticks

Paralysis tick

Description

The paralysis tick, Ixodes holocyclus, is the most important pest tick species in Australia and belongs to the family Ixodidae (the 'hard ticks'). It is also known by several other names according to its growth stage, including the grass tick, seed tick, bush tick or shell-back tick. The tick is oval in shape, and has a light-brown to greyish appearance when unfed.

Biology and ecology

The paralysis tick is most often encountered in wet native bushland and temperate rainforests in eastern Australia. Eggs are normally laid in moist leaf litter and the six-legged larvae hatch after 40–60 days. To moult to the next stage, the larval tick must have a blood meal.

When searching for a host, the tick shows a behaviour called 'questing', where it climbs to the top of nearest plant and slowly waves its forelegs around, hoping to contact a passing animal. This is usually a native animal such as a bandicoot, which is the main host, but possums, kangaroos and humans can also host the tick. Questing happens each time a host is needed for blood. Ticks usually do not climb more than around 50 cm up a plant. Once a suitable host is found, the larvae will feed on blood for 4–6 days, then drop from the host and moult to the nymphal stage. Nymphs need another blood meal for 4–8 days before they can moult to the adult stage.

Both female and male adult ticks quest for a host, but for different reasons — the female needs a blood meal and the male searches the host for female ticks so he can mate and sometimes feed from them. Male ticks rarely feed on a host's blood. The adult female paralysis tick will feed for up to 10 days, then drop off the host, lay eggs over several weeks and die. The entire life cycle of the paralysis tick, involving four stages and three hosts, takes around a year. Adults are more common in the spring and early summer, larvae in mid to late summer, and nymphs during winter.

Public health importance

The bite from the paralysis tick can cause allergic reactions, severe conditions from the toxins or the transmission of disease-causing microorganisms, especially spotted fever rickettsia. Allergic reactions are the most common medical condition associated with ticks. These reactions can vary from a mild itching with localised swelling, to widespread swelling with pain, to a severe and life-threatening anaphylactic condition. Unlike most other medical conditions associated with ticks, severe allergic reactions can occur in response to any growth stage of the paralysis tick, not just the adults. People who develop severe allergic reactions must always avoid contact with ticks and avoid potential tick-infested areas.

Tick paralysis is common in children with an adult female tick attached. The initial symptoms of tick paralysis may include unsteady gait, weakness of the limbs, multiple rashes, headache, fever, flu-like symptoms, tender lymph nodes and partial facial paralysis. Tick paralysis develops slowly as the tick fills with blood; it can take several days and the person can die because they are unable to breathe. Even if the tick is removed, the patient's condition will usually continue to worsen for a time and recovery is often slow. Other, undetected ticks could continue causing symptoms — if one tick is found on a person with symptoms, the entire body should be searched for others.

Twenty people died from paralysis ticks between 1925 and 1945. Improvements in modern medicine and the development of a tick antitoxin have prevented further deaths from tick paralysis in the last 65 years. However, a few cases of tick paralysis in children are seen at major hospitals each year. Ticks also take a high toll on pets every summer.

Spotted fever or 'tick typhus' is an infection with a rickettsia (bacteria-like organism) transmitted from native animals by ixodid ticks. Several species of rickettsia have been identified that can cause spotted fevers. Most cases occur along the east coast of Australia and on the Bass Strait islands. Symptoms include headaches, multiple rashes, swollen glands, fever and flu-like symptoms. The disease is rarely fatal and readily responds to antibiotic therapy.

Lyme disease or 'lyme borreliosis' is a tick-borne infection common throughout the northern hemisphere and is caused by corkscrew-like bacteria (spirochaetes) belonging to the genus *Borrelia*. Symptoms are varied and may include distinctive rashes, fever, muscle and joint pain, and arthritis. The disease is not fatal and is treatable with antibiotics. Despite clinical cases being reported in Australia from the mid-1980s, scientists are yet to confirm the presence of the disease in Australia.

First aid

Ticks can wander on the body for around two hours before attaching and this is how they can attach to a person's head (not, as many people think, because they fall out of trees). Avoid using any chemicals such as methylated spirits, alcohol or petroleum jelly on the tick, as this can increase any clinical symptoms.

The best way to deal with an attached tick is a matter of some debate. Unfortunately, most methods are based on assumption rather than scientific evidence, and there have been no clinical trials to find the best way to minimise the harmful effects of the tick. The most common method is to remove the tick with a pair of fine-tipped forceps, holding the tick as close as possible to the surface of the skin and then pulling it out. However, this method is rarely done correctly (even most medical clinics do not have the ultrafine forceps required) and can cause the tick to release more toxin into the patient and increase the severity of symptoms. The world's leading authority on the toxin of the paralysis tick, Dr Bernie Stone from CSIRO, recommends killing the tick with an insecticide cream containing permethrin, a common ingredient of scabies and head lice treatment products. The insecticide is toxic to the tick and prevents it from injecting its saliva. The tick should be treated a second time around one minute later and left to die. The dead tick will usually fall off after 24 hours, or it can be gently removed with fine-tipped forceps as described above. It is normal for a tick bite to remain slightly itchy for several weeks; however, if other symptoms develop, consult a general practitioner immediately.

