Research Paper

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# Microbiology of Cockroaches - A Public Health Concern

Science

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## ABSTRACT

*One of the indirect effects of arthropods is the transmission of disease to man, through mechanical means and feacal contamination. They also act as an intermediate host of various parasites and other microorganisms. Cockroaches are insects of the order Blattaria or Blattodea, of which about 30 species out of 3,500 are associated with human habitats. About four species are well known as pests and adapt readily to a variety of environments, but prefer warm conditions found within buildings. Cockroaches (Blattella spp.) have survived dinosaurs, ice ages, and who knows what since they first appeared early in Upper Carboniferous times. Astonishingly, there is almost no difference in form between ancient cockroaches and those in our homes today. They are the only insects to have lasted so long with so little change. Microbiological investigation of Cockroaches by early researchers showed an array of 29 different bacterial isolates, 17 different parasites, 7 different fungi spp. and a number of exotic viruses including Hepatitis virus. Recently Cockroaches have been implicated in the transmission of Salmonella spp. and Shigella spp. which are of serious clinical implication. These ubiquitous and indomitable Cockroaches continued to multiply despite many control measures applied by man. Their involvement in transmission of pathogens is a matter of public health concern and concerted efforts should be geared toward educating individuals and communities of the potent danger of harboring them in our homes and then, there should be a total eradication of these nocturnal insect, if we must stay healthy.*

**Introduction**

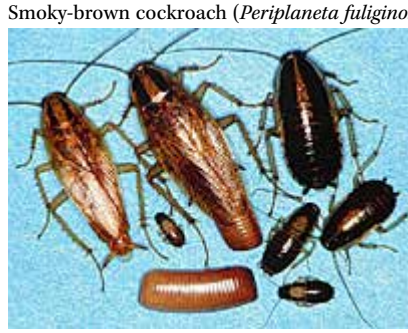
Cockroaches are found all over the world. There are more than 3,500 species of cockroaches. The most common varieties in Australia include German, American and Oriental cockroaches (Gary, 2004).

American cockroaches are large and black. German cockroaches are smaller and brown. Oriental cockroaches are medium sized and dark brown to black in colour. Because cockroaches eat a wide range of food, including rotten garbage, it is believed that they spread a number of diseases to humans including bacterial infections such salmonella and gastroenteritis. Recent studies indicated that cockroaches can also cause allergies (Tatfeng et al., 2005).

Common cockroaches are typified by their 5 - 73mm length and dual wing structure (Keiding, 1986). All cockroaches have a flattened appearance, and are yellowish brown in colour. Moreover, they exhibit endophagic behavior, feeding on garbage and feacal matters indoors (Thaddeus *et al.*, 2005). These arthropods are most active at night, scurrying in and out of latrines and other warm, man-made structures. Often, they breed outdoors, and opt to reside in colony form. Cockroaches are persistent and troublesome pests of homes, restaurants, hospitals, warehouses, offices, and other structures with food processing areas. These insects contaminate food and utensils, destroy fabric and paper products, and impart stain and odour to surfaces they contact (Valles *et al.,* 1999).

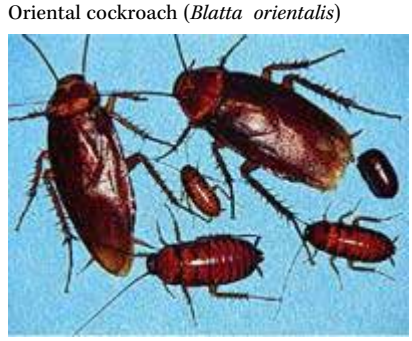
Cockroaches are universally loathed. One of the primary reasons is because they are associated with any place where there are biological waste products such as sewers, septic tanks, garbage cans, poultry houses, and animal cages (Melton, 2012). Their attraction to human and animal faeces, rotting food, secretions from corpses, sputum, pus, and the like gives them a well-earned "disgust factor" among the general public. These moist, organic habitats contain staggering amounts of bacteria, protozoa, amoebae, fungi, and other microbial material (William *et al.*, 2011). Microbes are an essential influence in the nutrition, ecology, and evolution of all cockroaches. The main source of nourishment for cockroaches is mines and sewers, for example, is human feaces, which can be 80% bacterial. German cockroaches have been observed feeding on mouth secretions of corpses riddled with lung disease; these secretions were almost 100% infectious bacteria (William *et al.*, 2011). The makeup of microbial population of the American cockroach gut by numerous investigators showed a variety of microorganisms, bacteria, archeans (Fotedar *et al.*, 1992). Some of the commonly found species are shown below ( figure 1a-1d).

