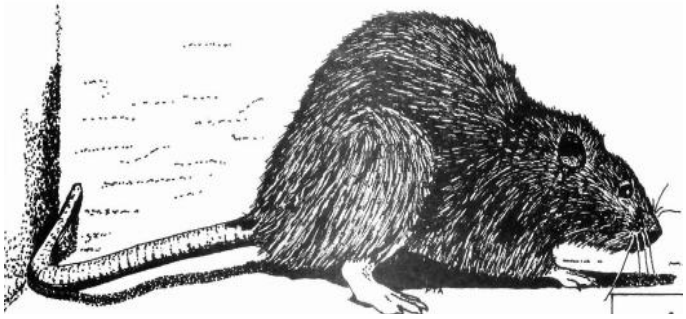
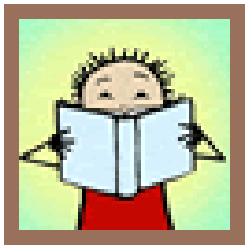
BIOLOGY, LEGAL STATUS, CONTROL MATERIALS, AND DIRECTIONS FOR USE

Norway Rat

Norway Rat, *Rattus norvegicus*
Family: Muridae



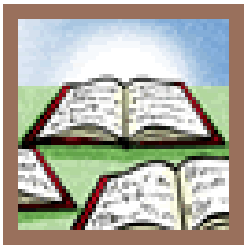


Introduction: Worldwide, rats are some of the most troublesome and damaging rodents. They consume and contaminate food, damage structures and property, and transmit parasites and diseases to other animals and humans. Rats live and thrive under a wide variety of climates and conditions; they are often found in and around homes and other buildings, farms, gardens, and open fields. Additionally, damage to livestock feed and agricultural crops can be extensive.

Often people do not see rats, but signs of their presence are easy to detect. In California the most troublesome rats are two introduced species: the roof rat and the Norway rat. It is important to know which species of rat is present in order to place traps or baits in the most effective locations.

Identification: Norway rats (*Rattus norvegicus*), sometimes called brown or sewer rats, are stocky burrowing rodents that are larger than roof rats. Their burrows are found along building foundations, beneath rubbish or woodpiles, and in moist areas in and around gardens and fields. Nests may be lined with shredded paper, cloth, or other fibrous material. When Norway rats invade buildings, they usually remain in the basement or ground floor. The Norway rat occurs throughout the 48 contiguous United States. Generally they are found at lower elevations but may occur wherever people live.

Table 1. Identifying Characteristics of Adult Rats.		
Characteristic	**Roof rat**	**Norway rat**
General appearance	sleek, agile	large, robust
color of belly	gray to white	mostly grayish
body weight	5 to 10 ounces	7 to 18 ounces
tail	extends at least to snout; black, fine scales	shorter than body; dark above; pale below; scales
head	muzzle pointed	muzzle blunt
ears	long enough to reach eyes if folded over	do not reach eyes



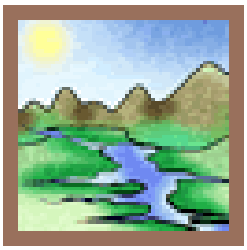
Legal Status: Norway rats are classified as nongame mammals by the California Fish and Game Code. Nongame mammals which are found to be injuring growing crops or other property may be taken at any time or in any manner by the owner or tenant of the premises. They may also be taken by officers or employees of the department of Food and Agriculture or by federal or county officers or employees when acting in their official capacities pursuant to the provisions of the Food and Agricultural Code pertaining to pests.

Damage: Rice, corn, melons, squash, asparagus, citrus, avocados, olives and nuts are among the crops damaged by Norway rats. Stored agricultural commodities may be consumed or contaminated by rat urine, hairs and feces, thus endangering human health and requiring stringent inspection procedures and preventive measures to exclude rats from warehouses and other food handling facilities. Rats may eat eggs and kill young birds on poultry farms as well as eating feed. Rats are hosts to the Trichinella worm. Humans may become infected with Trichinella if they eat poorly cooked pork after the hog has been eaten by an infected rat. Rat urine may transmit leptospirosis, and the feces may contain Salmonella bacteria. Bubonic plague and murine typhus fever may be transmitted by infected rat fleas. Rat bites may cause bacterial rat-bite fever or infection, as well as ugly scars.