Many people are concerned about the tick's mouthparts being left behind in the skin. If a tick is forcibly removed, the mouthparts will almost always break off and some part will be left behind. However, this is not a cause for concern, as the saliva glands that hold the toxin are in the tick's body, and the broken-off mouthparts will come out as the skin naturally sheds.

Never remove a tick using a punch biopsy; this is unnecessary and only makes the patient more uncomfortable.

Personal protection

The four key elements in personal protection strategies against the paralysis tick are to avoid known tick habitats; use a personal insect repellent containing DEET; cover up by wearing long pants, ideally tucked into socks; and, if a tick is found attached, quickly

deal with it. Insect repellents, particularly those containing DEET, can reduce or prevent tick bites. Another synthetic repellent, picaridin, is also effective. Botanical-based repellents are unlikely to provide the same level of protection as the synthetic repellents.

In areas where ticks are known to be active, wear light-coloured clothing to make ticks much easier to see and remove. Tuck trousers into socks and shirts into pants to minimise exposed skin. On returning from tick habitats, place all clothing into a hot dryer for at least 20 minutes to kill any ticks that may still be on the clothing. Search the body well for ticks, especially behind the ears and on the back of the head. Examine children and pets for ticks after visiting bushland areas.

Managing the pest and its impacts

There are several ways to reduce tick populations in areas where people contact ticks in their backyard. The paralysis tick cannot live in dry conditions, so decreasing soil moisture can lessen their impact. This can be done by cutting back plant foliage and shrub layers (which increases sunlight penetration to the ground), reducing mulching and watering, and ensuring that the lawn is kept mown short. Bandicoots, the main host of the paralysis tick, can be kept out of the backyard with animal exclusion fencing. This needs to go 0.5 metres below the ground surface so that the animals cannot dig underneath. If ticks continue to be a problem, then insecticide control is an option. The only registered insecticide for controlling the paralysis tick is bifenthrin.

Further reading

Doggett SL 2004. Ticks: human health and tick bite prevention. *Medicine Today* 5:33–38.

Doggett SL 2006. Tick ecology and control. In: *Pests of Disease and Unease: Synopsis of Papers*, Department of Medical Entomology, Westmead Hospital, Sydney.

Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance*, CRC Press, New York.

Russell RC 2001. The medical significance of Acari in Australia. In: *Acrarology: Proceedings of the 10th International Congress*, Halliday RB, Walter DE, Proctor HC, Norton RA and Colloff MJ (eds), CSIRO Publishing, Melbourne.

Sonenshine DL, Lane RS and Nicholson WL 2002. Ticks (Ixodida). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Stone B 1990. Tick paralysis — a suggestion. *Australian Veterinary Practitioner* 20(1):38–39.

The ornate kangaroo tick

Other ticks

Description

There are approximately 75 tick species in Australia, including a few introduced species. The majority belong to the family Ixodidae (commonly known as hard ticks) and a small number of species that belong to the family Argasidae (the soft ticks). Only a few species are medically important pests of humans. However, many are of veterinary importance, causing a risk to livestock as well as domestic pets.

Some of the most common ticks of medical importance in Australia are:

+ *Amblyomma triguttatum* — commonly known as the 'ornate kangaroo tick', this species is found in Queensland, New South Wales, Western Australia and South Australia. As the name suggests, this species is typically associated with kangaroos, but can bite humans and cause localised skin reactions.

+ *Bothriocroton* (formerly *Aponomma*) *hydrosauri* — this species is typically associated with reptiles (both snakes and lizards) and is found in Victoria, Tasmania, the south-eastern regions of South Australia, southern areas of New South Wales, and small pockets in southern Western Australia. Although primarily associated with reptiles, this species also bites humans and is a vector of *Rickettsia honei*, the microorganism that causes Flinders Island spotted fever.

+ *Haemaphysalis novaeguineae* — this species may transmit a spotted fever rickettsia in northern Queensland, although this association has not been confirmed. This tick is uncommon and rarely bites humans.

+ *Ixodes cornuatus* — this species has been identified as the cause of paralysis in children, but this is probably a misidentification of *I. holocyclus*. *I. cornuatus* occurs in Tasmania and pockets of Victoria, with reports of its presence in New South Wales being questionable. Unfortunately, similarities with *I. holocyclus* in morphology and possibly geographic distribution make it hard to assess the public health risks posed by *I. cornuatus*.

+ *Ixodes tasmani* — this species occurs throughout southern Australia, and bites humans and a range of other mammals. There is little information on the medical importance of this species, but it may transmit Queensland tick typhus and Flinders Island spotted fever. However, this species is generally considered to pose a small risk of disease transmission compared to other Australian ticks, such as *I. holocyclus*.

+ *Rhipicephalus sanguineus* — commonly known as the 'brown dog tick', this species is considered a pest of pet dogs and is found throughout the world. While primarily of concern for dogs, this species can also bite humans and has a greater potential to do this when dogs are kept indoors. This species has been associated with the transmission of rickettsia.

