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Stephen P. Kincaid

Northern Division; Naval Facilities Engineering Command, Philadelphia, Pennsylvania 19112

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NORTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
PHILADELPHIA, PENNSYLVANIA 19112

BATS, BIOLOGY AND CONTROL

Although **bats are not** commonly thought of as major members of the **animal** kingdom, they are one of the most numerous of land vertebrates. Bats are thought to have originated in the Old World Tropics and are now almost world-wide in distribution. Bats make up the order Chiroptera, and they are closely related to the hedgehog, shrew and mole.

Most bats in the United States are small, averaging 3-5 inches in body length, with some larger species reaching lengths of about 6 inches.

Although the bat is a nocturnal animal, its' eyes are small. To compensate for its' poor eyesight, bats have the relatively unique capability of using echo-location to navigate during flight. A bat will utter a series of high-pitched squeaks with the sound reflecting off nearby objects and this echo is then picked up by the bats' large and sensitive ears. This sonar-like system enables bats to ascertain both distances and directions of objects. This system, along with extremely quick reflexes, enables the bat to change directions of flight almost instantly and thus avoid obstacles or catch flying prey.

Bats usually mate in the late summer or early fall and young are born the following summer. A female bat usually produces only one offspring per year, but its longevity, up to 20 years, makes up for this brood size. Some bats carry their offspring with them while others leave them in nursery colonies while food is being gathered. No nest of any kind is provided.

There are about 65 different species of bats in the United States with the large majority insectivorous. The most infamous bat, the vampire, which feeds solely on blood, is presently restricted to parts of South and Central America. In regions where it gets cold in the winter and food is in short supply, bats will either migrate, following a source of food, or they will hibernate, waiting for warmer weather and a

renewed insect food supply. Those bats which hibernate during the winter originally did so in constant temperature caves but now they also overwinter in man-made structures.

Bats, as an order, have been very successful because of the special niche they occupy. They don't have any great competition for food or shelter and their seclusive habits and other traits tend to keep them relatively free from predation. Flight usually keeps them from predatory land animals and their nocturnal habits, generally keep them from predatory birds.

Bats can be said to be the victims of "bad press". This is because of the great amount of ignorance about them which has caused many legends and superstitions to build up over the years. When the layman thinks of bats, he usually thinks of vampires and witchcraft. Actually, bats in the United States are among the most harmless mammals. They occupy an important place in our environment. In the United States, they consume an enormous amount of insects, keeping potential pests in check. One bat will eat $\frac{1}{4}$ - $\frac{1}{2}$ its own weight in insects in one feeding, at a rate of about 500 an hour. Bats are also beneficial in that their manure, called quano, is an excellent fertilizer and is mined from bat caves. In the early part of this century, quano was mined from Carlsbad Cavern for 15 years at a rate of about 17,000 tons a year.

Bats are also used in scientific research in such diversified fields as zoogeography, systematic zoology, geriatrics and gynecology.

Bats do deserve much of the resentment man has towards them. When bats occupy buildings, their droppings deface, contaminate and stain surfaces and equipment. Usually, the most common complaint of bats in buildings result from the odor of their feces and urine. They sometimes produce an almost overwhelming ammonia odor which can persist for a long time even after bats have left. The crawling and squeaking noises produced by bats can be disturbing to building occupants.

Bats are very harmful economically. Some bats damage fruit and other agricultural products. They are important as far as air-strikes are concerned, too. For example, at one air base, in 8 months, there were 50 cases of bats striking airplanes with damages approaching \$200,000.

Bats are also important because of the fear people have of them stemming from myths of bats getting into long hair and of bats attacking humans. This fear can be both a safety and economic factor. There is a large Naval munitions manufacturing plant in the Midwest. Last year, they had bats roosting there in the attic of one of the explosive handling buildings. In this building, some of the ordnance handlers, mainly women, reported incidents wherein they were startled by bats flying in a hazardous production area. You can imagine the possible implications of such activity.

The primary hazard resulting from the relation of bats and man is that of disease transmission. Rabies is probably the most important disease transmitted by bats in the United States. Although only a small percentage of bats are actually rabid (1-3%), the Center for Disease Control in Atlanta lists bats 3rd in the rabies rate in animals after skunks and foxes with dogs, the animal most commonly associated with rabies, ranking 6th.