Smoky-brown cockroach (*Periplaneta fuliginosa*)



German cockroach *(Blatella germanica)*

Oriental cockroach (*Blatta orientalis*)



American cockroach ( Periplaneta Americans)

Asian cockroach (*Blatella asahinai*)
Adapted from Gary, 2004.

**Habitat**

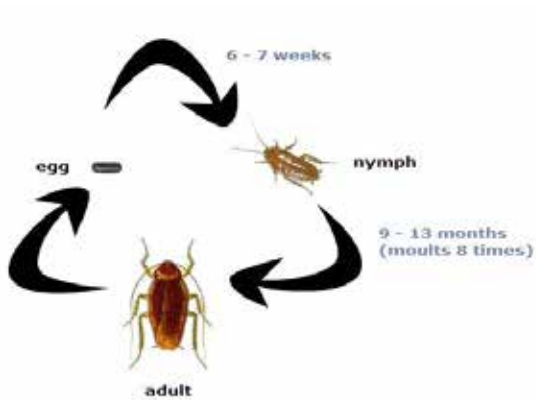
Cockroaches have amazing migratory abilities. They can travel up elevator shafts and drains, through heating and air vents, tiny cracks and crevices in walls and ceilings boards. They commonly spread out from areas that provide a steady food source, such as kitchens, pantries, restaurants, cafeterias, and garbage collection or disposal areas. When the weather is warm enough, they can migrate between structures outdoors, along the passageway of buildings and from dumpsters to nearby living units (Olkowski et al., 2006).

The Australian roach is more vegetarian than other species, and may be found in greenhouses. The American roach enjoys moisture and life on the seas; it is commonly found on ships, as well as in basements and sewers. The smoky brown roach can be found in sewers, but primarily lives outdoors. Oriental roaches are also moisture lovers, while the brown-banded roaches prefer warm, dry environments, such as closet shelves and the upper stories of houses (O' Connor- marer, 2006 ).

German roaches have the widest distribution of all domestic roaches and are often found in dead leaves and garbage piles, but also readily invade cartons, sacks and containers, and will enter empty or open bottles. They invade the indoors from outdoor habitats in the summer, and are usually found in basements and/or first floors, having a preference for the warm area around furnaces and heating ducts. This is the most common roach to be seen in food preparation areas in restaurants, cafeterias and kitchens – environments, where the combination of food, moisture and warm temperatures mimic that of their native East Africa habitat (Adler *et al*., 2002). In general, cockroaches prefer to live in kitchens and other food preparation areas, so they can feed off food spills and have access to water. Hide-out spots for the household cockroach include: cracks in walls, confined spaces, such as behind the refrigerator, in a pantry or underneath stack of magazines, newspapers or cardboard boxes, any furniture items that are generally left undisturbed, kitchen cupboards, below sinks, around water heaters, in drains and grease traps and gardens (Rivault *et al.,* 1993).

**The life cycle of a cockroach**

The life cycle of a cockroach consists of three stages– egg, nymph and adult. Anywhere from 6 - 40 eggs are put into a case at a time. The female drops her egg capsule within a day after it is formed. She often drops it in a suitable location near a food source or in a protected area. Each capsule has averages 10 to 14 eggs. Usually one capsule is produced each week and is often glued to a hidden surface with secretions from the female's mouth. The case is either kept safe internally of carried around until the eggs hatch. The next stage is the nymph. The nymphs go through stages of molting, getting larger each time, and changing color. Young nymphs are grayish brown and after the first few molts become reddish - brown. Under ideal conditions an adult female can live up to 15 months, males have somewhat shorter life span. The hatched young look the same as adult cockroaches, but smaller and without wings. Molting stops when the cockroach becomes an adult. Many types of cockroaches will become an adult as they grow a set of wings. The life cycle of a cockroach may help you identify the severity of an infestation. Depending on the conditions and type, a cockroach can live for up to 12 months. These insects are cold-blooded and thrive in warm, humid conditions. This is why buildings in the northern parts of Australia are particularly prone to infestations (Fotedar *et al.,* 1992 and Gehad *et al*., 2012).