Biology and ecology

The biology and ecology of Australia's tick fauna can vary markedly. The key difference between the life cycles of Ixodid and Argasid ticks is that, while both types of tick have four stages (egg, larva, nymph and adult), Argasid ticks have two or more nymphal stages. The nymphal stages of Argasid ticks will take a blood meal and the adult female will also take many small blood meals before laying numerous small batches of eggs. In contrast, Ixodid ticks generally lay one large batch of eggs and will only feed on blood once in each stage of their lives. For many species in Australia, limited information is available on biology and ecology besides their preferred hosts.

Public health importance

In Australia, the spotted fevers (Queensland tick typhus and Flinders Island spotted fever) are the main diseases transmitted to humans by ticks. These diseases are not common, with less than 50 cases of Queensland tick typhus reported per year in New South Wales. These diseases are caused by rickettsiae (*Rickettsia australis* and *R. honei*), which belong to a group of primitive bacteria-like organisms.

The symptoms of tick typhus include rashes, scabs, headaches, fever, flu-like symptoms and lymph node tenderness. Diagnosis is confirmed with specific blood tests. Tick typhus is treatable with antibiotics, although rare deaths have occurred.

Queensland tick typhus occurs along the eastern coastal strip of Australia, from northern Queensland to at least as far south as Sydney. It is caused by *R. australis* and appears to be transmitted to humans by the paralysis tick, *I. holocyclus*. Other species — such as *I. tasmani* — may also be involved, although this species rarely bites humans.

Flinders Island spotted fever occurs throughout Victoria and Tasmania (especially on Flinders Island) and is caused by *Rickettsia honei*. The tick that carries this disease is *Bothriocroton hydrosauri*, associated with reptiles.

No arboviruses have been isolated from ticks on mainland Australia and none of these tick species can transmit arboviruses. However, viruses have been isolated from ticks associated with sea bird populations on offshore islands and these viruses are thought to have caused human disease cases. The public health impacts of ticks, arboviruses and bird populations are low, but people working in close association with sea birds (including migratory sea birds and penguins) should be aware of the potential risks.

First aid

Pathogen transmission usually requires the tick to be attached for a long time, so it is important to remove the tick promptly. Details on how this should be done are included in the section ‘Paralysis ticks’ and the same techniques are appropriate for other Australian ticks.

Personal protection

See ‘Personal protection’ under ‘Paralysis ticks’.

Managing the pest and its impacts

See ‘Managing the pest and its impacts’ under ‘Paralysis ticks’.

Further reading

Doggett SL 2004. Ticks: human health and tick bite prevention. *Medicine Today* 5:33–38.

Ginsberg HS and Stafford KC 2005. Management of ticks and tick-borne disease. In: *Tick-borne Diseases of Humans*, Goodman JL, Dennis DT and Sonenshine DE (eds), ASM Press, Washington.

Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance,* CRC Press, New York.

Izzard L, Graves S, Cox E, Fenwick S, Unsworth N and Stenos J 2009. Novel rickettsia in ticks, Tasmania, Australia. *Emerging Infectious Diseases* 15(10):1654–1656.

Major L, Linn ML, Slade RW, Schroder WA, Hyatt AD, Gardner J, Cowley J and Suhrbier A 2009. Ticks associated with Macquarie Island penguins carry arboviruses from four genera. *PLoS ONE* 4(2): e4375. doi:10.1371/journal.pone.0004375

McDiarmid L, Petney T, Dixon B and Andrews R 2000. Range expansion of the tick *Amblyomma triguttatum triguttatum*, an Australian vector of Q fever. *International Journal for Parasitology* 30(7):791–793.

Murdoch FA and Spratt DM 2005. Ecology of the common marsupial tick (*Ixodes tasmani* Neumann) (Acarina: Ixodidae), in eastern Australia. *Australian Journal of Zoology* 53(6):383–388.

Renvoisé A, Mediannikov O and Raoult D 2009. Old and new tick-borne rickettsioses. *International Health* 1(1):17—25.

Russell RC 2001. The medical significance of Acari in Australia. In: *Acrarology: Proceedings of the 10th International Congress*, Halliday RB, Walter DE, Proctor HC, Norton RA and Colloff MJ (eds), CSIRO Publishing, Melbourne.

Sonenshine DL, Lane RS and Nicholson WL 2002. Ticks (Ixodida). In: *Medical and Veterinary Entomology*, Mullen G and Durden L (eds), Academic Press, New York.

Unsworthy NB, Stenos J, Graves SR, Faa AG, Cox GE, Dyer JR, Boutlis CS, Lane AM, Shaw MD, Robson J and Nissen MD 2007. Flinders Island spotted fever rickettsioses caused by 'marmionii' strain of *Rickettsia honei*, eastern Australia. *Emerging Infectious Diseases* 13(4):566–573.

Waudby HP, Petit S, Dixon B and Andrews RH 2007. Hosts of the exotic ornate kangaroo tick, *Amblyomma triguttatum triguttatum* Kock, on southern Yorke Peninsula, South Australia. *Parasitology Research* 101(5):1323–1330.

