

# Roach Crossing's Cockroach Husbandry Guide

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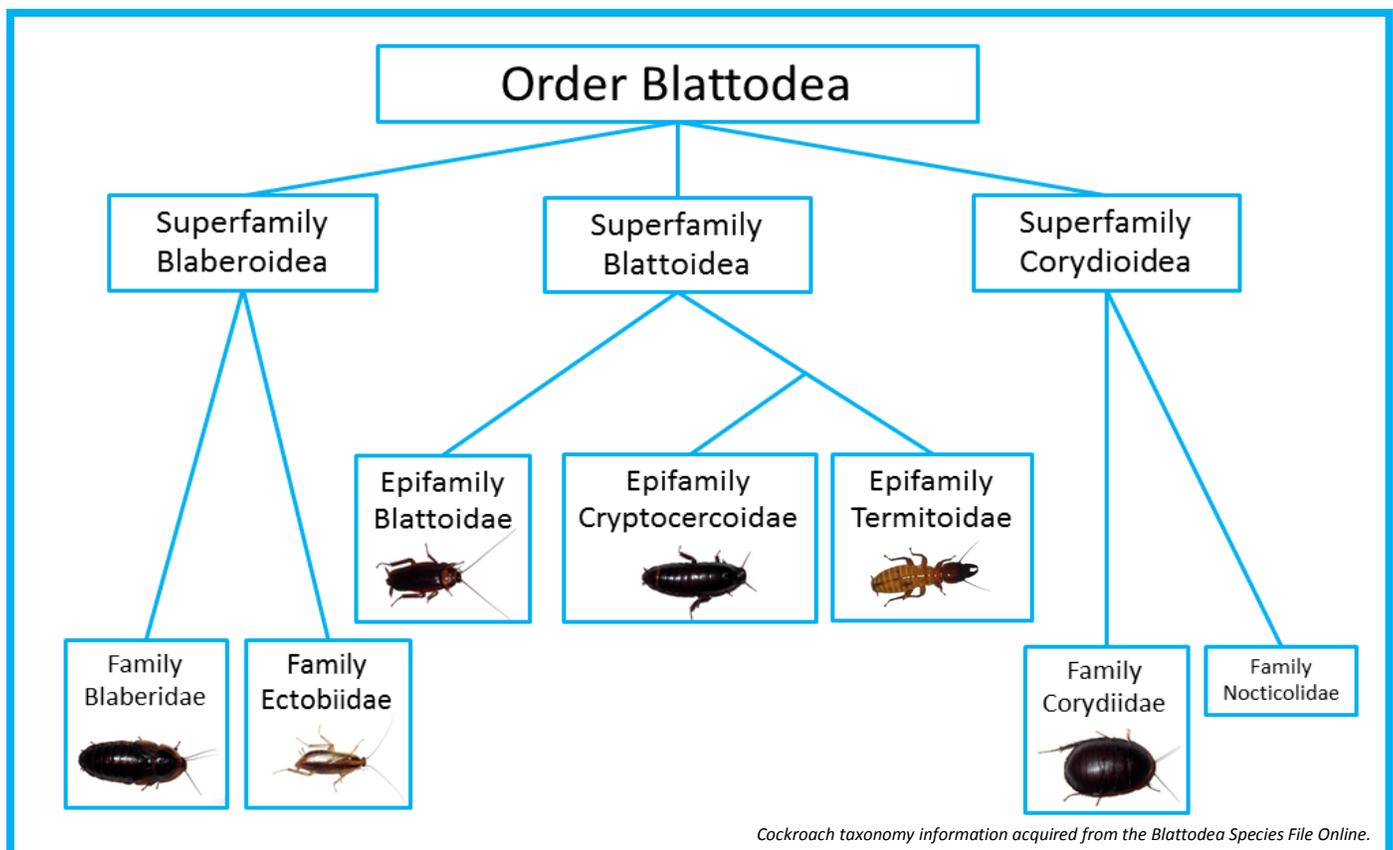
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## Introduction

Of all organisms reared in captivity, few rival the humble cockroach in its durability, prolificness, and tenacity. The ancient association of *Homo sapiens* and several species commonly referred to as pests extends thousands of years back in time, perhaps even to the very beginning of human civilizations. More archaic than this relatively recent union, it is not unlikely that the often commensal relationship between roaches and a mammalian host extends millions of years into the past, evidenced by present-day relationships between ancient roach lineages (such as the Corydiidae, or sand roaches) and modern hosts (burrowing mammals). It is on the basic premises of providing adequate food, water, shelter, heat, and space that most roaches thrive. Within the stable indoor microclimate of a properly equipped aquarium or plastic bin, it is easy and inexpensive to rear a thriving roach colony for feeding other organisms, watching, for research, and as an exciting and engaging hobby.

