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Reemergence of Bedbugs as Poultry Pests

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It is estimated that one of every five Americans has had a bedbug infestation at home or knows someone who has. However, today bedbug infestations are not limited to just homes. Cage-free poultry houses have been found to have problems with bedbugs, and the incidence continues to rise. This makes bedbugs another important external parasite for which poultry producers need to be wary.

Overview of Bedbugs

Bedbugs are nocturnal, blood-sucking insects. That is, they feed on blood, mostly during the night. Bedbugs are photophobic (they don't like light) and hide in cracks and crevices whenever possible. Their flattened shape allows them to hide in spaces as narrow as a business card, or in the holes of staples.

Bedbug adults are visible to the unaided human eye. They are flat, small, brown, oval, wingless, and about the size of an apple seed (Figure 1). Adults are said to resemble immature cockroaches, aphids, ticks, or other immature true bugs. After bedbugs feed, they become engorged, much like a tick does. The blood can be seen through the outer cuticle, making them appear redder in color.

Bedbug mouth parts are adapted for piercing skin and sucking blood (Figure 2). Both sexes can pierce animal tissue and remove blood with a pain-free bite. They have extremely fine, needle-like stylets that are inserted into the skin and withdrawn after feeding. The stylet has two tubes. One is for injecting a numbing agent and anticoagulant and the other for sucking the blood out of the host. To feed, a bedbug injects saliva containing 46 different protein components, some of which have anticoagulant properties. The severity of skin reactions from a bedbug bite varies considerably between individuals and can also vary based on the level of previous exposures.

Bedbug Life Cycle

Adults must feed to produce eggs and sperm. After mating, females can begin laying eggs in three to six days. They can lay 200 to 500 eggs in a lifespan of six to 18 months. Eggs are white, oval-shaped, and about one millimeter long, so they are visible to the unaided human eye. If blood meals are available, a female bedbug can lay five to eight eggs per week for 18 months. The optimal environmental conditions are 23°C (73.4°F) and 90 percent relative humidity. The eggs hatch within nine to 12 days at a room temperature of 22°C (71.6°F). Hatching will take longer under cooler conditions.

Newly hatched bedbugs are about one millimeter (0.04 inches) long, while adults reach six millimeters (0.24 inches). Nymphs look similar to adults, except they are smaller and nearly colorless or pale yellow. All life stages have a short, three-segmented, straw-like mouthpart and four-segmented antennae (Figure 3).

Figure 1. Adult bedbugs have brown, oval bodies that are roughly the size of an apple seed. 7th Son Studio/Shutterstock.com

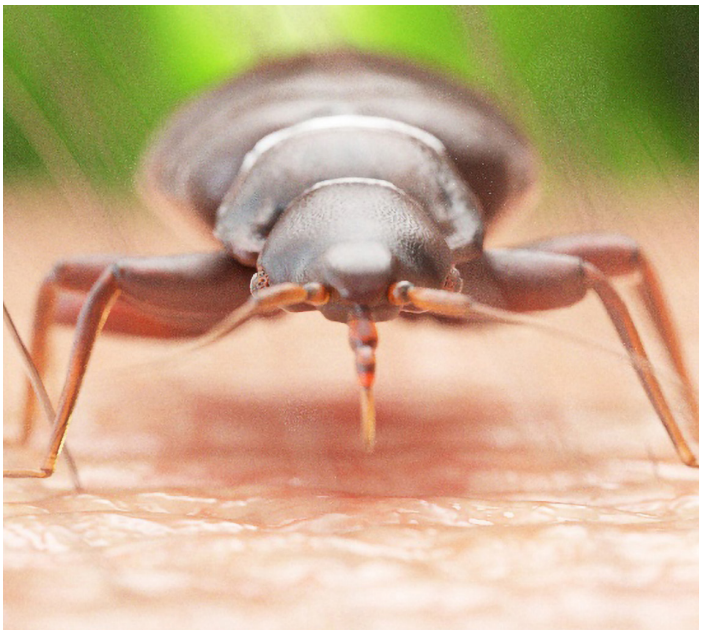

Figure 2. The mouth parts of bedbugs have needle-like stylets that are used for piercing the skin and sucking blood from the host. SciePro/Shutterstock.com