Miscellaneous Pests

Booklice (psocids)

Description

Booklice are a group of insects in the order Psocoptera. Psocids, as they are more correctly known, are found in most households and are often misidentified as a source of irritation. They can become noticeable when favourable conditions allow a substantial population to develop. There are over 300 species in Australia and the adults of most species are less than 5 mm long with a large head, protruding eyes and a stocky body. The species found inside buildings are usually wingless.

Biology and ecology

Most psocids are associated with damp natural areas with a build-up of leaf litter and other debris, and only a few species are associated with humans. These species feed on stored products and cellulose-based materials like paper, or graze on the mould that grows on these materials. Psocids take around four weeks to reach maturity and, under favourable conditions where there is a build-up of mould on stored books and paper, large populations can develop, especially towards the end of warm seasons.

Public health importance

Psocids are not thought to bite humans, but there are some anecdotal reports of psocid bites. They are not associated with any serious public health impacts, but skin irritation can occur in individuals working with heavily infested material. The risk of irritation from an allergic reaction increases when favourable conditions allow large populations to develop.

First aid

No specific treatment is available for irritation resulting from psocids. As with other insect bites, cold compresses, antiseptic lotions or antihistamine creams can reduce the irritation.

Personal protection

To minimise the risk of psocid population increase, store paper products (e.g. books, magazines, newspapers) in a well-ventilated and dry environment. In situations where exposure to psocids may be likely, take appropriate care to minimise direct contact with insect material (e.g. wearing gloves, mask).

Managing the pest and its impacts

Insecticides are rarely needed except to treat substantial infestations. In most cases, a large psocid population indicates a poorly ventilated room or building, and inappropriate storage conditions. Material infested with psocids can be removed to a drier or sunny area to kill the insects. Unless conditions within the room or building improve, the problem may reoccur.

Further reading

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*. NSW Department of Health, Sydney.

The bronze orange bug, *Musgraveia sulciventris*

Bronze orange bug

Description

These distinctive shield-shaped and flattened sap-sucking insects (*Musgraveia sulciventris*) belong to the order Hemiptera and are common on citrus trees in coastal areas of eastern Australia. Nymphs are green, well camouflaged and about 6 mm long; young adults are bronze to orange; and older adults are brown to black and up to 25 mm long.

Biology and ecology

Bronze orange bugs are often found in urban areas, especially where citrus trees are present, but they are more abundant in commercial orchards. The insects can be present in large numbers, occasionally becoming agricultural pests, but tend to concentrate on individual trees rather than spreading out across the whole orchard.

Public health importance

Many bug species produce secretions without causing concern to humans, but the secretions of the bronze orange bug are known for their unpleasant smell and potential for irritation. The foul-smelling fluid that comes from glands on the insects' sides can burn human skin and may leave a brown stain. It causes extreme discomfort if it gets into the eyes and prompt medical attention is needed to prevent permanent damage.

First aid

Wash fluid from the skin as soon as possible. If fluid gets into the eyes, seek medical attention immediately.

Personal protection

Avoid handling the insects and avoid trees where bugs are present, as fluid may fall from bugs above.

Managing the pest and its impacts

Insecticides registered for the control of bronze orange bug are available. Always wear eye protection whenever infested trees or plants are approached.

Further reading

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*. NSW Department of Health, Sydney.

A non-biting midge, *Chironomid* sp.

Chironomids (nonbiting midges)

Description

Commonly known as midges, chironomids (Diptera: Chironomidae) are small nonbiting insects that are closely related to, and often confused with, mosquitoes. There are around 200 species in Australia and although they share a similar body shape to mosquitoes, chironomids have a humped thorax and lack a long feeding tube.

Biology and ecology

Chironomids are considered one of the most important components of wetland ecosystems, and activity in areas close to wetlands is normal. Their life cycle includes egg, larval, pupal and adult stages. They breed in a range of aquatic habitats, including wetlands, lakes and streams, and although each female lays only one egg capsule, this can contain thousands of eggs. The larvae live in the sediment and feed on organic debris. Some species; larvae are red in colour (commonly known as bloodworms). but most are pale coloured. Problematic populations can build up after high nutrient inflows (e.g. stormwater run-off or surface flows from gardens and lawns where nitrogen fertilisers have been used). This increases algal growth, resulting in favourable conditions for chironomid development. Therefore, large chironomid populations are often a symptom of degraded or polluted habitats, although populations can also expand after extensive rainfall with flooding.

Public health importance

Chironomids do not bite humans or spread any disease-causing microorganisms, but they can generate exceptionally large populations. This causes substantial nuisance impacts as the insects are attracted to lights in and around houses, as well as light-coloured surfaces on buildings. Local authorities often receive complaints of insects that are mistaken for mosquitoes swarming around pathway lights and buildings, although people do report that the insects do not bite. In some parts of the world, chironomids cause widespread respiratory allergies when their populations are especially large, but there are no such reports in Australia. Control strategies for chironomids differ substantially from those for mosquito control. Higher concentrations of larvicide are required than are currently approved for mosquito control. Reducing algal growth in wetlands — and reducing factors contributing to such growth — can reduce chironomid populations.

