Think Like a Rat!

Understanding rodent behavior is one of the first steps to successful identification and control of this worldwide pest. This knowledge allows PMPs to make informed decisions when designing and implementing rodent control programs, resulting in satisfied customers and increased profits.

EXCERPT FROM **MALLIS HANDBOOK,** 11TH EDITION!

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Editor's note: **The Mallis Handbook of Pest Control** *has been an essential educational resource for pest management professionals for nearly eight decades, documenting the biology, behavior and control of virtually all structural pests they encounter. Later this year, PCT's parent company, GIE Media, will publish the eagerly anticipated 11th edition of this 1,300+page reference book featuring editorial contributions from some of the industry's most respected university educators, independent consultants and urban entomologists.*

In the following excerpt, Dr. Robert M. Corrigan, a frequent speaker at industry trade shows and educational events, shares his rodent control insights and offers PMPs real-world information on the behavior of rats. For information about the references mentioned here, visit bit.ly/3JccnWU.

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Rats and mice belong to the mammalian order Rodentia (from Latin rodere: to gnaw) and are characterized by a single pair of continuously growing incisors in each of the upper and lower jaws. The earliest record of rodents comes from the Paleocene Period shortly after the extinction of the non-avian dinosaurs about 66 million years ago.

Rodents are among the most successful mammals on Earth. A substantial portion of this success is due to their high adaptability, allowing them to colonize extreme variations among the Earth's different environments.

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The following excerpt will assist PMPs in gaining a better understanding of the behavior of rats, thereby providing a foundation for the successful identification and control of the most problematic species impacting their customers.

RAT BEHAVIOR. Because rats can adapt themselves to a great many environments, some aspects of their behavior can vary considerably. A city Norway rat may behave strikingly different than a country Norway rat living in a rural horse barn. Thus, it is important to be cautious when attributing certain set habits to one species or the other under different conditions.

The black rat, for example, is a better climber than the Norway rat, although the Norway rat also climbs vines and trees and utilizes attics, suspended ceilings, and other aerial sites. By the same token, roof rats will inhabit sewers and/or construct and use ground burrows.

Activity Periods. Generally, rats have two peak activity periods — one within the hour following sunset and again just before dawn. But rats will alter or even reverse their activity periods from night to the day depending on human activity, competition, and the availability of food or water resources.

In the different neighborhoods of New York City, most of the Norway rat colonies are active during the night, but the specific peak times of the night for a particular colony varies to a large degree on the refuse collection profile of the area (closing times of restaurants, building superintendent schedules, garbage collection times, etc.).

On a quiet street behind a large office building, rats may begin foraging within the hour following darkness. But a rat colony raiding the fresh discards of a fast-food restaurant in a nightclub district are most active in the early hours of the morning (2:00-4:00 a.m.) after the nightclubs shut down.

A rat or two seen during the day, especially if they are young rats, does not necessarily indicate a severe infestation. For example, rats infesting horse stables and zoos often exhibit peak activity periods when manure or animal feed are most available.

In undisturbed areas, and if they remain unmolested, rats may roam about, seeking food and mates during any part of the day or night. But if rats are reported both day and night,

Figure 1. The Norway rat is a burrowing rodent. In severe infestations, the earth will be heavily undermined, and many burrow entrances and exits will be constructed and used.

and the daytime sightings are frequent without any obvious explanation of food resources, a fast-producing infestation is likely. For pest professionals, analyzing each infestation according to local conditions is mandatory.

Harborage, Burrows & Nests. Rats and mice in urban areas often utilize different types of harborages. Harborage sites provide rodents protection from cold, heat, and rain, as well as from most (but not all) predators.

Some harborages provide protected travel paths as rodents forage within their territories or disperse to uncolonized areas. Within some harborages, nests are constructed for rearing young, resting, and storing food.

The primary harborage and nesting spaces of urban rats vary according to the species and specific locale. In general, Norway rats are ground-burrowing animals, and the roof rat is an aerial-nesting species. Both species, however, may construct nests in ground and/or aerial areas depending on the location and the profile of the rat's predators, resources, and competition from other rodents in the location.

Because the Norway rat originated in the grassy steppes of Central Asia, it is primarily adapted to digging ground burrows for its shelter (Figure 1). Provided any available earthen spaces are suitable, rats will nest in underground burrows even when nesting places are available within adjacent buildings.

