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THE EXTENDING OF COTTON RAT RANGE IN CALIFORNIA - THEIR LIFE HISTORY AND CONTROL

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ABSTRACT: Cotton Rats (Sigmodon hispidus eremicus Mearns) are known to have reached the Imperial Valley in 1921 from the Colorado River along canal banks. Recently (1967-69) cotton rats were found distributed throughout the irrigated portion of the Imperial Valley, Imperial County, California. Limited crop damage has occurred and is described. Life history information is included. Control measures are listed.

DISTRIBUTION AND SPREAD

Most species of cotton rats are found in Mexico and as far south as Peru (Weinburgh 1966). In California they are indigenous along the Colorado River, being found from below Palo Verde to near Pilot Knob (Grinnell 1914).

Since the 1850's the feasibility to irrigate the Imperial Valley with Colorado River water was recognized. In 1901, a canal, having its origin in the United States but running most of its length in lower California before recrossing the International Boundary, started bringing irrigation water to the Imperial Valley (Anon. 1965). Before that time the Imperial Valley was an arid desert and habitat for cotton rats did not exist, but the new canals served as highways for the spread of cotton rats into the developing valley (Dixon 1922).

No meadow mice Microtus sp. existed in the Colorado River bottom, so from a competitive standpoint, cotton rats had a clear right of way for spread (Grinnell 191*0. In 1921 Dixon (1922) trapped a cotton rat one half mile south of the International Boundary near Allison Heading. Extensively used cotton rat runways were also found in Imperial County on the American side. He then stated that cotton rats were definitely established in the Imperial Valley. Further movements in the Imperial Valley either to the west *or* north have not been reported in the literature.

Between 1967-69, through trapping and discovery of cotton rat runways and sign, the writer discovered that cotton rats had spread throughout the irrigated portion of the Imperial Valley (see map).

Cotton rats are now found from the East Highline Canal to the West Side Main Canal; and from the International Boundary north to around Niland and the southern end of the Salton Sea. This spread represents an additional westward spread of about 29 miles and a northward movement of 45 miles from the point of original entry into the valley.

Undoubtedly the completion of the All American and Alamo Canals from the Colorado River and the subsequent construction of over 3,100 miles of canal systems within the Valley accounts for this range extension.

The movement of cotton rats in the Imperial Valley may not be considered great but it is indeed significant. The Valley is irrigated entirely by canal systems. This brings a highly destructive vertebrate pest within easy reach of nearly every cultivated field in the Imperial Valley.

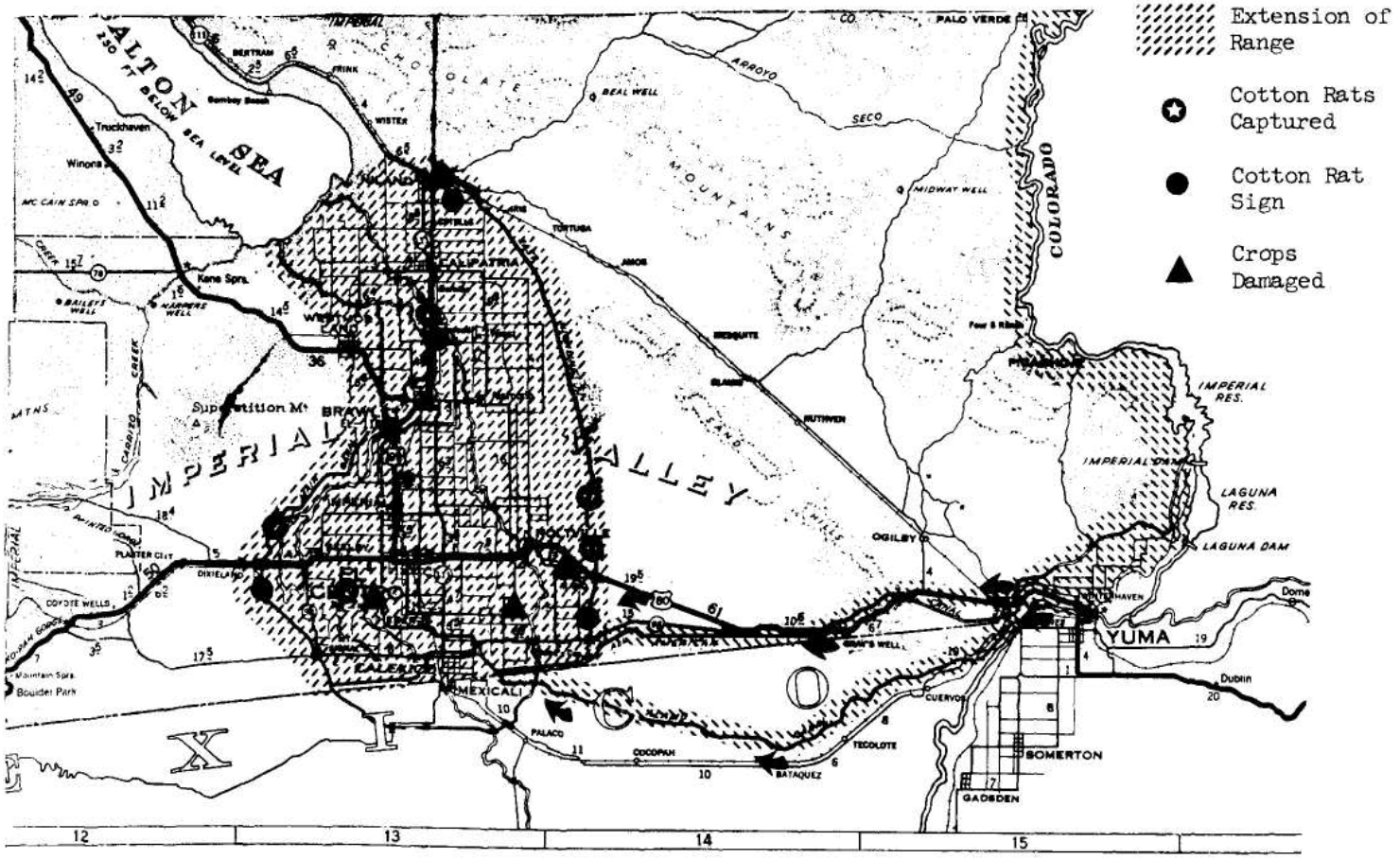
The Coachella Branch of the All American Canal, which continues northward into the agricultural Coachella Valley, was completed in 1949 (Anon. 1965). One may surmise that cotton rats are now or may soon be found here.