## Description

Cockroaches are members of the taxonomic class Insecta, order Blattodea. Within this fascinating order are several families and similar groupings, outlined below. Of these groups, the most frequently cultured species belong to the families Blaberidae, Ectobiidae, Blattidae, and Corydiidae.



In general, cockroaches are dorsolaterally flattened insects with chewing mouthparts, long, filamentous antennae, large pronota (head shields) hiding a sizable head, robust abdomens, and legs adapted to running or burrowing. Wing presence is highly variable; more familiar species are fully winged but many roaches may be wingless (apterous), partially winged (brachypterous), or minutely winged (microptery); even more interestingly, some species may have a mixture of different wing forms depending on sex and locality. Cockroaches become sexually mature after a final molt, during which time the wings emerge (if present) and the internal genitalia become fully developed. Reproduction occurs sometime after maturity and the time between an individual maturing and producing offspring can be as little as three months in some species (*Blattella germanica*), or as long as several years (*Macropanesthia rhinoceros*). Though some species are not exceptionally long-lived, the average of all possible roach adult lifespans (about 8 months) most likely exceeds the average adult lifespan of insects in general (best estimated at 3 months). To accompany their variable life span, cockroaches come in every shape, size, color, and habit imaginable, with members of the order confirmed on 6 continents (and rumored to be all 7). They thrive wherever they occur, from the hottest deserts to the slopes of Mount Everest. Surely, these incredible insects deserve more than a passing glance at best and indignantly thrown shoe at worst. It should come as no surprise that these sturdy creatures require easily obtainable supplies to thrive with even the newest hobbyist.

### Supplies

A roach enclosure can be as elaborate as a bio-active, densely-planted vivarium in a glass tank, or as simple as an old take-out deli cup. The scale of the enclosure depends on how many individual roaches one starts with; in general, it is best to start with a smaller than expected enclosure and move the colony into gradually larger enclosures as it grows. The dollar shoe boxes offered at many department and dollar stores are ideal for beginning most roach colonies; from here the 20 or so quart containers are an appropriate step up and so on. Most roaches do best with some ventilation; depending on the size of the species's offspring, brass microscreen, pin-head sized holes, or 1/16 inch (standard) aluminum window screening are all effective go-tos. For non-climbing species kept in glass aquaria, a screen aquarium lid is typically sufficient; additional screening or precaution will be needed for climbing or flying species.

Once the enclosure has been prepared, substrate and furnishings can be added. The substrate is perhaps the most vital component of the enclosure and is discussed at length in the following section. Décor for feeder roaches is typically egg carton or other shaped pulp products. These hold up best in enclosures with good ventilation and will easily collapse if kept moist for extended periods. In feeder scenarios where egg cartons are not effective, particle board or similar material can be cut to form then stacked or tilted vertically, providing there is consistent spacing. For more exuberant enclosures locally collected wood and bark, cork bark, and other fixings can be provided. Though they do run the risk of introducing potential pests and unwanted organisms into the colony, wood materials collected outdoors should not be feared due to potential "parasites" or "pathogens" in most cases. Heating such materials in a standard oven for 30 minutes at 300 degrees Fahrenheit is sufficient for sterilization.

Once the inside of the enclosure has been equipped, a viscous barrier will need to be applied if the enclosure will house a climbing species in order to prevent escape. Roach Crossing recommends petroleum jelly, though any persistent oily substance can be used, including cooking oils. Keep in mind that as with anything inside the roach enclosure, the barrier will be nibbled on and degraded over time and will need to be tended to. Fluon-based products can also be used as a barrier, though their effectiveness seems to vary depending on air humidity.

Perhaps the largest misconception in roach keeping is that they are creatures which crave heat; in many cases this is outright false. Many tropical species are nocturnal, avoiding both the heat and predators associated with the daytime and coming out at night to perform their vital activities. Despite the typical perception of the tropics being a consistently warm place, it is important to note that the average temperature difference between day and night is considerably greater than the temperature difference during different seasons. Elevated temperatures also decrease adult size and reduce the frequency and size of successful litters, despite encouraging rapid growth. For these reasons, Roach Crossing does not recommend keeping roaches consistently at temperatures exceeding 85 degree Fahrenheit, particularly considering many species appear to benefit from a night time temperature drop. Although there are a handful of species which thrive at higher temperatures (e.g., *Supella longipalpa*), these are certainly the exceptions to the general roach trend. Perhaps the ideal temperature range for most roaches is between 70 and 85 degrees Fahrenheit; infrequent dips above and below this range are usually not problematic.