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The typical rat burrow is 2 to 3 inches in diameter, with lengths varying between 1.5 to 6.5 feet, containing two or more entrances and a central den. Burrows rarely extend more than 18 inches below the ground, but rats may burrow 4 feet or more to get in — or out — of buildings.

Roof rats also have been recorded tunneling under foundations extending more than 30 inches below the surface of the ground. If a slope exists in earthen areas vulnerable to Norway rat burrowing, the rats establish their burrows in the high end of the slope, thereby facilitating drainage of rain waters and reducing the risk of constant wetness and flooding of nest chambers (i.e., where immobile, vulnerable pups

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may be present).

To construct the burrow, the rat digs the earth in the tunnels with its front feet and shoves the loose soil back under its belly. The rat kicks the soil back with the powerful strokes of its hind feet. It then turns around and pushes the soil along with the forepart of its body.

Active burrow holes have a smooth, well-worn appearance at the entrances. Inactive entrances often are covered with vegetation or cobwebs. To confirm an active burrow, it is best to collapse the burrow and recheck the next day.

Often, one or two "bolt holes" exist within the tunnel system, permitting an alternative route for fast exit or entry in times of danger. Bolt holes may be hidden under grass or boards, or they may be exposed areas and lightly plugged with earth, leaves, scraps of litter, and other materials.

New burrow holes from perhaps a young rat arriving to establish a new home may only be 1 to 2 inches in diameter. In systems that have been established for years, and/or are part of large infestations containing many reproducing adults, the main entrances can become main thoroughfares and have diameters of 6 to 8 inches.

In urban areas, rats often utilize the constantly occurring cracks, crevices, and holes of sidewalks, streets, curbs, and structural foundations to access the various void spaces within or below. In most cases, rats utilize openings in these areas that have enough space to allow quick entry (i.e., diameters of 1 inch or more).

To confirm rat use of these types of burrow entrances, it is best to look for hair and/or the greasy stains around the hole's perimeter left by the rats as they come and go.

Inside buildings, almost any cavity or void (e.g., walls, floors, ceilings, furniture, and equipment) accessible to the rodent and located near food and water may be utilized by rats for one type of harborage or another (e.g., nests, travel zones, food consumption spots, escape holes). When rubbish and merchandise are stored undisturbed for prolonged periods in or around structures, rats and mice often attempt to establish nests within.

When Norway rats occupy city sewer systems, they establish their nests within areas containing breaks in the sewer wall or along seam breaks in the sewer laterals leading back to the structure. In these spots, rats commonly excavate chambers for nests in the surrounding soil supporting the bricks, or within the soil alongside the lateral pipes at the seam breaks.

The behavior of black (roof) rats in some ways differs dramatically from that of the Norway rat. Most important, however, is the black rat's adaptation to seeking shelter in trees and other above-ground,

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Figure 2. Removing old palm fronds and dead vegetation is important when reducing harborage resources for roof rats.

Figure 3. Rats will take full advantage of urban environments and feed on garbage that is not properly managed.

dense vegetation rather than digging subterranean ground burrows because of the roof rat originating in the arboreal jungles of Southeast Asia (Innes 1990).

The roof rat's superb climbing ability is aided by an extra pad on its feet and a long tail that provides balance and leverage when traveling up, down, and across branches, vines, pipes, cables, wire bundling, etc. In California, Storer (1948) noted that roof rats nest in palms and other trees, as well as in dense hedges and vines on fences. Thus, removing old palm fronds and dead vegetation is important when reducing harborage resources for roof rats (Figure 2).

In urban areas, the roof rat becomes well established in ceiling spaces, hard-to-reach soffits and the sequestered, elevated nooks of all types of buildings from skyscrapers to single-story residential homes. In tall buildings, ceiling infestations can become numerous and widely distributed among multiple floors, requiring intensive and expensive professional labor to resolve (Yabe 2000).

In the absence of Norway rats, roof rats will commonly nest in underground burrows near buildings, beneath or in piles of rocks, or any other type of available debris. In California and Arizona, this rat has been found in sanitary sewers, a habitat usually associated more with Norway rats (Brooks 1964).

Food Habits. Much is said about rats having "favorite foods" in urban environments. For the most part, the commensal rodents are opportunistic omnivores. This simply means they tend to consume many different types of foods as they encounter them.

Because of their origins (grassy steppes), Norway rats exhibit some preferences for cereal grains. But in urban areas, rats will accept locally available food that provides their necessary nutrition, and many variations occur in the actual foods consumed. In city sewer systems, for example, rats can be well fed by the foods disposed of in the sewer system.