Rat gnawing causes spillage of feedstuffs and damage to woodwork and electrical wiring, resulting in shorted circuits and possibly in fires. Rats cut and shred clothing and other fabrics when making nests. And, rats may annoy or frighten some persons.

Range: Norway rats can be found throughout lowland California in urban and agricultural zones, except for arid desert areas.

Norway Rat

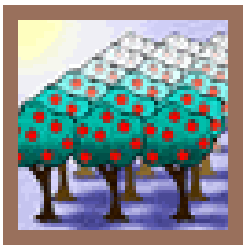


Habitat: Norway rats live in close association with people. In urban or suburban areas they live in or around warehouses, farm buildings, houses, irrigation dikes, sewers, rubbish dumps, wood piles, building foundations, ships. Norway rats are good climbers, but they are usually found within one story of ground level on multiple level buildings.

Biology: The Norway rat is a good digger and burrows along foundations of buildings, beneath rubbish piles and in fields. Rats are superb gnawers and can enter and live in most buildings. Norway rats are aggressive and will drive out roof rats from the lower floors of buildings. They will not hesitate at times to attack children, especially if provoked. Norway rats will fight viciously if cornered. Despite these traits, the Norway rat is colonial and gets along fairly well with other Norway rats though there is a definite "pecking order."

The tail of a Norway rat is shorter than its head and body combined. Norway rats have relatively poor vision but keen senses of smell, touch, taste, and hearing. The sense of touch is served by the long whiskers (vibrissae) on the snout. Domestic rats and mice run close beside a wall where these sensory hairs touch to give the animal information about its surroundings. The home range is frequently 100 to 150 feet. Norway rats and other domestic rodents are mainly nocturnal but they may come out in undisturbed places during the day. They feed on virtually anything edible and are vulnerable to predation by owls, hawks, weasels, and foxes.

Norway rats are prolific breeders, a fact which has made them useful, in their albino form, as the standard laboratory rat in biological experiments. The average length of life is about one year, and sexual maturity is attained in three to five months. The young average eight to ten per litter (extremes 2 to 22), and although 12 litters a year are possible, the average is four to seven per year. The gestation period is 21 to 22 days and the young may run about at three weeks of age. The average number of young weaned per year by a female in the wild is 20.



Damage Prevention and Control Methods

Rat Damage Indicators: Droppings can be found along 'runways' in feeding areas, and near shelter. They may be as large as ¾ inch long, and ¼ inch wide. Fresh droppings are soft in texture.

Tracks can include footprints or tail marks, and can often be seen on dusty surfaces or mud. Rats can be tracked by placing a small amount of flour in a patch across a suspected runway area overnight. The presence of tracks indicates rodents.

Urine both wet and dry will fluoresce under ultraviolet light. Urine stains may occur along travelways or in feeding areas.

Runs or burrows can be found next to walls, along fences, next to buildings, under bushes or debris. Rats memorize pathways and use the same routes habitually.

Smudge marks (rub marks) can occur on beams, rafters, pipes, and walls due to oil and dirt rubbing off a rats fur as it frequently travels routes.

Gnawing is a basic rat activity. One way rats keep their paired incisor teeth worn down is by gnawing on hard surfaces. Size of entry holes differ from mice, rat entry holes are often 2 inches whereas mice are slightly smaller. Rats can easily enlarge holes and cracks in wood and even concrete.

Rats can often be heard climbing in walls, gnawing, clawing, squeaking, and making fighting noises.

Exclusion: Physical barriers are an excellent way to prevent rats from gaining entry to structures where food and shelter are available.

Rats can be excluded by sealing all holes and openings larger than 1/2 inch. Use strong materials that will resist rodent gnawing; concrete mortar, galvanized sheet metal, steel wool, and heavy-gauge hardware cloth.

To prevent rodents from climbing or traveling along a particular route, install guards made of sheet metal or similar materials. Guards must be wide enough and positioned to keep rodents from reaching their outer margins by climbing or jumping. Exclusion with this method is quite difficult because of the rats climbing abilities.

Sheet metal band attached to a wall can sometimes prevent climbing by rodents. Rodent guards should be 12 inches to 18 inches wide. Inside buildings, such guards can prevent rats from climbing at corners. Guards also can be installed to prevent rodents from climbing the outside of buildings having rough exterior walls. When used in combination with hardware cloth or other suitable material, they can make a building essentially rodent-proof. This technique has been used to make corn cribs, barns, and other older buildings rat-proof. However, rats are quite ingenious and can sometimes find a foot hold and circumvent those types of barriers.