If additional heating is needed for a roach colony, either raising the room temperature (i.e., ambient heat) or providing a basking light/ceramic heat emitter are the best options. Under tank heat mats are acceptable when other options are inviable, but are not ideal as roaches will burrow/hide under cover to escape heat and sunlight in the wild. Providing heat from the bottom up can prevent this behavior with potentially severe consequences.

Cage location is a matter of personal choice. Even mostly nocturnal roaches can deal with daily cycles in ambient light without ill-effect, though constant exposure to bright light without retreats can cause stress-related harm. Drafts and sudden temperature changes are typically not a problem, as a well-equipped enclosure with substrate will provide them with appropriate retreats should adverse conditions creep from outside the enclosure inward.

### **Substrate**

Lowly dirt always gets the soiled end of the stick. The opposite could not be truer with respect to roach keeping. Standing firmly next to proper housing and varied diet, substrate is one of the most critical components of a thriving roach colony. In addition to providing additional nutrition, substrate provides a temperature and humidity buffer zone, a comfortable place for young roaches to hide, and a bank of beneficial macro and microorganisms from which the roaches and keeper may benefit. Though many choose to forego a proper substrate, doing so ultimately decreases the vigor and overall health of the colony for most feeder and pet species.

The best primary component of a substrate mixture is coconut fiber, also known as plantation soil, coco coir, and several other commercial names. This miraculous substance is non-abrasive on the insect epicuticle, is wonderfully absorbent and water-retentive, light

enough for active burrowing, and considerably hygienic. It can be purchased pre-expanded in bags or in condensed brick form from most pet stores and some garden/hydroponic outlets. Ideally, the average particle size should be about 3 mm; the more powdery material does not seem as absorptive or beneficial.

Most species will thrive on coconut fiber alone, though Roach Crossing substrate mixes combine more organic materials and two particle sizes of coconut husk materials (the aforementioned approximately 3 mm particles and the larger variety often sold as coconut husk or chip). A good mulch is appreciated and helps aerate the substrate; hardwood mulches must be used as softwoods (pine, spruce, fir, cedar, etc.) release aromatic insecticidal compounds over time. Well-rotted wood from outdoors can also be used, preferably sterilized. Leaf litter is readily consumed and is usually the first substrate component in need of replacement. Roach Crossing has used oak, beech, birch, maple, sycamore, magnolia, apple, and cherry leaves without problem, though oak is the leaf of choice as it appears to decompose in a manner rendering irresistibly tasty to roaches. It is important that the leaves are dead, dry, and brown; dried greens leaves may retain chemical defenses harmful to roaches. When experimenting with new leaves and wood types, offering a small amount to a colony over time and monitoring the response is an effective way to test their safety.

Other possible substrate additions include sphagnum moss (to provide excellent substrate aeration and microbial activity), sphagnum peat moss (inexpensive and retains water well), aged manure or compost (additional nutrition), and vermiculite (substrate aeration). Despite their name, it is not recommended to keep sand roaches (or any roaches) on sand-based substrates; sand is very abrasive to the insect epicuticle and it is difficult and ineffective to replicate the oasis-like microhabitats encountered by wild sand roaches. Considering there are other effective and accessible substrate components, it is wise to avoid sand.

A gradient of substrate moisture is important for most roaches. Providing a front-back or top-bottom substrate humidity difference allows the roaches to find just the right spot to rest. This can be accomplished by selectively adding water to the substrate/misting one corner or half of the enclosure during regular maintenance. When given proper substrate, most roaches do not require an additional water source (e.g., daily misting, water crystals) and can regulate their hydration without problems.

## Feeding

In addition to sharing our dwellings, another delightful roach trait is their polyphagous nature. Simply put, they are willing and delighted to feed on most of the same food items humans do. Although a roach colony can be maintained on a diet of dog food, carrots, and apples alone, it is much more fulfilling to provide them with meal scraps and unused/spoiled produce. There are very few things a thriving roach colony won't eat, with tomatoes and potatoes ranking near the bottom of their culinary delight lists.