In natural areas away from humans, Norway rats consume a wide range of grains, nuts, vegetation, and seeds. Insects, slugs, earthworms, snails, and other invertebrates are commonly taken, as are birds, fish, and other small mammals as opportunities arise. Rats will also sift through the feces of other mammals, such as dogs, horses, and livestock, then pick out undigested food particles.

The roof rat, because of its tropical background, can survive in areas of lush vegetative growth within established neighborhoods by feeding on snails, nuts, berries, and fruits. Thus, it has less dependency on human foods than does the Norway rat.

Both rat species, however, take full advantage of suburban environments that provide bird feeders, outdoor dog pens, and improperly managed garbage or compost piles (Figure 3). When rodent colonies become stressed due to food shortages, rats

will cannibalize other rats, especially weak and young members of the colony.

Rats commonly feed at dusk and again prior to dawn, although there may be several forays out for food each night and during the day. Rats consume about 10% of their body weight daily.

An "average" consumption among rat colonies containing subadult and adult rats is often given as one ounce daily. Because these are relatively large amounts of food, the main point for pest professionals the world over is when a severe rat infestation is present in an area, it is usually indicative that the resident population has ample food easily available to them (i.e., a sanitation problem).

Young rats in the nest begin to acclimate to various food tastes, first from the taste of the mother's milk, supplemented by the smells, and eventually the taste of the food residues from the mother's face and body. Later, young follow the older rats on feeding forays, learning which foods are acceptable, as well as in some cases which foods are dangerous (Lavin et al. 1980; Beck and Galef 1989).

Davis (1949) found that city rats, feeding on garbage, grew more rapidly and attained heavier weights than farm rats that were limited to commercial animal feed.

If food is abundant in areas where rats are well established (and often it is), the local colonies frequently disregard or are highly cautious of new food and objects (e.g., bait boxes, baited traps, etc.) that suddenly appear in their area. This behavior is generally described as "fear of new things" (neophobia, Barnett 2001), and more recently coined as equipment aversion and disregard (EAD) (Koizumi et al. 2021; Corrigan 2021).

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These skittish rodent behaviors can persist for periods lasting hours, days, or even weeks, but the length of time is strongly tied to the continuing presence of the rat's familiar foods.

Disregard or neophobia of foods by rats are, in part, functions of resource availability. If food is abundant and consistently available, rodents can afford to ignore new foods for varying lengths of time. Rats with both available food and neophobic tendencies may never interact with new foods.

In city parks, livestock operations, and zoos where rat colonies have been feeding on the same food for years, rats may ignore strategically positioned bait stations containing fresh rodenticide for six to eight weeks and even longer. Once such stations begin to receive visits from some members of the local colony, however, the visits are regular thereafter.

When a rat's available food resource disappears (e.g., via clean-up programs), or when a rat population exceeds the available food, the rats no longer have the option of ignoring any food — new or old. Many field reports exist within the pest management industry that describe rodents attacking rodenticide or going for trap baits the moment the baits or traps are placed.

Water. Norway rats and roof rats must have water daily either by drinking from a source or via moist food sources. The amount of water consumed daily depends on temperatures, activities, age, food sources, and other factors.

Rats consume 1 to 2 ounces of water daily. Rats drink water by lapping directly with their tongue or cupping it in their front feet. If moisture-laden food is readily available, such as fruits, vegetables, insects, worms, slugs, and other items, the need for free water may be lessened significantly.

Norway rats are often associated with natural water sources, such as along river, lake, and stream banks. They are also denizens of drains and sewers in cities, where water and food are readily available.

It is common for rats to obtain moisture by licking the condensate off pipes, the dew on grass, or when need be, climb onto the roofs of buildings and drink the water from stagnating water puddles, clogged gutters or leaking utilities. Under conditions of severe water deprivation (e.g., grain warehouses in the summer), rats have been observed drinking undiluted human urine (Frantz 1979a).

CONCLUSION. A thorough understanding of rodent behavior allows PMPs to make informed decisions when designing and implementing rodent control programs, resulting in satisfied customers and increased profits. ✦

A native of Brooklyn, N.Y., the author has more than 40 years of industry experience. He is owner and president of Bobby Corrigan Consulting, designing rodent management programs for cities and other large entities around the globe, including airports, health care facilities, shopping malls, university campuses, and food production/storage facilities. One of the world's leading rodentologists, Corrigan received Purdue University's J.V. Osmun Alumni Professional Achievement Award in 2018.

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