Habitat Modification: Good sanitation is an excellent way to minimize rat pest problems. The elimination of food and water through good building sanitation can do much towards reducing any type of rodent infestation. Proper garbage and refuse disposal containers along with an exterior sanitation program are also very helpful. Emphasis should be placed on the removal of as much harborage as is practical.

Poor sanitation is one of the basic reasons for the continued existence of moderate to high rat populations in urban and suburban areas. In agricultural environments, proper sanitation cannot always eliminate rat populations, but it can often prevent rats from flourishing in large numbers and can help detect their presence.

Sanitation involves good housekeeping, including proper storage and handling of food materials, feed and edible garbage. Warehouses, granaries and grain mills, silos, port facilities, and similar structures may provide excellent habitat for rats. Store bulk foods in rodent-proof containers or rooms. Stack sacked or boxed foods in orderly rows on pallets in a way that allows thorough inspection for evidence of rats. In such storage areas, keep stored materials away from walls. A 12-inch white band painted on the floor adjacent to the wall will aid in detecting rodent droppings and other rat sign. Sweep floors frequently to permit ready detection of fresh rat presence.

Pet food is a common source of food for rats in and around homes. Keep all such materials stored and subsequently removed for disposal. Proper refuse storage containers are heavy-duty, rust resistant, rat-and damage-resistant, and equipped with a tight-fitting lid. Sturdy vinyl or plastic containers are good but rats can gnaw into them. Racks or stands prevent corrosion or rusting of containers, reduce rat shelter under containers, and minimize the chance of containers being overturned.

Bulk storage containers for refuse, such as those used at apartments, businesses, and housing projects, should be similarly rodent-proof. Large metal refuse containers (dumpsters) sometimes have drain holes to facilitate cleaning. These drain holes should be fitted with a wire mesh screen or a removable plug; otherwise, the container becomes a hugh feeding station for rodents.

Sewers are inhabited by Norway rats in some towns and cities. Rats may enter at outlets and through manholes, catch basins, broken pipes, or drains. Since Norway rats are excellent swimmers, water traps do not impede their movement; in fact, they can travel upstream against a current. The problem of rats in sewers is usually greatest in places where sanitary sewers are interconnected with storm sewers, thus providing multiple entry points for rats. The domestic sewage of an average community provides enough food to sustain a large number of rats..

Regular removal of debris and control of weeds from around structures will reduce the amount of shelter available to rats. In some instances, a strip of heavy gravel placed adjacent to building foundations or other structures will reduce rat burrowing at these locations. Gravel should be at least 1 inch in diameter and laid in a band at least 2 feet wide and 1/2 foot deep. In any event, keeping the periphery of buildings and other structures clean of weeds and debris (including stacked lumber, firewood, and other stored materials) will discourage rat activity and will allow easier detection of rat presence.

Frightening: Rats are wary and frighten easily when they encounter unfamiliar sounds. However, most rodents, including rats, rapidly become accustomed to new sounds when heard repeatedly. Frightening devices may lead to temporary success, and rats may be repelled from an immediate area, but they will ultimately return and resume their normal activities.

Many commercially available devices produce ultrasonic sound to frighten, claiming it controls rodents. Research shows that rodents may be repelled temporarily from an immediate area, but will return and resume normal activities in the same way any new sound will affect the rodents. Ultrasonic devices are often expensive and their effectiveness is questionable. They are not recommended as a solution to rodent problems.

Fumigants: Fumigants (poisonous gases) are used to control rats in their burrows at outdoor locations. Compounds including aluminum phosphide and gas cartridges are registered for this purpose. The gas cartridge burns, producing carbon monoxide and other gases that suffocate rodents in their burrows.

Because most fumigants are highly toxic to humans and other animals, they should be used only by persons familiar with the necessary precautions. Do not use fumigants within 15 feet of an occupied building or in any situation that exposes the occupants of a building to the fumes. Only licensed structural pest control operators should use fumigants in buildings or other structures.