Without belittling their wide appetite, Roach Crossing's colonies are regularly fed apple, banana, orange, pear, squash, apricot, nectarine, peach, tangerine, plum, lettuce, zucchini, carrot, cucumber, pumpkin, sweet potato, and eggplant, topped off with a conservative portion of dry brown dog kibble. It can be very entertaining to watch each roach claim a spot on a chunk of food as it is whittled away over hours (or sometimes minutes), and I encourage roach keepers to experiment with new food items for their roaches. The only foodstuffs that should

be offered with caution are tree nuts (which contain natural insect-nibble deterring chemicals and insecticides) and raw meat (which poses a sanitary risk for the keeper). Residual pesticides are typically not an issue but are discussed in the “Cockroach Health” section.

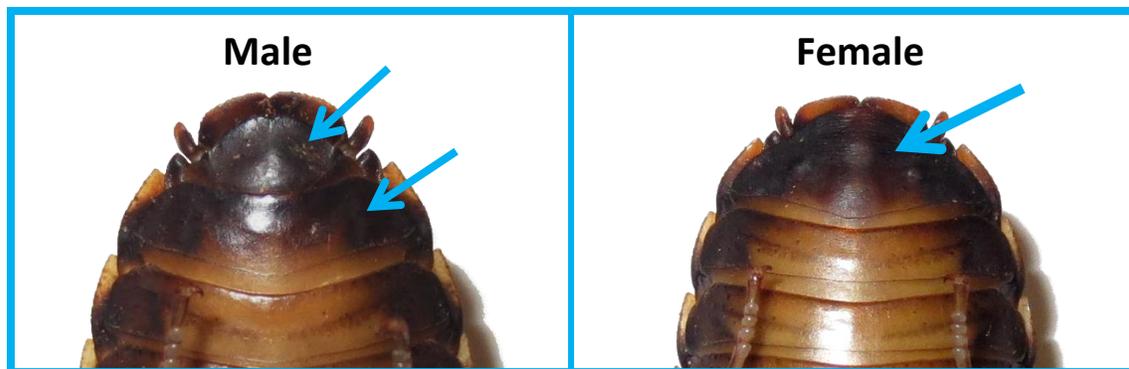
It should be noted that powdered roach diets do not provide ideal nutrition. It has been established that roaches are driven to select food items based on their present micro-nutrient needs and do best when given a selection. Feeding a powdered diet bombards the roach with nutrients it may already have in excess, decreasing fitness and reproductive ability.

Excessively proteinaceous diets (those where only or mostly high-protein foods, such as cat food, are offered) are detrimental to cockroach fitness as well. Thanks to their internal nitrogen-recycling symbiosis with bacteria, cockroaches are able to thrive on lower protein diets. Providing only protein or high-protein foods can cause gout and ultimately death in species not equipped to deal with it. Some species are capable of passing extra nitrogen in the form of white fecal pellets (*Parcoblatta sp.*, *Paratemnopteryx sp.*), but are not immune to the effects of an overly protein-rich diet. It is thus important not to over supplement in this regard.

In terms of how much to feed, this varies greatly by colony size and species. Often, a zealous keeper will over-feed a small colony of new roaches, only to panic when little of the food is consumed. In these situations, it is best to gauge the colony’s appetite over some time: ideally, all food should be consumed within a few days of being added. Food can be provided ad infinitum as long as older material is consumed as fresher material is added. Large quantities/pieces of durable food items (sweet potatoes, apples, carrots, and zucchini) can be provided prior to extended vacations and effectively fill the colony’s nutritional requirements for weeks.

### Sexing and Breeding

Most cockroach species are sexually dimorphic externally. In hissing cockroaches, this is obvious in the “horns” of the adult male and relatively smooth pronotum and thicker abdomen of the female. In other species, males are typically less robust and smaller than females; males are also often winged while females err towards brachyptery or aptery. Fortunately, even in species where males and females seem identical, most roach species may be sexed ventrally as early as the third instar using the below method.



***In most male roaches, there are two small segments on the bottom side of the end of the abdomen; females have one larger segment. The segments of very young roach nymphs tend to look male. Cryptocercids cannot be sexed using this method.***

Assuming all of the previously discussed parameters have been met, a mixed-sex group of roaches is almost guaranteed to reproduce. If a group of roaches has been in your possession for over a year without reproducing, consider the following:

1. Are the roaches sexually mature? If so, are both sexes present?
2. Are the roaches comfortable? Is there too much or too little space?
3. Is the temperature sufficient for reproduction?
4. Is the diet varied? Are the roaches offered a good selection?
5. Is there a substrate humidity gradient? Do they appear to favor one end over the other?
6. Is a long gestation typical of this species?
7. Is container escape-proof, both for the adults and newborns of the species?
8. Do the roaches need a diapause to mature or reproduce?
9. For egg-laying species, is there a sufficiently moist or appealing place to deposit oothecae (egg cases)?
10. Are the roaches in good physical condition? Do they appear vigorous, or do they appear too old to reproduce?