First aid

No first aid is necessary after exposure to chironomids.

Personal protection

No specific personal protection strategies are required. If chironomid populations are high, head nets may provide some protection for individuals working close to wetlands.

Managing the pest and its impacts

Although some insecticides and insect growth regulators are effective in controlling immature chironomid populations, the preferred option for managing these potential pests is to address the factors that contribute to favourable breeding conditions in nearby water bodies.

Further reading

Midge Research Group of Western Australia 2007. Chironomid midge and mosquito risk assessment guide for constructed water bodies. Western Australia Department of Health, Perth.

Webb CE and Russell RC 2008. Managing non-biting midges. *Professional Pest Manager* April/May:12–21.

Rove beetles belong to the genus *Paederus*

Rove beetles

Description

Beetles represent the largest order of insects (Coleoptera), but pose very few public health risks. One exception is the so-called blister beetles, whose body fluids can cause blistering on human skin. In Australia, insects commonly known as rove beetles can cause this irritation, including various species belonging to the family Staphylinidae (especially members of the genus *Paederus*).

Biology and ecology

Adults generally feed on other small invertebrates, but will also eat certain plant materials. Enormous populations of adults have been recorded in some agricultural habitats. Rove beetles can be attracted to outdoor house and garden lighting.

Public health importance

Contact with rove beetles' body fluids can cause serious irritation that has been likened to the results of chemical warfare. Reddening of the skin, sometimes with only a mild reaction, is most common. Blistering may appear from two to four days and the painful irritation can remain sensitive for up to ten days. The irritation can often present as a narrow, linear series of marks, probably produced by the person brushing the beetle off their skin and triggering the beetle to release secretions. Rove beetles may be the cause of previously undiagnosed acute blistering disorders, particularly in areas where the beetles are abundant. One study in Queensland identified around 250 cases of skin blistering resulting from exposure to beetles. No disease-causing microorganisms are spread by beetles.

First aid

There is no specific treatment for the irritation caused by rove beetles. Immediately washing the site with soap and water can reduce the symptoms. As with other insect bites, cold compresses, antiseptic lotions or antihistamine creams can reduce irritation. Since blistering is common, take particular care to avoid secondary infection.

Personal protection

There is no specific strategy for avoiding these beetles, although reducing outdoor lighting that may attract fewer of these insects to the garden. When camping, it is important to ensure that fly screens are used to stop beetles entering tents or cabins when attracted to lights. Avoid disturbing or handling beetles to reduce the risk of exposure.

Managing the pest and its impacts

Rove beetles can offer some horticultural benefit by preying on plant pests, so consider this before using long-acting insecticides for beetle control. Control is rarely required based on public health concerns alone.

Further reading

Banney LA, Wood DJ and Francis GD 2001. Whiplash rove beetle dermatitis in central Queensland. *Australasian Journal of Dermatology* 41(3):162–167.

Claborn DM 2004. Environmental mimics of chemical warfare agents. *Military Medicine* 169(12):958–961.

Kanamitsu K and Frank JH 1987. *Paederus*, sensu lato (Coleoptera: Staphylinidae): natural history and medical importance. *Journal of Medical Entomology* 24:155–191.

Whelan PI, and Weir, TA 1987. Skin lesions caused by *Paederus australis* Guerin-Meneville (Coleoptera: Staphylinidae). Journal of the Australian Entomological Society 26: 287-288

Thrips

Description

Thrips are small insects in the order Thysanoptera. Often less than 15 mm long with a cylindrical body and two pairs of wings, these insects are not normally considered a serious public health risk. Generally, they are a pest of plants, but occasionally cause minor irritation to humans when they are encountered in gardens in very large numbers.

Biology and ecology

Most thrips have rasping mouthparts and feed on a variety of plant material including sap, leaves and pollen; some species also feed on fungus and some are predatory. Eggs are usually laid on or inserted into plant material. The immature stages of thrips lack wings and thrip populations are usually greatest during spring and summer.

Public health importance

There are no serious pest effects associated with thrips. During the warmer months, they may be attracted to light-coloured and damp items hanging on washing lines and can be accidentally brought inside, coming in contact with humans and occasionally causing some mild skin irritation. The most commonly reported effects occur in babies, when thrips are attracted to cloth nappies on clotheslines. Thrips can also be brought indoors on garden plants and may contact humans in this way, but reports of thrips causing major problems are often questionable.

First aid

There is no specific treatment for irritation resulting from thrips. As with other insect bites, cold compresses, antiseptic lotions or antihistamine creams can reduce irritation.

Personal protection

Inspect clothes and remove any thrips before bringing items inside the house. Clothes can also be placed in a hot dryer for a short time to kill any thrips that may be present.