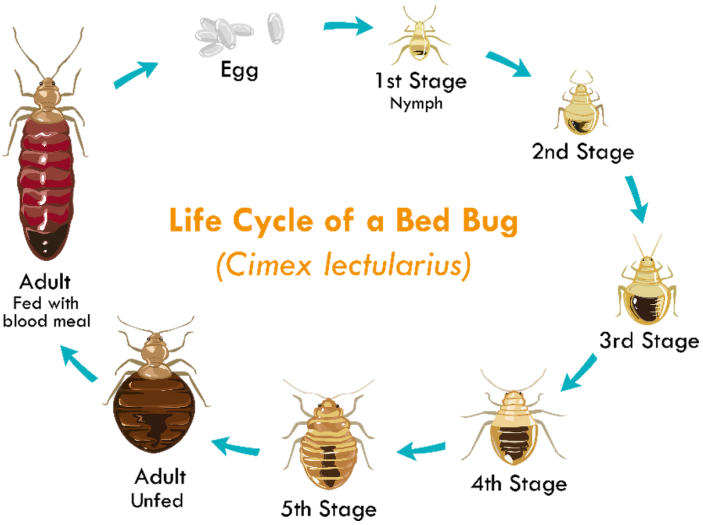

Figure 3. The life cycle of bedbugs includes five juvenile stages, also called instars. Crystal Eye Studio/Shutterstock.com

Bedbugs have five juvenile stages, called instars. These juveniles have been described as miniature versions of the adults in general appearance but having different sizes and colorations. The first instar is about one millimeter (0.04 inches) in length and off-white in color until it feeds. Unfed adults are five to six millimeters (0.20 to 0.24 inches) long and a deep reddish brown. All juvenile stages and adults of both sexes require blood for nutrition and development.

The length of the life cycle is variable and dependent on ambient temperatures. The life cycle ranges from 1.5 to 4.5 months, depending on temperature and accessibility of blood meals. Each instar must feed to molt to the next stage. If conditions are favorable, later juvenile stages and adult bedbugs can survive for well over a year without feeding. Under cool conditions of 10°C (50°F), a fed bedbug can live for up to 485 days.

Bedbug Behavior

Bedbugs do not like the light, so they mostly feed at night and early morning. They can, however, sometimes feed during the day. Hosts for the common bedbug include humans, mice, rats, rabbits, guinea pigs, horses, cattle, and poultry.

Bedbugs do not fly or jump, so they have to walk to their host or be carried on fomites (objects or materials that are likely to carry infection, such as clothes, utensils, and equipment). Although bedbugs are wingless, they can travel quite far. They are reported to be able to travel over four feet per minute and will travel an average of 20 feet in search of a blood feed. There have been reports of bedbugs travelling over 60 feet in search of food. Research has shown that bedbugs will walk around randomly in search of a host. They can detect carbon dioxide (CO_2) and will follow CO_2 gradients in the air to find their way to CO_2-exhaling hosts. Once in close proximity, bedbugs will then be further attracted by host body temperatures.

Bedbugs of all life stages are typically found living together in large groups. There will be cast skins from molting, and blood droplets can usually be seen. In addition, after each blood meal, bedbugs excrete reddish-brown or purple fecal spots on or near the host or in their daytime hiding spaces.

Bedbugs stay close to each other and release aggregation pheromones to help locate their harborage after a blood meal. You can usually detect their hiding places from the fecal spotting in the area. Bedbugs also release alarm pheromones, which become most evident during the course of a treatment. The smell is very typically "buggy" in odor, with some describing it as "sickly sweet."

Many blood-feeding arthropods can serve as biological vectors for human pathogens. This includes mosquitoes, ticks, fleas, and lice. More than 100 years of research, however, has not provided evidence to indicate that bedbugs also transmit infectious disease agents.

Bedbugs and Poultry

The preferred hosts of bedbugs are humans, but they will feed on other warm-blooded animals, including poultry. The entire life cycle of bedbugs takes only four to five weeks at 27.8°C to 30°C (82°F to 86°F) and 75 to 80 percent relative humidity, making the poultry barn an excellent bedbug incubator.

Bedbug Resurgence

Bedbugs in American poultry houses date back to the early 1930s. Recently there has been a reemergence of bedbugs in poultry houses. Farm managers typically describe a mite-like creature on their birds, equipment, support posts, nest boxes, and egg belts. They may also see brownish-red spots on eggs from bedbug fecal material.