If the above series of inquiries does not yield any insights, it is possible the species may require something quirky to reproduce (a particular food, certain structures or substrate, temperature cycles, etc.). One of the most rewarding aspects of roach keeping is “cracking the code” to a difficult or challenging species; it is incongruent with Roach Crossing’s experience that any roach is unbreedable. It may simply take time, persistence, or creativity to figure the species out.

### **Family-Specific Set-Ups**

Many of the large, charismatic roaches in culture are members of the family Blaberidae. These subtropical and tropical insects mainly dwell in soil, leaf litter, rotting logs, and caves, and are adapted to consistently moist conditions. Likewise, members of the family Blattidae can be found in similar environments and appreciate similar housing. However, members of the three other frequently cultured cockroach families have representatives adapted to different habitats and may require differently outfitted enclosures.

#### **Family Corydiidae**

Usually referred to as “sand roaches”, Corydiids can be found in caves, deserts, under bark, and many other places. This family retains some traits considered ancient among roaches, such as the formation and shape of the wing veins. Despite the common name, Corydiids do not fare well on sand in captivity. In the wild, even those species found in sandy habitats may not extensively burrow through sand; in the case of *Arenivaga sp.* from the southwestern United States, the roaches tend to sit in the light duffy mixture of droppings, plant material, and bedding that accumulates at the bottom of rodent burrows. Other genera, such as *Eremoblatta sp.*, may be better suited to a life of abrasive sand-digging as suggested by the dense fur which envelopes the body, protecting it from excessive contact with sand particles. If the abrasiveness is factored out, it is still important to note that it is difficult to regulate the humidity of a primarily sand substrate; too much water causes compaction preventing or discouraging

burrowing. Too little water and abrasive substrate can cause immediate and fatal abrasion of the epicuticle.

It is therefore recommended to keep Corydiids on a substrate of dry coconut fiber. Even when dry to the eye, coconut fiber still retains water that can contribute to the air humidity of the enclosure micro-climate. Some Corydiids, like *Arenivaga sp.*, are able to absorb water directly from the air using specialized mouth parts, and humid air in an enclosure with seemingly dry substrate allows them to make use of this skill. It is still advisable to provide a moist corner of substrate, as adult males seem to lack this ability

Other Corydiids prefer more humid substrate with good ventilation in the air column. The infamous *Therea sp.* and *Ergaula sp.* fall into this category. Allowing the top 1/3 of the substrate to dry while maintaining typical humidity in the remainder allows the roaches to vertically orient themselves in the substrate column, and providing a front-to-back gradient provides the ideal spread of options.

### Family Ectobiidae

The Blaberidae and Ectobiidae form the clade Blaberoidea, and the similarities between these groups is visible when observing the sub-anal plate of the adults. Ectobiids are typically tiny roaches about a centimeter or so in length, but also include the titanic *Megaloblatta sp.* They tend to be quick, prolific, and numerous, even in the wild. Their habitats include homes (in the case of *Blattella germanica* and *Supella longipalpa*), leaf litter, grassy areas, and under bark. Despite their small size and fecundity, many of the tiniest species have proven tricky to culture.

After numerous attempts to culture small Ectobiids, a breakthrough was made by reverting to classical roach keeping. Though not as hygienic (covered in detail in the next section) as holistic, substrate-based set-ups, traditional roach set-ups consist of a piece of egg carton and food dish. The **SESU**, or **Simple Ectobiid Set-Up** combines this insight with frequent care. It consists of a 64 ounce deli cup (typically used for shipping and displaying organisms, as well as for fruit fly cultures), cloth lid, several pieces of bark (if the species was collected from it) or egg carton, and food pieces (which are added to a convenient spot within the set-up as needed). Care must be taken to mist the culture frequently; ideally, daily or once all water droplets on the sides of the container have disappeared.