Rabies is a viral disease which is highly fatal to man and other animals. Usually, once a person displays symptoms of rabies, death is certain. There is at least one case where a person was bitten by a rabid bat and died even though an anti-rabies injection series was initiated the same day as the bite. There is evidence that bats can transmit rabies not only through their bites but also by contaminating air with fine particles of urine containing the rabies virus. This second method of rabies transmission is known to occur only very infrequently and only in caves where bats occur in very large numbers.

Signs of rabies in bats include: 1) bats attacking other bats; 2) an unusual number of dead bats in a localized area; 3) frequent daytime sightings of bats and; 4) probably the most typical sign is a bat flapping its wings helplessly on the ground. But rabies can also occur in a bat without the bat showing symptoms and the rabies virus can remain viable for relatively long periods of time after the host dies. If rabies is confirmed in a bat population, control should not be attempted without supervision of the State Public Health Department. If you intend to have a bat checked for rabies, make sure the head is undamaged because it is in the brain that rabies virus collects.

Bats also carry a number of ectoparasites such as ticks, mites and fleas which may also attack man. Bats also serve as reservoirs for such human diseases as Chagas' disease, relapsing fever, encephalitis, and dermatomycoses. A fungus causing histoplasmosis can also develop in dusty bat manure.

The detection of bats is usually associated with their harmful effects such as odor, noise and droppings. If a colony is well hidden, it may be detected only when they emerge from a building at dusk for feeding. Unexperienced persons could confuse bat and mouse droppings, which are very similar in appearance. Dry bat droppings are easily crushed into fine fragments and usually contain insect fragments, while mouse droppings are firm and do not readily fragment.

Before undertaking bat control, public health personnel should determine what protection the bat is afforded under state and local laws. Two bats are protected by the Federal government as endangered species. One, the Hawaiian Hoary Bat, is found only in Hawaii. But the other, which you may encounter, is the Indiana Bat. Control of these bats can only be undertaken if they demonstrate a threat to human safety, and then, the only people who may practice control measures are employees or agents of the Fish and Wildlife Service, a Federal land management agency, or a State conservation agency.

Bats may enter buildings through various vantage points such as unprotected louvers and vents, broken windows, siding and through just about any opening $\frac{3}{8}$ inch or larger. So if you can put your little finger through a hole in a structure, some species of bats can enter through this opening.

Although the only permanent way to keep bats out of buildings is by bat-proofing, repellents are still often used. Repellents are sometimes useful when the area to be protected has a large outside opening and exclusion would be impractical. The only chemical bat repellent registered with the Environmental Protection Agency is naphthalene. Paradichlorobenzene, a chemical often used to repel bats, is not registered with the EPA but some states may have individual registrations for it. Legally, to use a chemical to repel bats, it must be so stated on the label. The odor of naphthalene is apparently extremely offensive to bats and they begin to leave immediately even in broad

daylight. Flakes are usually spread under the area where bats are roosting or they may be hung in small cloth bags from rafters and other points where bats gather. The best recommendation for the amount to use is to follow the rates printed on the label of the product you are using. Problems associated with the use of naphthalene include its odor which may be offensive to human occupants of a building as well as the bats. Also, the repelling action is only temporary. If the space in which it is being used is well ventilated, the odor will dissipate rapidly because of the high volatilization rate of naphthalene and therefore the flakes must be frequently replenished. With the cost of naphthalene at about 70¢ a pound and rising, and with high labor costs, control by use of repellents can be an ever increasing expense.

Another method of repellency, with its legality varying, is the use of glass fiber insulation blown into spaces occupied by bats. The glass fibers irritate the bats' skin. Like naphthalene, it does not have a residual effect.

Lights are sometimes used to discourage bats from indoor roosts. One major problem with lights as a repellent is that the opposite effect may occur. The lights may attract insects which may, in turn, attract bats to feed on the insects.

One additional repellent used which is interesting is that of high frequency sound, with the intent of interfering with bat flight. In 1969, 500-1000 bats were interfering with the construction of 2 atomic reactor buildings in Illinois. In addition to roosting inside the building, the bats were apparently disturbed by the welding. One welder was bitten and the bats were making welding on high platforms dangerous. In an attempt to repel the bats from the area, 12 high frequency dog whistles, were connected to compressed oxygen cylinders. After 48 hours of continuous operation, all the bats were gone. A few bats returned several days later but were quickly dispersed with a single blast from a whistle.

If repellents are used in bat control, they should, if possible, be used in conjunction with bat-proofing. Bat-proofing is the only permanent way to keep bats from maintaining roosts in buildings. As mentioned previously, smaller bats can crawl through an opening as small as 3/8 inch.