NAME

Cotton rats were so named because their distribution closely corresponded to the cotton growing area at the time they were first described (Bailey 1931). Their scientific name Sigmodon hispidus is derived from Greek and Latin. Sigmodon can be broken down - "sigma" being equivalent to the English letter "S" and "odous" means tooth. These refer to the pattern of enamel on the grinding surfaces of certain molar teeth which, when worn, show the letter "sigma" or "S." Lower molars show this characteristic more clearly. The specific name is Latin for "rough" and describes the texture of the fur (Schwartz and Schwartz 1959).

DISTRIBUTION OF COTTON RATS IN IMPERIAL VALLEY, CALIFORNIA

IMPERIAL COUNTY



DESCRIPTION

Cotton rats are similar in appearance to meadow mice but have a larger body and a longer tail. Cotton rats also resemble a half-grown Norway rat, Rattus norvegicus, but Norway rats are larger and the ears are not hidden by hair.

Cotton rats are medium sized (about 12 inches long), robust rodents and usually weigh 3 to 4 ounces. They have a scaly, sparsely haired tail (4 to 5 inches long) which is shorter than the combined length of the head and body. Eyes are moderately large and their large ears are nearly hidden by hair. There are four toes and a small thumb on the front feet and five toes on the hind feed (hind feet 1-1 1/2 inches long).

The fur is rough and coarse, or hispid. Coloration of both sexes is similar. The back and sides are a mixture of tan, brown, and black, with less black on the sides, resulting in a grizzled appearance. Underparts are lighter, usually whitish to gray or buff; feet are gray to dark brown. The tail is dark above and fades to lighter underneath. Young tend to be darker in appearance. Albino and melanistic races are rare (Schwartz and Schwartz 1959).

HABITAT

Cotton rats are dependent upon a dense stand of vegetation for both food and protection from predators. Within their range, cotton rats occupy grassy fields and meadows, marshy areas, wastelands, and roadsides and ditch banks overgrown with weeds. On occasion they inhabit cropland.

In California, outside of cropland, cotton rats have been found in association with drain ditches, canals, and seeps. Common vegetation in these areas includes arrow weed Pluchea sericea, saltgrass Distichlis spicata, common reed Phragmites communis, screwbean mesquite Prosopis pubescens, cattails Typha sp., sedges Cyperus sp., Tamarisk Tamarix sp., Heliotrope Heliotropium sp., and annual grasses. Cotton rats have been found inhabiting thick cactus patches and may live in scattered forests at elevations as high as 1,700 feet in the southern Appalachians (Cahalone 1954) and are also found in salt marshes of tide flats and brackish expanses of rank grass in the Everglades (Weinburgh 1966).