To fumigate rat burrows, close the burrow opening with soil or sod immediately after introduction of the fumigant. Rat burrows often have multiple entrances, and all openings must be sealed in order for fumigants to be effective. Fumigants are less effective in soils which are very porous or dry.

Repellents: None registered and not an effective method of rat control.

Toxic Bait

CDFA labels

2% Zinc Phosphide grain bait

0.005% Chlorophacinone grain bait

0.005% Diphacinone grain bait

0.005% Diphacinone Rodent Bait Block

Toxicants for controlling rats are classified into two groups: anticoagulants and acutes.

Anticoagulants are a good bait material for controlling rats. They do not cause bait shyness, are easy to apply, and when used properly are relatively safe to use around humans, livestock, and pets.

Rats poisoned with anticoagulants die from internal bleeding; the result of the loss of the blood's clotting ability and damage to the capillaries. Most anticoagulants (except bromadiolone and brodifacoum) require multiple feedings over several days to cause death. Normally, low chronic doses are fatal. Feeding does not always have to be on consecutive days, where it is, death may occur as early as the third or fourth day. For optimal effect, several feedings should occur within a 10 day period no longer than 48 hours apart.

Norway rats are susceptible to all anticoagulants. However, anticoagulant resistance can occur from time to time within any population of Norway rats. Some individuals are always less susceptible to anticoagulants than others. Research indicates both in the USA and internationally that wherever anticoagulants have been used for long periods of time in one location there is an increased potential for some members of the rat

population to be resistant to the lethal effects of bait.

Resistance is often difficult to determine since documentation of resistance is not normally part of operational rat control programs.

If resistance is known to be present or suspected, second generation anticoagulants or non-anticoagulant type baits are the preferred method of control.

Resistance is only one possible reason for failure of anticoagulants. Care should be taken to ensure that one of the following reasons does not apply:

Where highly accepted baits fail:

- The period of bait exposure is to short, or bait has not been replenished.
- There are too few bait stations, or bait stations are too far apart.
- The control area for treatment is too small. This allows rats to move from untreated areas.
- Genetic resistance (see above). This is likely the case if the same amount of bait is taken daily for several weeks.

Where anticoagulant baits are poorly accepted:

- Poor bait choice may be the reason, or bait is improperly formulated. Other food choices may be preferred by the rats.
- Bait may be tainted e.g. moldy, rancid, or insect infested. Replace periodically.
- Improperly placed bait stations.

Non Anticoagulants: There are four non-anticoagulant rodenticides registered by the EPA for control of Norway rats: bromethalin, cholecalciferol (vitamin D_3), red squill, and zinc phosphide. However, only zinc phosphide is registered for agricultural use. All can be used for controlling anticoagulant-resistant populations of rats. Where rat numbers are large costs of baiting with non anticoagulants may reduce overall costs.

Bromethalin (Assault®, Vengeance®) is formulated in ready-to-use bait as a chronic rodenticide, applied so that rats will have the opportunity to feed on the bait one or more times over a period of one to several days. Because it is a slow-acting compared to zinc phosphide or red squill, bait shyness is not usually a problem, nor is prebaiting necessary to get good control in most situations.

Cholecalciferol (vitamin D_3, Quintox®) is similarly formulated in ready-to-use bait, serving as a chronic rodenticide. Death occurs 3 or 4 days after ingestion of a lethal dose. Because the toxicant is slow-acting, bait shyness is not reported to occur. It is claimed that rodents cease feeding once a lethal dose has been ingested.

Red squill is a selective and relatively safe toxicant for use only against Norway rats. It acts as an emetic, which provides some degree of protection to certain nontarget species that might accidentally consume the

bait. Rats, which cannot vomit, are unable to rid themselves of the toxicant once it is consumed. In the past, one problem was the variation in the quality of the material, which is derived from a plant. Red squill must be stored in a sealed container, as moisture will cause it to lose potency. Use for more than a few days at a time may result in bait shyness.

Zinc phosphide is a dark gray powder, insoluble in water that has been used extensively to control rodents. It is available in ready-to-use dry baits and also in concentrates to prepare fresh baits. Its strong garlic-like odor appears to be attractive to rodents that are not bait-shy.

Toxicants (for Norway and Roof Rats):
Anticoagulants -- % on bait for:

Spot baiting -- (Bait stations or stations, bait trays, and paraffin blocks):

0.005% (chlorophacinone, diphacinone).