Managing the pest and its impacts

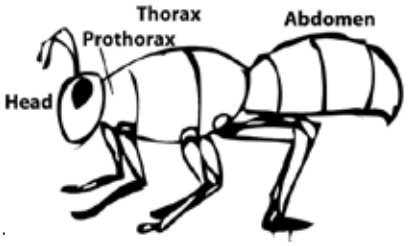
If thrip populations are particularly high, numbers can be reduced using appropriate insecticides available from the local nursery or garden centre. However, control of thrips is rarely required from a public health perspective.

Further reading

NSW Department of Health 1987. *Common Pests and Public Health in New South Wales*, NSW Department of Health, Sydney.

PART III–**RESOURCES**

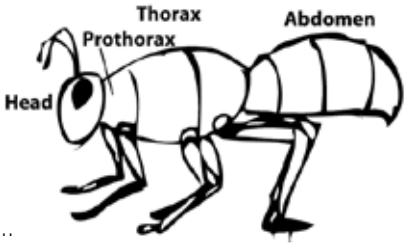
Glossary

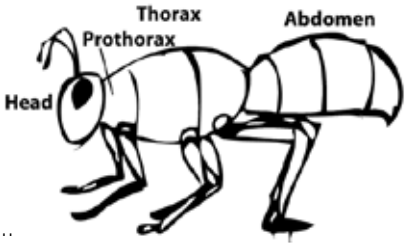
Abdomen	The rear body region of an insect, behind the head and the thorax  See also *prothorax, thorax*
Antivenene	A biological product used to treat the symptoms of envenoming bites or stings. Antivenene contains antibodies that neutralise the envenoming toxin and stop the symptoms. Also known as antivenom or antivenin. See also *envenomation*
Arboviruses	A broad group of viruses that are specifically transmitted by arthropods. The word arbovirus is a contraction of 'arthropod-borne virus'. In Australia, the main vectors for these viruses are mosquitoes. See also *biological transmission*, *vector*, *virus*
Arthropod	A wide classification of animals that includes insects, mites and ticks, arachnids (spiders) and crustaceans (lobsters, crabs and prawns). Arthropods have segmented bodies, jointed legs and external skeletons. All of the pests listed in this book are arthropods. See also *exoskeleton*
Australian Pesticides and Veterinary Medicines Authority (APVMA)	An Australian federal government agency that registers all urban and agricultural pesticides, and veterinary chemicals marketed in Australia.

Bacterium (plural *bacteria*)	A tiny organism that is not visible to the naked eye and consists of a single cell. Some species of bacteria can be beneficial to humans, some can cause disease and some can do both, depending on the circumstance. See also *microorganism*, *pathogen*, *infection*
Biological transmission	A method of passing along disease-causing microorganisms where the organism multiplies in the body of an arthropod (the vector) and is transferred to a vertebrate animal during feeding. An example of biological transmission is an arthropod passing a virus to a human when it feeds on the person's blood. Diseases such as Ross River virus disease, Barmah Forest virus disease, dengue and malaria involve biological transmission. See also *mechanical transmission*, *vector*
DEET	A chemical that is commonly used in insect repellents. The full chemical name is *N*,*N*-diethyl-3-methyl-benzamide, but it is also commonly listed as *N*,*N*-diethyl-m-toluamide. See also *insect repellent*, *picaridin*
Disease-causing microorganism	See *pathogen*
Dormant	A stage of some living things when they are alive but are neither growing nor very active, usually due to adverse conditions (such as cold or drought). When better conditions return, such as more food or water, they start growing or feeding again.
Encephalitis	Inflammation of the brain. Encephalitis can be fatal and may lead to permanent damage to the nervous system in those that survive. Arboviruses such as Murray Valley encephalitis virus can cause this condition. See also *arbovirus*, *infection*, *virus*
Entomology	The study of insects. An entomologist is a person who studies insects.
Entomophobia	The fear of insects.
Envenomation	The clinical effect of an arthropod's venom, which may come from a sting (e.g. wasps or ants) or a bite (e.g. spiders or ticks).
Exoskeleton	The hard, outer shell of an arthropod. See also *arthropod*
Haemorrhage	Severe bleeding on the inside or outside of the body. Some viral infections such as dengue may cause haemorrhaging and can be fatal.
HEPA filter	A filter that is very efficient because of its special design and can capture smaller particles than other filters, such as viruses and bacteria. HEPA stands for high-efficiency particulate air.