Broiler breeder farms have historically been the poultry houses affected by bedbugs. Once bedbug populations are established, they are extremely difficult to eradicate. Compared to broiler breeders, laying hens have a much longer production cycle, so bedbugs have a longer period in which they can affect laying hens. The U.S. egg industry is transitioning from caged to cage-free housing systems. Problems that were absent in caged facilities are becoming increasingly prevalent in cage-free systems. The resurgence of blood-feeding ectoparasites is one of these problems. Bedbugs are now becoming common in cage-free systems. Research has shown that bedbug infestations in poultry houses can result in anemia in laying hens and up to a 10 percent drop in egg production. Many small flock owners utilize free-range management systems, making their operations highly susceptible to bedbug infestations.

Bedbugs can cause irritating white welts on the skin of chickens. Large infestations in a flock will lead to excessive feather loss, cloacal irritation, and lesions on the breasts and legs. In severe cases, the birds will become anemic.

Infested poultry houses can be a source for bedbug infestations in workers' homes. The bedbugs hitch rides on clothing, boxes, and bags. In addition, bedbugs can spread between farms on shared equipment.

Bedbug Control in Poultry Houses

Limited information is available on which chemical or non-chemical methods are effective in eradicating bedbug infestations in poultry houses. One limitation is that chemical treatments used in other facilities, such as people's homes or hotels, cannot be used in poultry houses while live birds are present and producing meat or eggs for human consumption. As a result, different strategies need to be devised for use in poultry houses to prevent the introduction of bedbugs, to treat the houses if infestations occur, and to prevent them from spreading to other areas.

Bleach is often used to kill microbes in poultry houses. Household bleach has 5.35 percent available chlorine, while industrial

bleach has 12.5 percent available chlorine by weight, or 15 percent by volume. Bedbugs are hard to kill due to the impermeability of the exterior cuticle, but when 25 to 50 percent industrial-grade bleach was sprayed directly on bedbugs, 70 to 100 percent of bedbug adults and nymphs were killed within 24 to 72 hours. In addition, 25 to 50 percent industrial bleach killed all bedbug eggs (zero percent hatch rate). The efficacy of the industrial-grade bleach is dependent on the direct application of the chemical on the insect body or egg. This direct contact may be difficult because the bedbugs hide in cracks and crevices and may avoid the bleach application.

Bedbugs can live three months without a blood meal, but they can also feed on alternative hosts, such as rodents, barn swallows, or humans, when poultry are not present. Any control of bedbugs in a poultry house, therefore, needs to include stringent rodent and wild bird abatement programs. The foundations and eaves of the roofs are often overlooked as entry points for bedbugs. Exterior application of insecticides is recommended.

Bedbugs do not travel far from their most recent blood meal. This makes nest boxes, roosts, slats, curtains, and support posts ideal hiding places for them. It is important that all people working with poultry or entering the poultry house be trained in bedbug identification. Clothing and other items that move between poultry houses and homes should be inspected regularly. Bedbug traps can also be placed in nest boxes as an early detection system.

Bedbugs feed on poultry at night and hide in cracks and debris within the poultry house during the day. Treating the birds is not effective in controlling an infestation. Treatment must target all cracks and crevices, as well as the corners of the buildings. Because of the time required for bedbug eggs to hatch, repeated insecticide treatments are necessary.

The main insecticides currently recommended for the treatment of external parasites, including bedbugs, are pyrethrum-based. However, many parasites have developed resistance to such pesticides. Bedbugs are extremely waxy insects and are very resilient to dehydration. Dust formulations containing silica gel or diatomaceous earth (DE) are often anecdotally cited as being effective in controlling pyrethroid-resistant bedbugs, but there is very little scientific literature to support the use of DE. Diatomaceous earth can also be dangerous to the birds and caretakers if inhaled.

Resistance to several different drug classes has been observed with many of the external parasites that can affect poultry. Resistance is caused by genetic mutations, which occur naturally in the population. When a type of drug is first introduced, resistance genes will be rare. As the frequency of treatment increases, selection pressure on the resistant gene increases, resulting in an increase in the number of resistant organisms in the population. Due to the short life cycle of bedbugs and their high reproductive capacity, resistance can spread rapidly through a population.

Different insecticides are being considered, although there is also considerable interest in developing biological control methods and vaccinations to control external arthropod parasites.