**Mode of transmission**

Like the household fly, cockroach eats virtually anything ranging from food spills on a kitchen floor to faecal matter. Ingested bacteria can survive in the cockroach's digestive system, sometimes for months or even years, and are passed in its droppings (Thaddeus *et al*., 2005). Cockroaches vomit and defecate on exposed food items and it is obvious that pathogens would be transmitted to humans, when he feeds on food contaminated by cockroaches. Most of the substances they feed on may and may not contaminated, but as they moves from one location to another, it spreads the infectious agents along their path (Fotedar *et al*.,1992).

Aside being infected with the pathogens from contaminated food. There are recorded cases of allergic responses to feacal matter from cockroaches. The exposure may not be deliberate but could be inhaled as aerosol, or from it bites at night. Exposed food items which are not properly stored may be contaminated with the distinct smell or feace, salivary gland secretions, as well as particles of dead roaches, in turn, lead to human infection and will cause asthma (Allergic reaction) and other health conditions.

**Effects**

About 32 different bacteria isolates have been associated with cockroaches:

- *Aeromonas* spp., cause wound and other infections, diarrhea.
- *Alcaligenes faecalis* causes of gastroenteritis, urinary tract infections.
- *Bacillus cereus* causes food poisoning.
- *Bacillus subtilis* causes conjunctivitis.
- *Campylobacter jejuni* causes enteritis.
- *Clostridium perfringen* causes food poisoning, gas gangrene.
- *Enterobacter* spp., cause bacteremia (temporary presence of bacteria in the blood, which is commonly followed by the development of various infections including abscesses).
- *Enterococcus* spp., cause urinary tract and wound infections.
- *Escherichia coli* may cause diarrhea and wound infections.
- *Klebsiella* spp., cause pneumonia and urinary tract infections.
- *Mycobacterium leprae* causes leprosy.

- *Morganella morganii* causes wound infections
- *Nocardia* spp., causes actinomycetoma (chronic infection of the skin and underlying tissues).
- *Oligella urethralis* may cause bacteremia, septic arthritis that mimics gonococcal arthritis and peritonitis.
- *Pantoea* spp., cause wound infections.
- *Proteus rettgeri* causes wound infections.
- *Proteus vulgaris* causes wound infections.
- *Proteus mirabilis* causes wound infections, gastroenteritis.
- *Pseudomonas* spp., cause respiratory infections, gastroenteritis.
- *Salmonella* spp., cause gastroenteritis, food poisoning
- *Salmonella typhi* causes typhoid.
- *Salmonella pyogenes* causes pneumonia.
- *Serratia* spp., cause food poisoning.
- *Shigella dysenteriae* causes dysentery
- *Sphyngobacterium* spp., causes sepsis (presence in the blood or other tissues of pathogenic microorganisms or their toxins).
- *Staphylococcus aureus* causes wound infections, skin infections, infections of internal organ.
- *Staphylococcus epidermalis* causes wound infections.
- *Streptococcus faecalis* and other species, cause pneumonia.
- *Yersinia pestis* (isolated from oriental cockroach), causes plague (Collins *et al*., 1995, O' Connor- marer, 2006).