Host	A species that supports the life cycle, or part of the life cycle, of a parasite or disease-causing organism. See also *life cycle*, *parasite*, *species*
Immunotherapy	A treatment to either suppress or increase an immune response. In this book, immunotherapy refers to suppressing an allergic reaction by giving small doses of the allergic substance (desensitisation 'shots'). This treatment is most common for people who are allergic to bee stings.
Incubation period	The time from establishment of a disease-causing microorganism in the host to when the disease symptoms start to appear. See also *host*, *infection*, *pathogen*
Infection	The invasion of a host by a microorganism (such as being bitten by a mosquito carrying an arbovirus), with subsequent establishment and growth of the microorganism. Infection may or may not cause overt disease. Infections are generally caused by bacteria, viruses, protozoa or rickettsia. See also *bacterium*, *host*, *pathogen*, *protozoan*, *rickettsia*, *virus*
Infestation	An occupation or invasion of arthropod pests. This can include, for example, a home, school or other dwelling infested with bird lice; an animal infested with fleas; a tree infested with caterpillars; or a person infested with head lice.
Insecticide	A chemical that kills insects or other arthropods.
Insect repellent	A chemical that repels insects or arthropods, or stops them from biting. Most repellents do not kill the biting pest.
Instar	A substage of the larval stage in the life cycle of some insects. See also *arthropod*, *larva*, *life cycle*
Larva (plural *larvae*)	The stage of an insect's life cycle between eggs and pupae. The larvae often look like 'worms' or caterpillars. There may be several larval stages, known as instars. The larvae of flies are commonly called maggots; mosquito larvae are called wrigglers. Ticks and mites also have larval stages, but they do not pupate. See also *instar*, *life cycle*, *pupa*
Larvicide	A chemical that kills larvae. See also *larva*
Latrodectism	Envenomation by a redback spider. Symptoms can include severe muscle cramps, headache, nausea, joint and muscle pain, and fatigue. Latrodectism is usually not life threatening, but a victim should be taken to hospital for treatment with an antivenene. See also *antivenene*, *envenomation*

Life cycle	The entire cycle of life and reproduction of an organism, including all stages of its development. Depending on the type or species of arthropod, their life cycle stages may be different.
Maggot debridement therapy (MDT)	The use of fly larvae (maggots) to treat wounds that will not heal with antibiotic treatment or surgical debridement. Live disinfected maggots are placed in the wound, contained in special dressings so they cannot escape. The maggots do three things: digest dead tissue (known as debridement); kill bacteria in the wound; and speed up the healing process. MDT is considered safe and effective, as the larvae only eat dead tissue. The larvae used are from a particular species of fly. See also *larva*, *species*
Mechanical transmission	A method of passing along disease-causing microorganisms on a body part of an arthropod or via some other substance. An example of mechanical transmission would be a fly landing on your arm, and passing along viruses or bacteria that are on its leg from previous contact with faeces. See also *bacterium*, *biological transmission*, *vector*, *virus*
Microorganism	An organism that is too small to see with the naked eye, such as bacteria, viruses, protozoa and rickettsia. Not all microorganisms cause disease. See also *bacterium*, *pathogen, protozoan*, *virus, rickettsia*
Moult	The shedding of an arthropod's exoskeleton to allow the body to grow or move onto the next phase in the life cycle. See also *exoskeleton*, *life cycle*
Myiasis	The infestation of living tissue (animal or human) by the larvae of a certain classification of flies, called myiasis flies, or by the adults of certain fleas. Myiasis can lead to secondary bacterial infection. See also *infection*, *infestation*, *larva*, *maggot debridement therapy (MDT)*, *secondary infection*
Nymph	Immature arthropods that look like small versions of the adult. As they moult through their different nymphal stages, they get larger until they reach the final adult stage. There is no pupal stage. See also *instar*, *larva*, *life cycle*, *moult*, *pupa*
Parasite	An organism that lives in or on another species. The parasite benefits from the partnership and the host may suffer or may be unaffected. Parasites must live in or on a host to survive and complete their life cycle. See also *host*, *life cycle*, *species*
Pathogen	A microorganism that causes disease when it infects a human or other living thing. Pathogens are also known as disease-causing microorganisms. These can include bacteria, viruses, protozoa and rickettsia. See also *infection*, *microorganism*

Pediculosis	The infestation of a human or animal with lice. See also *infestation*
Picaridin	A chemical insect repellent that offers similar protection to DEET. Also known as icaridin. See also *DEET, insect repellent*
Proboscis	A mouthpart found on some arthropods. It is often long and thin, and is sometimes called a feeding tube.
Prothorax	The segment of an insect's thorax that is directly behind the head.  .. See also *abdomen*, *thorax*
Protozoan (plural *protozoa*)	A type of microscopic animal that consists of one cell. They are often larger than bacteria and reproduce differently. Protozoa can be either parasitic or free-living. Many protozoa that affect humans invade the red blood cells, such as the protozoan that causes malaria. See also *bacterium*, *host*, *parasite*
Pupa (plural *pupae*)	The stage of an insect's life cycle where it transforms from larva into adult. The pupae do not feed. Insects with a nymph stage do not have a pupal stage. See also *larva*, *life cycle*, *nymph*
Pyrethroid (synthetic)	A synthetic chemical that kills non-insecticide-resistant insects. Some synthetic pyrethroids, particularly those in space sprays, act as a quick knockdown that rapidly disables the insects, while others are much slower acting and tend to be applied to surfaces as a residual (long-lasting) insecticide. See also *insecticide*
Questing	The action of a tick when it crawls up a plant and waves its forelegs around, searching for a nearby host to latch on to. See also *host*
Rickettsia	A bacteria-like organism that is very small and lives as an intracellular parasite in arthropods. They are often transmitted by mites, ticks and lice (and less commonly in Australia, by fleas), and can cause disease in humans and other animals. See also *bacterium*, *biological transmission*, *parasite*