HABITS AND LIFE HISTORY

Where cotton rats occur they may be detected by their well-defined runways and connecting burrows. These features are meadow mouse-like. Runways are about three inches across and burrows are correspondingly larger. Indications of active areas are runways with small piles of freshly clipped vegetation and scattered or small piles of 1/2 inch long droppings.

Cotton rats are primarily vegetarians and take a wide variety of stems, leaves, roots, and seeds; however, insects and animal flesh (including that of their own kind) will be readily eaten. Dead animal carcasses are eaten and cotton rats caught in traps are often partially consumed by other rats overnight (Bailey 1931).

Their nests are built in shallow burrows or under a rock or log at the ground surface. Nest material includes dry grass, fibers stripped from stems of larger plants, or any other suitable material, such as cotton. Occasionally abandoned dens of skunks and ground squirrels will serve as nest chambers. It is interesting to note that cotton rats do not hibernate or accumulate any noticeable fat in the wild state and apparently do not store food for the winter (Meyer and Meyer 1944).

Cotton rats are very prolific but overall numbers are subject to both an annual and a multiple year cycle. They are more abundant in the fall and seem to have a yearly drop in numbers in the spring (Odum 1955). High densities or population peaks occur every 2 to 5 years (Schwartz and Schwartz 1959).

Cotton rats breed throughout the year, but somewhat less in the winter. Breeding does not appear to be influenced by day length, but temperature is important (Odum 1955). Unmated females come into heat every 7 to 9 days and may mate within a few hours after giving birth to a litter. The gestation period is 27 days and it is not lengthened when young are suckling, as occurs in some other small mammals (Schwartz and Schwartz 1959). Several litters are produced annually (2 to 10, average 5.6) often in rapid succession. One to 12 young per litter have been recorded but 5 to 7 is average (Hall 1955). Female

cotton rats are good mothers, give unusually good care to their young and will care for foster young equally well (Meyer and Meyer 1944). Several generations may be living in the same nest at one time (Cahalone 1954).

Newborn cotton rats weigh about 1/4 ounce, are about 3 inches long and are precocious, well-developed and hairy at birth. They are able to run even before their eyes are open. Eyes will open and ears unfold in 18 to 36 hours. Young gain weight at the rate of one gram per day (Svihla 1929). They are weaned naturally at 10 to 15 days of age (Meyer and Meyer 1944) however, young have been weaned at only five days of age. This corresponds closely to when their incisors erupt and solid food may be eaten. Most young breed for the first time at 2 to 3 months of age but occasionally some breed at 40 days of age. The average life span of a cotton rat is six months and they are considered full grown at the age of five months (Schwartz and Schwartz 1959). Cotton rats are primarily nocturnal but show some daytime activity. They are very excitable and pugnacious and hardly an adult animal lacks battle scars. Cotton rats can swim and do so with little hesitation. Stickel and Stickel (1949) found that the range of females is less than that of males. The home range is calculated to be 1/4 to 3/4 acre for females and 1 to 1 1/4 acres for males (Schwartz and Schwartz 1959).

Mites, ticks, fleas, and lice are common ectoparasites. Three species of rat mites were collected from cotton rats in California (Hoplopleura arizoniensis, Neorcholaelaps dentipes, and Androlaelaps lahrenholzi).

Cotton rats do well in captivity (Hall 1955) and have been used successfully in the study of virus organisms that cause influenza in man. They are also used in laboratory studies for research on poliomyelitis, diptheria, tuberculosis, and typhus (Schwartz and Schwartz 1959). Studies of the effects of "atomic" materials on mammalian life have been done with cotton rats (Hall 1955).

DAMAGE

The amount of damage done by cotton rats depends on their abundance and the type of crop attacked. After a crop begins to grow, the rats move into various parts of the field and build up their runway and burrow systems, remaining as long as food and shelter are available, or until appropriate control measures are administered.

Cotton rats are known to damage a wide variety of field crops; these include cotton, grasses and alfalfa, grains, vegetable and fruit crops, squash, sugarcane, corn, sweet potatoes, and melons (Altman_____; Anon. 1959).

The flesh and seeds of tomatoes are eaten, leaving only the outside shell. Sugarcane losses of from 36-78% have been reported (Carr 1936). Cotton rats can be especially troublesome in fields of melons.