The keystone to this set-up involves the intricate osmoregulation and immunology of Ectobiids which inhabit strongly ventilated habitats. Those species which frolic through the upper, thoroughly dry portions of leaf litter are able to retreat into the lower, humid areas when necessary to preserve body moisture until they are able to drink standing water or receive it from moist food items. Persistently wet conditions (those otherwise preferred by some roaches) can cause two problems:

1. Inability to properly osmoregulate. With constant humid or dry conditions, the roach either retains too much or too little water and dies. Misting in the aforementioned manner allows the roaches to rehydrate as-needed while preventing lingering water.
2. Presence or growth of detrimental organisms. Moist conditions within a roach colony are conducive to the growth of some bacteria and fungi; proliferation of an otherwise harmless variety may overwhelm the immune system of roaches unadapted to dealing with persistent fungal or bacterial pathogens. The ventilation and relative sterility of this set-up discourages growth of these other organisms, keeping roach-pathogen interaction at levels encountered in the wild.

The **SESU** should be used as a quick go-to or stepping stone for figuring out the care needs of novel tiny and small Ectobiids, though it is also effective for some non-Ectobiids with similar habitat preferences.

### **Family Cryptocercidae**

The Cryptocercids, or hooded roaches, represent a unique evolutionary split in the roach family tree, branching off from their closest stereotypically “roach-y” relatives (the Blattidae), before splitting from their closest kin: the termites. Intriguingly, their overall build resembles that of the unrelated hissing cockroaches (Gromphadorhini), perhaps due to convergent lifestyles of living in and under rotting logs. Their namesake cryptic habits, gut microorganism communities, and dutiful parenting skills have long made them subjects of both professional and scientific intrigue.

For years it was believed that Cryptocercids were not easy to cultivate. Speculation ran amok, blaming the sensitivity of their gut flora to heat and cold, shipping stress creating hyperoxic body chemistry, the need for family units to pass microorganisms onto young individuals, and the old standby of failure to thrive in captivity. Despite years of unsuccessful culture attempts under these assumptions, an extremely practical breakthrough was pioneered by roach enthusiast Mark Mayer. Cryptocercids can be reared solely on powdered cellulose, which is readily available as a cosmetics and dietary additive. Simply fill the desired enclosure with powder, hydrate it until it forms a homogenous clump, add the roaches, and enjoy. A 16 quart enclosure filled  $\frac{3}{4}$  with cellulose powder can conceivably last a fledgling colony of a dozen mixed sized *Cryptocercus* a year or more, making what was once believed to be a difficult species into perhaps the easiest and lowest maintenance roaches.

As to why earlier attempts failed, Roach Crossing has a few speculations. Wood collected outdoors, even when properly sterilized, may contain fungal spores which can infect the substrate and stress captive colonies. It is also possible that certain fungi break down the cellulose in wild wood to the point that it is no longer nutritious for the roaches. Prior assumptions regarding the “delicate” nature of Cryptocercids may also have led to incorrect husbandry, creating conditions that were too moist or poorly ventilated.

### **Cockroach Health**

The popular culture depiction of cockroaches is of an indestructible nuisance capable of surviving a nuclear blast, decapitation, drowning, starvation, and essentially every horror nature could dish out. This could not be further from the truth, as millions of cockroaches perish each day due to parasitoids, viral infections, fungal attack, and bacterial illness. It is imperative to note that the conditions which afflict roaches do not affect humans; they are simply organisms and pathogens with harmful effects on the physiology of roaches and their relatives and are of no threat to mammals. That being said, the roach immune system is quite impressive, and there is much to be learned from it for the benefit of human medicine. In captivity, the average roach has been isolated from its wild kin for many generations, feeding on a completely different diet and under relatively cushy care. Occasionally, a long-term captive colony may have health issues arising from accidentally introduced pathogens, inadvertent changes in husbandry, or physical damage. See the following table for approximate diagnoses.

Condition	Symptoms	Severity	Causes	Treatment
Aborted oothecae	Unhatched oothecae from live-bearing species in the enclosure	Mild	Stress, unknown	Check husbandry to ensure proper conditions
Cannibalism and wing-biting	Decreasing population size, freshly molted individuals with missing body parts, tattered wing tips	Mild to Severe	Dehydration, malnutrition, starvation	Increase food variety and/or quantity, mist or provide water source, or increase frequency of feeding and watering
Densonucleosis virus	Excessively swollen abdomen, organ prolapse	Severe	Unknown	Lethal but not highly contagious
Entomophagous fungus infection	Recently dead individuals with white or green fungus covering the body	Mild to Severe	Fungal spore presence and/or stress	Lethal to some roach species; increase ventilation and/or decrease humidity
Hyperpigmentation disorder	Increased contrast between normally dark pigment areas and light/translucent areas	Mild	Low temperatures	Increase temperature
Hypopigmentation disorder ("Reddening")	Abnormal red or orange coloration, decreased reproduction, mismolting	Mild	Dehydration	Increase humidity, mist or provide water source
Mites, cement	High-density, whitish mites clinging to body segments, on upper legs, and on face	Moderate to Severe	Overfeeding, wet substrate	Isolate unaffected individuals, manually remove mites using fingernails or stiff brushes, change substrate, feed sparingly until no mites are detected
Mites, commensal	Fast-moving, dark red mites crawling across the body surface and between the leg joints of hissing cockroaches	Harmless	None	None
Mites, scourge	Shiny reddish mites clinging to and feeding on limbs, abdomen vent, or mouth; infesting substrate	Mild to Moderate	Unknown; possibly due to wet substrate	Remove and keep roaches dry for several days, change substrate, feed sparingly until no mites are detected
Old age	Missing limb tips, tattered wings, discolored patches on body, lethargy, broken antennae	Mild	A life well-lived	Personalized care