**Worms, Protozoa, Fungi, and Viruses Carried By Cockroaches**

In a related study by Etim *et al.* (2013), a total of 322 cockroaches were trapped from the different sites within the households and all identified as *Periplananta americana* species. Out of the 322 cockroaches examined, 58.6% were infected with one or several species of gastrointestinal parasites. Parasites isolated and identified include *Balantidium coli* (8.8%), Hookworms (9.6%), *Entameba coli* (10.4%), *Enterobius vermicularis* (12. 9%), *Entameba histolytica* (13.7%), *Trichuris trichuira* (16.9%) and *Ascaris lumbricoides* (27.4%), collected from the external and internal surfaces gastro-intestinal tract of the cockroaches collected. There were mixed infections in some cockroaches as 30.6% of the cockroaches examined harboured all the parasites identified, 16.9% had four parasites each, 14.8%, two parasites each while 14.2% had five parasites each and 11.6% had one parasite while 1.5% had three parasites each. These parasites are of significant importance to public health. At least 17 fungal species(*Candida* sp*, Rhizopus* sp*, Aspergillus* sp*, Mucor* sp,), three protozoan species oocysts of *Cryptosporidium parvum, Cryptosporidium Cayetenensis* and *Isospora belli,* cysts of *Balantidium coli*, and two strains of polymyelitis virus (Tatfeng *et al*., 2005). Australian, American, and Madeira cockroaches become infected with the protozoan *Toxoplasma gondii*, the causative agent of Toxoplasmosis after feeding on faeces of infected cats.

This suggests the possibility of cockroach involvement in the maintenance and dissemination of this parasite, which infects humans and other animals (Thaddeus *et al*., 2005). At least eleven proteins isolated from German and American cockroaches can cause allergic reactions and contribute to asthma in humans. The allergens are heat-stable and persistent in the environment even after the insect death (Brenner *et al*., 1992). The cockroach mite (*Pimeliaphilus cunliffei*) is a parasite of cockroaches. It feeds on live individuals and has been linked to bites of humans living in households with cockroach infestations (Thaddeus et al., 2005, Melton, 2012).

**Control**

The key to long-term cockroach control is the elimination of food, water and harborage sources needed for it to survival. Roaches evolved as scavengers of dead plant material and prefer carbohydrates to protein and fat as a result. They will, however, eat almost anything when hungry, such as starch-based paints, wallpaper paste, envelope glue and bar soaps, which all contain carbohydrates (Olkowski *et al*., 2006).

Your local council may offer information and advice on dealing with a cockroach infestation. Some general suggestions to eliminate cockroaches yourself include:

- Thoroughly clean the house at least weekly.
- Pay special attention to the kitchen and other food preparation areas.
- Clean regularly underneath the fridge, stove, toaster and other movable appliances.
- Empty the kitchen's rubbish bin regularly.
- Do not leave out pets' food or food scraps in pet bowls.
- Clean up any food spills promptly
- Make sure there are no sources of water such as a dripping tap, as cockroaches need a steady water supply to survive.
- Store food in sealed containers.
- Repair any holes, cracks or gaps in the walls, skirting boards and inside cupboards.
- Don't stack newspapers, magazines or cardboard boxes anywhere in the house.
- Keep compost bins screened and away from the house.
- Use appropriate insecticide and follow the manufacturer's instructions.

Cockroach baits contain poison that a cockroach carries back to the nest, which may help kill the rest of the nest (Valles et al., 1999).

Use physical traps, such as greased margarine tubs containing a smear of honey as the lure – cockroaches will climb in for the food, but be unable to get out because of the grease (or oil) on the tub (Olkowski *et al*., 2006)

**Professional pest control**: A qualified and licensed pest control operator can determine the type, source and extent of the infestation and use registered insecticides to control the cockroaches (Olkowski *et al*., 2006). Good hygiene practices, such as frequent house cleaning, should reduce the risk of further infestations (Keiding, 1986, O' Connor- marer, 2006).

**Conclusion**

Cockroaches carry micro-organisms on their surfaces and fecal pellets. They carry food-borne pathogens and food spoilage organisms wherever they crawl or forage in the home. Their presence in homes compromises the best practices in food safety and quality. Cockroaches spread a range of disease-producing organisms to humans including salmonella, staphylococcus and streptococcus. Cockroaches prefer warm, humid conditions with a ready food source. The bacteria carried by the cockroaches display multiple antibiotic resistances.

Therefore, utmost effort must be taken to drive cockroaches out or by controlling their population at the household level. Being aware of the potential for carrying pathogens, people at the household level should strive to keep their kitchens and toilets clean and prevent cockroach infestation. You can treat an infestation yourself or hire a professional pest control operator.

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