Zinc phosphide -- % on bait for:

Spot baiting -- 2.00%

Directions for Use (with reference primarily to farms and other agricultural or field use)

Spot Baiting (non-anticoagulants): Follow bait label instructions carefully. Generally, place bait in each active burrow or scatter small amounts of bait in protected places frequented by rats, but inaccessible to livestock, poultry, wildlife and children. Whenever practical and if recommended on the label, prebaiting several days before applying acute or one-shot toxic bait will achieve better control and will give an indication of how much toxic bait to put out. Prebaiting should be conducted where natural food is abundant if possible.

Bait should be picked up and disposed of upon completion of rodent control program. Do not retreat with zinc phosphide baits for at least three months.

Anticoagulant Baits:
NOTE: A single feeding of second generation anticoagulant baits may be lethal to rats although these cannot be used in agricultural areas away from buildings. Baits of first generation anticoagulants must be eaten over a period of several days to give adequate control.

Place 4 to 16 ounces of bait in bait box or shallow container, preferably in protected feeder stations. Place bait stations in dry locations such as in concealed places, in corners, or along walls where rats feed, drink or frequent. Inspect stations daily and add bait as needed; increase the amount when bait in feeder is entirely consumed overnight. Replace moldy or old bait with fresh bait. An uninterrupted supply of bait should be maintained as long as any bait is taken which may be two to four weeks. Put bait at or near ground level and at burrows and harborages.

Where a continuous source of infestation is present, permanent bait stations should be established and the bait replenished as needed. Bait should be picked up and disposed of upon completion of rodent control program.

Paraffin bait blocks: Always follow label instruction and apply only where allowed. Cereal baits (diphacinone) embedded in paraffin are often used in sewers, outdoor placement or other excessively damp locations where unprotected bait would spoil rapidly. The bait blocks are reasonably weatherproof, eliminating the need for bait stations in some situations.

Paraffin bait blocks have been particularly valuable in orchard situations where the blocks can be fastened to a branch near the damage site. Be sure to secure them well so they don't fall and present a hazard to domestic animals. Check the product label to ensure this application method is allowed.

As old blocks are eaten away, replace with new ones. Bait should be picked up and disposed of upon completion of rodent control program.

Tracking Powder: Toxic dusts or powders have been used for many years to control rats and mice. When rats walk over a patch of toxic powder, they pick some of it up on their feet and fur and later ingest it while grooming. Tracking powders are useful in controlling rats where food is plentiful and good bait acceptance is difficult to achieve. Rats are more likely to ingest a lethal amount of a poorly-accepted toxicant applied by this method than if it is mixed into a bait material. There is little likelihood of toxicant shyness developing when using tracking powders.

Because the amount of material a rat may ingest while grooming is small, the concentration of active ingredient in tracking powders is considerably higher than in food baits which utilize the same toxicant. Therefore, these materials can be more hazardous than food baits. For the most part, tracking powders are used by professional pest control operators and others trained in rodent control. Tracking powders containing either single-dose poisons or anticoagulants are commercially available, although some are Restricted Use Pesticides.

Place tracking powders along runways, in walls, behind boards along walls, or on the floor of bait stations. Placement can be aided by using various types of sifters, shakers, or blowers. Dampness may cause the powder to cake and lose its effectiveness. Care must be taken to place tracking powders only where they cannot contaminate food or animal feed, or where not-target animals cannot come into contact with them. Do not place tracking powders where rats can track the material onto food intended for use by man or domestic animals. Because of potential hazards to children and pets, tracking powders are not generally recommended for use in and around homes. Where possible, remove tracking powder after the rodent control program is completed.

Baiting Techniques: All baits should be placed in travel ways or near rat burrows and harborage. Do not expect rats to go out of their way to find bait. Placing bait under cover may assist as rats will feel more secure while feeding. Bait placement for roof rats differs from Norway rats because the two species nest and find shelter in different areas. Roof rat bait should be placed in elevated locations such as in the crotch of a tree, on the top of a fence, or high in a vine. If bait is placed above ground level make sure it is securely fastened so that it will not fall where children or pets may find it.