Organ prolapse	Organs extruding from the abdomen tip, appearing balloon or “worm”-like	Severe	Physical trauma, viral infection, unknown	Lethal in most cases; euthanize
Pesticide poisoning	Lethargy, unusual and uncoordinated twitching movements, inability to flip over when on back	Moderate to Severe	Contaminated food or substrate	Lethal to most infected individuals; wash and carefully select produce; ensure the substrate does not contain softwoods
Red bacterial (?) infection	Recently dead individuals or living individuals with non-functioning reddish limbs and other body parts	Mild to Moderate	Wet conditions or low ventilation	Decrease humidity or increase ventilation
Wing, limb, and body deformities; mismolts	Curled, tattered, deformed, or torn wings; missing or twisted limbs and bodies	Mild to Severe	Dehydration, overcrowding, malnutrition	Increase humidity, increase diet variety, increase enclosure size or cull, or provide vertical surfaces for molting

***It is important to note that although some conditions are reversible in roach nymphs, many illnesses cannot be fixed in adults.***

### **Clean-Up Crews and Enclosure Pests**

Nature exists as a complex, integrated system. In some cases, removing a single gear in this metaphorical machine can have dramatic consequences on the whole. It has been the tradition in laboratory and zoological practice to keep each species in a relatively sterile, tightly monitored system. While this ideology has its place in rigorous experimentation, it is not always ideal from an aesthetic and functional standpoint. In roach cultivation, it is usually healthier and more practical to maintain a small ecosystem within the enclosure, replicating the various roles performed by a diverse cast of organisms in the wild. Scavengers, aerators, decomposers, and predators may all be introduced with purpose into roach colonies to better replicate wild conditions and to deal with roach waste and pests when the roaches themselves cannot.

In large-scale feeder roach set-ups, there may sometimes be an abundance of deceased adults, and with the large number of individuals there can be occasional (but unsubstantial) losses of nymphs due the rigors of mass-production. In these cases, clean-up crews may be introduced to prevent the reproduction of pest organisms and to improve the aesthetics.

On the other end of the spectrum, even decorative and pet roach breeding set-ups have their problems; mold on uneaten food, deceased adults, and competing organisms can cause problem in certain scenarios. Clean-up crews can be used in these situations to reduce or prevent mold, consume roach frass, outcompete detrimental organisms, or simply add to the look of the enclosure.

The table below includes some common pests and problems encountered in roach rearing, as well as suggested clean-up crews for dealing with them. Some issues may be fixed without use of a clean-up crew, though having one present substantially reduces the need for frequent maintenance.

Problem	Description	Causes	Clean-Up Crew
Food mold	Variably colored molds growing on or engulfing food items	Overfeeding, high moisture or low ventilation	Springtails, isopods, amphipods
Frass build-up	Exuviae (shed exoskeletons), hatched oothecae, and carcass bits accumulating in the enclosure	Typical of healthy colonies; excessive build-up due to colony problems	Springtails, isopods, amphipods
Fruit flies	Tiny, yellow to brown flies with bright red eyes. Tending to hover about the enclosure, resting on fruit or vegetables.	Overfeeding	Isopods, amphipods
Fungus gnats	Tiny, black flies. Relatively delicate-looking, tending to flutter clumsily about the enclosure	High substrate moisture and/or organic matter content	Isopods, tiny rove beetles
Grain mites	Microscopic, white-ish mites, often forming a "powder" around grain-based food items or on the enclosure sides.	Overfeeding	Springtails, isopods, amphipods, lesser mealworms, dermestid beetles (depending on enclosure humidity)
Phorid flies	Tiny to small brown flies. Prefer to scuttle around the enclosure, moving in short spurts. Usually found on dead roaches or very rotten food items.	Overfeeding, overcrowding, frass and carcass build-up.	Lesser mealworms, dermestid beetles, isopods
Substrate mold	Fluffy or fuzzy molds carpeting the substrate	Overfeeding, frass build-up, strong fungal presence in substrate, high moisture or low ventilation	Springtails, isopods, amphipods
Unpleasant odor	Foul or discouraging smell wafting from the enclosure	Overfeeding, overcrowding, wet conditions, numerous other causes	Springtails, isopods, amphipods, lesser mealworms, dermestid beetles (depending on exact cause)