It is necessary to make sure that all bats be out of a building before exclusion measures are completed. Bat-proofing should not be performed in early to mid-summer if it might involve a nursery colony of females and young. Otherwise, the young bats will be shut up inside where they will die and decompose, producing foul odors and attracting insects. Usually, the most suitable months for exclusion of such colonies are March and November. When bat-proofing is attempted, all possible entrance-ways for bats into a building must be located. If a number of openings are found, all but one or two of these should be closed. Large openings should be covered with sheet metal or 1/4 inch mesh hardware cloth if ventilation is necessary. Narrow cracks can be plugged with some type of packing material and sealed with caulking compound. Any bat-proofing material used should not leave any openings larger than 1/4 inch. After bats have gotten used to using the remaining entrance-ways (3-4 days), these entrances should be closed off after the last bat has left the roost for feeding. When bats are active, all occupants leave the roost within 15-20 minutes after the first starts out at twilight. If, by chance, any entrances have been overlooked, the bats will soon find them. Therefore, it is advisable to watch the building closely at dusk for several evenings to determine if the bats have gained entrance through any overlooked holes.

If bat-control, or bat-proofing is attempted in the fall, the area treated should be inspected, if possible, the following summer. The reason for this is because the bats may have migrated about the same time proofing was attempted, and one may think exclusion has been achieved while the bats have only migrated. If so, and you have not closed off all the entrances, bats will return the next year since they usually prefer to return to traditional roosts.

At the present, there are no chemicals registered to kill bats; although the anticoagulant ROZOL, used in rodent control, has been issued an experimental label for bat control. A State may, if bats present a significant public health problem, apply to the Federal EPA to use DDT to kill bats. Section #18 of the Federal Insecticide, Fungicide and Rodenticide Act allows for this exemption. For example, this exemption has been issued to the States of New Jersey and Massachusetts for emergency rabid bat control so far in 1975

Whenever personnel engage in bat control, they should exercise proper safety precautions. First of all, they should be provided pre-exposure rabies prophylaxis, usually a duck embryo vaccine. During inspections, control efforts, and clean up, hard hats, heavy gloves and coveralls should be worn. If working around bat droppings, one should wear a respirator approved for nuisance dusts by the National Institute of Occupational Safety and Health (NIOSH). Since humans are subject to attack from bat ectoparasites, they should use an insect repellent on clothing. When handling dead bats, it is advisable to use tongs or heavy forceps. Clothing should be changed at the completion of the work, followed by thorough washing. Disinfection of gloves and towelng a 1% quaternary ammonium chloride (QAC) solution is advised. If bare hands are inadvertently exposed to bats, they should be thoroughly washed with soap and water followed by rinsing in a 1% QAC solution.

Disposal of dead bats and droppings should also be carried out with safety in mind. The best place to dispose dead bats is in a pathological incinerator. If such equipment is not available, bats should be disposed of in a sanitary landfill.

If possible, bat droppings should be removed by hosing rather than by sweeping, as to prevent stirring up disease carrying fungus which may be growing in the manure. If sweeping or shoveling is necessary, proper respiratory equipment must be worn.

After removal of dead bats and droppings, measures should be taken to insure that bat ectoparasites are killed. Also, if a disagreeable odor persists, there are many commercially available odor suppressants which can be used.

In dealing with the general public in the area of bats, ideas which must be stressed are exclusion rather than extermination of the bat, understanding instead of fear of the bat and emphasis of permanent as opposed to temporary (chemical) control methods.

VAMPIRE BATS

Vampire bats are found, in the wild, only in the Western Hemisphere. Their range presently is from Central Mexico to Northern Chile and Argentina. As opposed to popular belief, vampire bats don't suck

blood but rather puncture the flesh and lap up blood. A vampire will ingest its own weight in blood at a single feeding. A single bat drinks about 6 gallons of blood a year. About 1,000,000 cattle are killed each year in Latin America with a loss of about \$250 million because of vampire bats.

Probably the most interesting research being conducted today on bats is in the area of vampire bat control. One method is to inject an anticoagulant into the stomach of cattle where it goes into the circulatory system.

The poison doesn't have any adverse effect on the cattle, but will kill a vampire bat after a few days of feeding. Another method is to catch a few vampires, and smear their bodies with an anticoagulant in petroleum jelly. The treated vampires are then released and return to their colonies. Here, the bats preen and clean each other transferring the poison throughout the colony. The slightest capillary fractures or abrasions resulting from this contact causes the contaminated bats to bleed to death. This research with anticoagulants has produced promising results with 90-100% effectiveness.