Bait Stations: Bait stations or boxes limit poison bait exposure and are a safeguard for children, pets, and other animals. The stations should be large enough to accommodate several rats at a time, and should contain a self feeding hopper or bait compartment for holding bait. Each station should have two 2 inch (6.5cm) openings for rats. Commercially available bait stations are available either for rats or mice, and generally come in designs of plastic or metal. Self constructed bait stations are usually made of wood, and are hinged for ease of access, and have a clasp for locking to make them tamper resistant. An alternative to

wood is to use corrugated 4 inch drainage tubing for constructing a bait station.

All bait stations should be clearly labeled with the appropriate warnings. To ensure that bait station used indoors is tamper resistant, it should be secured to the wall, floor, rafter, or some other part of the structure so that it cannot be tipped over, spilling the bait. If used outdoors, away from a building, it should be securely staked to the ground or well anchored in a post or tree. When used outdoors, a bait station provides the additional advantage of keeping bait dry in inclement weather as well as safeguarding non target animals. When using bait stations, follow rodenticide label instructions carefully.

As with traps, bait stations must be placed where rodent sign is evident. Indoors, place them along walls, on rafters, within a cupboard, etc. Indoor baiting is not recommended as rodents may die in an inaccessible place, creating an unpleasant odor.

Non-anticoagulants: Follow bait label instructions carefully. Generally, and if recommended on the label if possible although these cannot be used in agricultural areas away from buildings. Always follow label instruction and apply only where allowed. often in some situations Check the product label to ensure this application method is allowed.

Trapping:

Trapping can be an effective method of controlling rats, but it requires more skill and labor than most other methods. Trapping is recommended where poisons are inadvisable. It is the preferred method to try first in homes, garages, and other small structures where there may be only a few rats present.

Trapping has several advantages: 1) it does not rely on hazardous rodenticides; 2) it permits the user to view success; and 3) it allows for disposal of the rat carcasses, thereby eliminating odor problems from decomposing carcasses which may remain when poisoning is done within buildings.

The simple, inexpensive, wood-based snap trap is available in most hardware and farm supply stores. Traps should be baited with a small piece of hot dog, bacon, or nutmeat tied securely to the trigger. Gluing a piece of dry dog food to the trap can be quite effective. Peanut butter or marshmallows also may be used as bait. Baits that become stale lose their attractiveness.

Set traps close to walls, behind objects, in dark corners, and in places where rat activity is seen. Place the traps so that when rats follow their natural course of travel (usually close to a wall) they will pass directly over the trigger. Set traps so that the trigger is sensitive and will spring easily. When traps can be set in rats' runways or in travel routes, effectiveness can be increased by enlarging the trigger. This can be done with a square of cardboard, metal, or screen wire that fits just inside the wire deadfall.

Use enough traps to make the campaign short and decisive. Leaving traps unset until the bait has been taken at least once reduces the chance of rats escaping the trap and becoming trap-shy.

Other kinds of traps are also effective in catching rats. Wire-mesh cage traps such as the Tomahawk® and Havahart® can be used effectively to capture rats alive, although humane disposal is a problem. Wire funnel-entrance traps have also been used for this purpose.

Keep traps reasonably clean and in good working condition. When dirty, clean them in a hot detergent solution with a stiff brush. Human and dead-rat odors on traps do not reduce trapping success.

An alternative to traps are glue boards, which catch and hold rats attempting to cross them much the same way flypaper catches flies. Place glue boards wherever rats travel -- along walls, or in established pathways. Do not use glue boards where children, pets, or wildlife can contact them. Glue boards lose their effectiveness in dusty areas unless covered, and temperature extremes may affect the tackiness of some glue. They are considered less effective for capturing rats than for mice. You can purchase ready-to-use glue boards, or you can buy glue to make your own boards or traps. Dispose of live trapped rodents in a humane manner; euthanize live, trapped rodents by asphyxiation with carbon dioxide, or use a stick to kill them with a sharp blow to the base of the skull.

Other: Rats may have an initial aversion to some odors and tastes, but no repellents have been found to repel them for more than short time, if at all.

Predators such as owls, foxes, skunks, raccoons, opossums, and snakes do feed on rats. Because of the rat's great reproductive potential, predators are usually unable to keep rat numbers below damaging levels.

Sometimes cats and dogs are good rat catchers, but generally enough rodents escape and thrive in their presence. In fact some studies suggest that owners of cats and dogs are more likely have rodents present, probably because of the availability of food i.e. pet food.

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