A rat will take cotton from a field and haul it back to its burrow where the seeds are eaten and the cotton fibers cached. One such cache had more than 1/4 bushel of cotton stored and another of over three feet in diameter was reported to have been taken by a pair of cotton rats (Dixon 1922).

In California, known damage by cotton rats has occurred in two crops, sugarbeets and citrus. One thirteen-acre citrus grove (Valencias) south of Meloland sustained heavy damage in 1967. Tree trunks were girdled and a high percentage of the trees were set back severely and many died. Fallen fruit were completely hollowed out.

Of three sugarbeet fields receiving cotton rat injury in 1968, one, a thirty-acre field near Date City, suffered moderate damage throughout. The other two, one south of Niland and one southwest of El Centro, suffered only a trace of damage. Rats ate into the beets near ground level. During mechanical harvesting these beets broke off at the site of the injury and the main portion of the beet stayed in the ground causing considerable hand labor to complete harvest.

Other types of losses can occur, such as when large numbers of cotton rats build up on canal banks and their burrowing causes leakage or breaks in canal banks. Cotton rats also have a detrimental effect on other wildlife. They have been reported to be of outstanding importance in relation to the quail supply in the southeastern United States. Cotton rats eat quail eggs and those of other ground nesting birds, such as meadowlarks, and it has been determined that they feed on thirty different kinds of quail food (Cahalone 1954).

CONTROL

High population peaks are known to occur every two to five years and the last period of high cotton rat populations in the Imperial Valley was in 1968. Because of this, some type of control measures probably will be needed in the near future. Fortunately, a number of procedures have been worked out in California and in other parts of the United States.

Control through natural means is of assistance when populations are at a low ebb. Cotton rat populations are affected by predators, such as foxes, dogs, coyotes, raccoons, badgers, weasels, mink, domestic cats, owls, hawks, and snakes (Altman ; Anon. 1959; Schwartz and Schwartz 1959). Coccidiosis is common and plague and murine typhus have been found occurring naturally in cotton rats (Weinburgh 1966).

During times of high population a fungus disease, aided by wet weather, takes a great toll on the rats. In time a population will "crash" and cotton rat density will again become average (10-12 per acre; Stickel and Stickel 1949).

Certain preventative measures are helpful in keeping cotton rats away from any particular field. This may be done by keeping the natural habitat of dense vegetative cover removed from surrounding ditches, roadsides, etc., by the use of systematic burning, plowing, or chemical weed control.

When cotton rat populations are approaching or are at a peak, more acute control measures are necessary.

Ludeman (1962) reports the use of mechanical barriers to deter cotton rats. Barriers of solid metal have been erected to completely encircle a crop of high value.

Control is most often accomplished by the use of strychnine or zinc phosphide on baits such as oats, corn, barley, wheat, milo maize, carrots, sweet potatoes, and white potatoes. In Florida, raw sweet potatoes were found to be the most desirable vegetable bait (Carr 1936). Lightly rolled oat groats have proven effective in California.

The most practical time to control rats is during early spring when the populations are naturally at their lowest; however, baiting may be done at any time of the year. In certain situations retreatment may be warranted about 30 days after the first bait application. To help eliminate bait or poison shyness, more effective control may be achieved by alternating toxicants and/or baits.

Hand baiting may be accomplished with teaspoon-sized baits lightly scattered in the rat runways near active burrows, or placed at 12 to 30 foot intervals in the runways.

Broadcast baiting is done by dispensing bait at the rate of five to ten pounds per acre (two to four kernels per square foot), depending on the severity of the infestation. The bait will fall through most vegetation to the ground surface. Bait should not be applied when trees or grass are wet, or when rain is likely to occur within 24 hours.

Cubed vegetable baits have been effective when placed in runways in a similar manner as with grain baits. Rates of five pounds per acre have been consistently effective (Carr 1936).

Cotton rats inhabit areas that are often prime bird habitats and all possible precautions should be taken to eliminate hazards to birds and other non-target species. Insofar as possible, all baits should be dyed so as to help deter feeding by birds (Kalmback and Welsh 1948). Whenever possible, grain baits should be modified by crushing or rolling. This changes the natural shape of the grain and helps to prevent ingestion of the bait by birds. Even though gallinaceous birds are highly resistant to strychnine, care should be exercised in bait placement. Baits placed under cover may be accessible to quail, but are relatively inaccessible to most other birds. Zinc phosphide treated vegetable baits are seldom attractive to birds (Ludeman 1962).

BAIT FORMULAS

Many slightly different formulas to mix bait for cotton rats occur in the literature. The following formulas are considered "standard" or have reportedly given consistent results.