Researchers are currently investigating a new group of insecticides, insect growth regulators, which are synthetic mimics of natural arthropod hormones and enzymes. The result is prevention of arthropod growth and development. There are several categories of insect growth regulators. The two main ones are juvenile hormone analogs and chitin synthesis inhibitors. The juvenile hormone analogs mimic the hormone involved in the molting that occurs between different life stages. Such products have been used to treat crop and household pests. There is currently one licensed product available for bedbug treatment that is approved for use in poultry houses: Gentrol, sold by Zoëcon Professional Products (https://www.zoecon.com). Insect growth regulators have been successfully used to treat housing for bedbugs. The bedbugs die during molts that occur after the treatment. Unfortunately, in order to go through a molt, the bedbugs must first have a blood meal. So the use of insect growth regulators as a treatment for bedbugs requires that the birds be available as a blood source.

Chitin synthesis inhibitors have also been investigated. They work by blocking the production of chitin, a major component of the outer cuticle of arthropods. While many chitin synthesis inhibitors are currently available for plant pest species, there are few for pests affecting humans and domestic livestock and poultry.

A biological control would offer an environmentally friendly alternative to the use of insecticide and acaricide drugs. It would also provide a parasite control tool for organic poultry producers. Various types of biological control have been investigated, including essential oils and fungi. Azadirachtin is a naturally occurring compound produced from the neem tree (*Azadirachta indica*) that has been observed to deter feeding and disrupt growth in many arthropod species. There are many pest control products containing azadirachtin available for treatment of bedbugs in poultry facilities. An example is AzaGuard by BioSafe Systems.

Many plant extracts and essential oils have been tested as potential insecticides. Bush tea (*Lippia multiflora*) extracts, chamomile extract, cassia and cinnamon oils, and garlic extracts have been studied. Initial successes are encouraging, and natural plant products are commercially more appealing than chemical pesticides.

Fungal-based pesticides have been used in the control of crop pest species for many years. There has been some research into their potential in controlling human and animal parasites. Although in vitro results are promising, application in the field has been challenging.

An additional insecticide being investigated is spider venom. There have been some promising results, but a method of application has not yet been developed to make the products commercially available.

Research is also ongoing into a commercial vaccine to control bedbugs and other external parasites. A commercial vaccine was developed for the control of a tick (*Rhipicephalus microplus*) that can have an economic impact on cattle production worldwide. Vaccine use for tick control in mammals is feasible, cost-effective, and environmentally friendly. Unfortunately, the avian immune system is not as well understood as that of mammals, but various research groups are studying the immune response of birds to parasites. An effective criterion for the development of a successful anti-parasite vaccine is whether or not host antibodies are taken up by the parasite so that they can have a debilitating effect. Blood-feeding parasites would allow for the host antibodies to be ingested, making the potential of a vaccine feasible.

While there is active research to find alternative chemical controls for bedbugs in poultry houses, producers should only use insecticides that are approved and list poultry houses as approved sites for applications. Always read and follow all label directions.

Non-chemical Bedbug Treatments

To control external parasite infestations, alternative control methods need to be found. Temperatures of 45°C (113°F) have been shown to kill all stages within one hour. Temperatures above 60°C (140°F) will quickly kill all bedbugs. Whole-room heating, however, is not recommended, since it can cause the infestation to spread, as the bedbugs seek cooler temperatures. Steam cleaning of poultry houses, with particular attention paid to infiltrating all cracks and crevices, has proven effective. Application of heat after an insecticide treatment is often recommended.

Conclusions

Bedbugs are considered one of the most challenging insects to control. This is due to widespread insecticide resistance, current lack of effective insecticides, and the biology of the pest. Bedbugs hide in tiny cracks and crevices, making detection and control difficult. Scouting for and preventing bedbug colonization is one of the best methods for combating infestations. It should be a common practice to inspect clothing and other items that move between multiple poultry houses, or between poultry houses and caretakers' homes. Those who find bedbugs in their homes should consider hiring a pest management professional to eradicate the infestation before returning to their flocks. Any small flock owner who experiences a bedbug infestation in either the home or poultry house needs to address the problem as soon as possible to prevent transfer of infestations.

Historically, a succession of pesticide treatments has been used to control external parasites of poultry. Each one has appeared to be initially successful but has become less cost-effective over time, usually due to the emergence of resistance in the target parasites. It is clear that action must be taken to effectively manage these parasites, including the development of alternative insecticides and control methods.

Indications are that bedbugs will continue to be a home and poultry pest for many years to come. It is unlikely that a magical silver-bullet technology will be developed for controlling this pest. Research on bedbugs is required in many fields, but especially in the area of pest management. Prevention is easier than treatment. Early detection is key to control.

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