## Cohabiting Species and Hybridization

Unlike hobbies such as fish-keeping, which have had decades to experiment with mixed-species enclosures, roach keeping has not yet explored this fascinating and potentially groundbreaking concept. In general, roaches are not aggressive or defensive insects and many are more than content to commingling as long as there is apt space and resources. It is advisable for those seeking to culture multiple species in one enclosure that a good amount of space be given to allow each its own special niche. Species of dissimilar habits, such as burrowers and climbers, may be suitably accommodated if given enough space. Differently sized roaches are also good candidates for mixing, as this can enable spatial separation of the species by providing décor that only the smaller species can access. It is likely that within the next few decades as the understanding and popularity of roach keeping continues to increase, cohabiting multiple species in luxurious planted and outfitted enclosures will become commonplace.

It is **critical** to note that some roach species will hybridize readily if kept together, with two popular examples being some *Blaberus sp.* and *Gromphadorhina/Princisia sp.* crosses. Hybridization is detrimental to the keeper because it:

1. Dilutes the genetic composition and identity of a species or strain which may already be rare in captivity
2. Contributes to misinformation about the phenotype of the species
3. Runs the high risk of distribution of hybrid stock as pure stock among those unversed in roaches (which may lead to contamination of pure stock as well)

Some hobbyists argue that as captive organisms, it is in human interest to create hybrids in search of desirable characteristics like new colors or vigor. In Roach Crossing's experience, hybrid roaches tend to be smaller, less vigorous in growth and reproduction, prone to deformities, and frequently plagued by spontaneous death. Their appearance often tends to be a muddled or pastiche version of the parent species' colors, and while it is conceivable such variations could be selected for and modified, it may ultimately take more time and effort to do so than if one were to do the same using pure stock.

The following genera/species groups that have been proven to hybridize in captivity (as well as those in which hybridization may be possible) are shown below.

Proven Hybrid-Forming Groups	Suspected Hybrid-Forming Groups
Gromphadorhina portentosa Gromphadorhina oblongonota Gromphadorhina grandidieri Princisia vanwaerebeki	Elliptorhina sp. Therea sp. Gyna sp.
Blaberus discoidalis Blaberus boliviensis Blaberus parabolicus Blaberus atropos Blaberus sp. "Venezuela"	Rhyparobia sp.
Blaberus craniifer Blaberus cf. peruvianus Blaberus fusca	Eurycotis sp.

## **Conclusion**

From their humble beginnings in the Carboniferous era over 300 million years ago to their current global presence, cockroaches have intrigued, disturbed, and persisted with man as long as man has existed. Be it as household pests or pets, the fates of cockroaches and humans are forever intimately intertwined. With time, perhaps the world will gain a greater appreciation for these rugged survivors, regardless of whether they are encountered in the urban jungle or elsewhere. For now, those of us who cultivate and admire them must do our best to share and spread our passion, just as our six-legged subjects have spread across the planet.

## **Acknowledgements**

I would like to thank all of the keepers who pioneered roach husbandry, especially Dr. Louis Roth for his extensive research, invertebrate guru Orin McMonigle for building the foundation of blatticulture, and long-time hobbyist Peter Clausen. To my field work and husbandry discussion friends Kim Wismann, Alan Jeon, Satchell Watts-Kerr, William Samojeden, Samson Braden, Kim Klisiak, Eric Rosenberg, and Benjamin Senigaglia, thank you for the hours of rigorous discussion and support in all my projects. A huge thank you is due to Mark Mayer and his breakthroughs in rare roach husbandry as well. To my girlfriend Kati Tatseos and her tireless work on the technical side of [www.RoachCrossing.com](http://www.RoachCrossing.com) as well as her bottomless support for my occasionally overzealous enthusiasm, I am particularly grateful.

To all of my customers, thank you for years of support, encouragement, and patronage. Roach Crossing in its total form would not be possible without you.

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