Secondary infection	Infection with a disease-causing microorganism that happens as a result of previous damage. Secondary infections of arthropod bites can occur after excessive scratching of the bite site, which breaks the skin and allows microorganisms to enter the body. See also *infection*, *microorganism*
Species	A classification of organisms that are similar enough to each other so that they can successfully breed fertile offspring.
Synthetic pyrethroid	See *pyrethroid (synthetic)*
Thorax	In insects, the section between the head and the abdomen. The thorax is made up of different segments and the prothorax is the segment directly behind the head.  .. See also *abdomen, prothorax*
Vector	Any living thing that transmits disease-causing microorganisms (pathogens) from one host to another. Vectors can transmit pathogens biologically (where the pathogen develops within the vector) or mechanically (where the vector simply transfers the pathogen and is not essential to its life cycle). See also *biological transmission*, *mechanical transmission*, *pathogen*
Videodermatoscopy	A method of detecting skin diseases, such as scabies, that uses a high-magnification camera. This technique is useful because it is quick and accurate, and does not require a skin sample from the patient. Videodermatoscopy is usually only done in highly specialised surgeries.
Virus	A type of microorganism that is smaller than bacteria and can only replicate inside a host cell. Some viruses can cause disease; some viruses are spread by arthropods. See also *arboviruses*, *biological transmission*, *host*, *microorganism*, *pathogen*
Wheal	An allergic skin reaction that usually presents as a red and very itchy bump, and can be a few centimetres in diameter. Wheals are often called hives and usually only last a few hours, although wheals caused by bed bug bites can last for several days.

Australian Pesticides and Veterinary Medicines Authority 2009. *Pest Management in Schools.* Australian Pesticides and Veterinary Medicines Authority, Canberra

Further reading and resources

Gerozisis J, Hadlington P and Staunton I 2008. *Urban Pest Management in Australia*, University of New South Wales Press, Sydney.

Goddard J 2000. *Physician's Guide to Arthropods of Medical Importance*, CRC Press, Boca Raton, United States.

Henderson A, Henderson D and Sinclair J 2008. *Bugs Alive! A Guide to Keeping Australian Invertebrates*, Museum Victoria, Melbourne.

Mullen G and Durden L 2002. *Medical and Veterinary Entomology*, Academic Press, New York.

Strickman D, Frances SP and Debboun M 2009. *Prevention of Bug Bites, Stings, and Disease*, Oxford University Press, New York.

Zborowski P and Storey R 2010. *A Field Guide to Insects in Australia*, Reed Books, Chatswood.

Useful websites

Australian Entomological Society, www.austentsoc.org.au/wordpress

Australian Entomological Supplies, www.entosupplies.com.au

Australian Museum, http://australianmuseum.net.au

Australian Pesticides and Veterinary Medicines Authority, www.apvma.gov.au

Australian Quarantine and Inspection Service (AQIS), www.daff.gov.au/aqis

Australian Venom Research Unit, www.avru.org

CSIRO Entomology, www.csiro.au/org/Entomology

Department of Medical Entomology, University of Sydney and Westmead Hospital, http://medent.usyd.edu.au

Department of Medical Entomology, Centre for Disease Control, Health Protection Division of the Department of Health and Families, Northern Territory, www.health.nt.gov.au/medical_entomology

Entomological Society of NSW, www.entsocnsw.org.au

Entomological Society of Queensland, www.esq.org.au

Entomological Society of Victoria, http://home.vicnet.net.au/~vicento/index.htm

Mosquito Control Association of Australia, www.mcaa.org.au

Museum Victoria, http://museumvictoria.com.au

Queensland Museum, www.qm.qld.gov.au

South Australian Museum, www.samuseum.sa.gov.au

Western Australian Insect Study Society, www.insectsocietywa.org.au

Western Australian Museum, www.museum.wa.gov.au

Contact details for further advice on arthropod pests

State or Territory	Arthropod group or category	Agency	Department/Unit	Phone	E-mail	Website
ACT/National						
New South Wales						
Northern Territory						
Queensland						
South Australia						
Tasmania						
Victoria						
Western Australia	Mosquitoes	WA Department of Health	Mosquito-Borne Disease Control, Environmental Health Hazards Unit	08 9285 5500	mosquito@health.wa.gov.au	http://www.public.health.wa.gov.au/3/1152/2/mosquitoes.pm
	Garden Pests and Diseases	WA Department of Agriculture	Pest and Disease Information Service	Freecall 1800 084 881, or (08) 9368 3333	enquiries@agric.wa.gov.au	http://www.agric.wa.gov.au/PC_92910.html
	Arachnids	WA Museum	Arachnid & Myriapod Collection	(08) 9212 3700	reception@museum.wa.gov.au	http://museum.wa.gov.au/research/collections/terrestrial-zoology/arachnid-and-myriapod-collection
	Arboviruses	UWA	Arbovirus Surveillance and Research Laboratory	(08) 9346 2212		http://www.biomedchem.uwa.edu.au/research/marshall-centre/arbovirus