Zinc Phosphide Bait

Zinc Phosphide Formula 1 - Hand Baiting

*Oat groats	100 pounds
**Lecithin-mineral oil	2/3 quart
Dye	2 ounces
Zinc phosphide	16 ounces

Mix dye with dry zinc phosphide before adding oil. Warm oil (Do not boil) and stir in zinc phosphide until it is evenly mixed. Pour over grain and mix thoroughly. Bait may be sacked immediately.

Zinc Phosphide Formula 2 - Broadcast Baiting

Oat groats	100 pounds
Lecithin-mineral oil (22 ozs. liquid)	2/3 quart
Dye	2 ounces
Zinc phosphide	32 ounces

Mix dye with zinc phosphide before adding oil. Warm oil (Do not boil) and then stir in zinc phosphide until it is evenly mixed. Pour over grain and mix thoroughly. Bait may be sacked immediately. (California Department of Agriculture)

Zinc Phosphide Formula 3 " Vegetable Baits

Cubed sweet potatoes	100 pounds
Vegetable oil	2 pounds
Zinc phosphide	1 1/2 pounds

Cut sweet potatoes into 1/2 inch cubes and dust with zinc phosphide powder until uniformly gray. Then add oil and mix until black. Mix fresh bait daily (Ludeman 1962).

Strychnine Baits

Strychnine Formula 1

Ingredients	Strengths	
Steam crushed oats or whole oats	800 lb.	500 lb.
Strychnine Alkaloid	50 oz.	25 oz.
Sodium bicarbonate	3 lb.	1 1/2 lb.
Glycerin	8 lb.	5 lb.
Salt	24 lb.	15 lb.
***Standard Spreader	15 qt.	9 qt.

Standard Spreader Preparation

1. Place required amount of Blue Karo syrup (10 gallons) in the steam cooker and bring to slow boi1.
2. Add 3 pounds of dry starch, paste in 1 1/2 quarts of cold water for each ten gallons of syrup. (Variation in starches sometimes makes modification of this 3-lb. recommendation necessary to secure the desired consistency). Use amounts of prepared spreader as listed in above formulas.

Mixing Procedure

1. Weigh grain in hopper scales.
2. Measure the hot spreader required for the batch into mechanical mixer.

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* Other suggested baits - lightly rolled, or crimped, or whole oats (recleaned) or lightly rolled barley (not flat).
** If lecithin-mineral oil is not available, 40 ozs. of corn oil may be used cold with rolled oats. Do not use straight mineral oil (California Department of Agriculture).
***Quantity of spreader will vary in different lots of oats, depending on size of kernels, degree of crushing and variety of grain used (Ludeman 1962).

3. Add the strychnine and soda to the hot spreader while it is being agitated.
4. Add glycerin and mix for 3 minutes.
5. Transfer grain from scales to mixer and the completed strychnine paste from the mechanical mixer to the pressure tank.
6. Close tank and apply steam pressure (90 1b.) to force the solution over the grain in the batch mixer.
7. After the strychnine solution has been applied and the bait mixed for about 1 minute, add salt. Mix additional 3 minutes then elevate into storage bins.
8. Allow bait to remain in bins for about 8 hours before sacking.

Strychnine Formula 2

Wheat, milo maize, steam rolled oats	20 pounds
Laundry starch	1/2 ounce
Water	3/4 pint
Corn syrup	1/4 pint
Baking soda	1 ounce
Borax	1 ounce

Stir laundry starch into water, boil and stir until lump-free. Then add corn syrup. Separately in a one gallon container, mix powdered strychnine, one ounce baking soda and stir well. Then pour the entire mixture over grain bait. Mix well and spread to dry (Anon. 1959).

Strychnine Formula 3 - Vegetable Baits

Sweet potatoes	16 pounds
Salt	1 handful
Bicarbonate of soda	1 ounce
Strychnine	1 ounce

Cut sweet potatoes into one-half inch cubes. Sprinkle salt, soda, and strychnine over sweet potatoes. Stir cubes until evenly coated. Use immediately (Weinburgh 1966).

Another control technique for cotton rats reported by Hall and Dalquest (1963) is interesting to note. Natives of Veracruz, Mexico, trap rats by means of a clever dead fall. This consists of two sticks pushed into the ground about six inches apart. A strand of sawgrass is tied between these sticks, about six inches from the ground. A single kernel of corn is tied in the center of the strand of grass. A flat rock is leaned against the grass. The cotton rat enters beneath the rock and cuts the strand of grass in order to obtain the corn. This releases the rock which falls and crushes the rat.

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