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CONTROL OF MEDITERRANEAN PINE VOLE POPULATIONS IN THE SOUTH OF FRANCE

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ABSTRACT: The control of the Mediterranean pine vole through manual bait placement is too fastidious. It prevents the realization of collective control on large areas. In this situation, mechanization is necessary. A burrow builder, made of a tubular ploughshare, has been devised in order to make artificial runs in the soil where baits may be deposited. This plough was successfully tested in fall 1989 in apple orchards with a wheat-based bait treated with chlorophacinone, chosen for its good resistance to moisture. The treatment efficiency varied between 86.7% and 96.4% with 25 and 50 artificial runs per hectare, respectively. A humid but well-dried-out (i.e., moist but not wet) soil is the necessary condition for successful treatments so that the runs may not collapse. New tests with other types of baits in other crops overrun by the Mediterranean vole are necessary to confirm these results.

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INTRODUCTION

Farmers of the French Mediterranean areas can fight against the Mediterranean vole (Pitymus duodecimcostatus) populations thanks to the control techniques developed by the ACTA-FRGDEC-INRA-SPV[1] National Study Group since 1986. However, treatments based on a manual application of baits are very fastidious and high in constraints due to the required labor which increases the costs. This leads to a certain lassitude, particularly among the arboriculturists in charge of large farms as the long duration of the treatments makes it impossible to collectively control large areas, thus lowering the efficiency of vole control on the most ravaged and susceptible crops. This underlines both the urgency and necessity to mechanize the distribution of the baits. This is developed in the following pages, after some discussion of the depredatory activity and the biology of this vole.

CROPS DAMAGED

Living mainly underground, the "twelve rib vole" mainly feeds on the underground parts of plants. As it feeds principally on roots, stems at ground level, and the bark of trees, this damage often quickly leads to the death of the plant. From the cultural point of view, the subsequent damages are sometimes spectacular in many agricultural crops except vineyards, which seem not to suffer from this ravager. Generally speaking, the perennial crops represent an extremely favorable environment to the settling and survival of the vole. The fruit trees (apple, peach, cherry, etc.), the vegetable crops (artichoke, asparagus), the seed-breeding crops (alfalfa, etc.) are particularly susceptible. Paradoxically, in recent years, the market gardening crops have been attacked too, despite their very short vegetation (growing) periods. The economic impact of the observed depredations is substantial, as losses often reach several thousands to tens of thousands French francs per hectare (Guedon 1987, and grower survey in progress).

[1]ACTA = Association de Coordination Technique Agricole.
FGDEC = Fédérations des Groupements de Défense contre les Ennemis des Cultures.
INRA = Institut National de la Recherche Agronomique.
SPV = Service de la Protection des Végétaux.

AREA OF DISTRIBUTION

Only found in western Europe, the Mediterranean vole lives in the main part of the Iberian peninsula and in the south of France, inhabiting the areas of Perigord, Languedoc, Roussillon, Provence, Alps, and Rhodanian basin (Fig. 1) (Schilling et al. 1986).

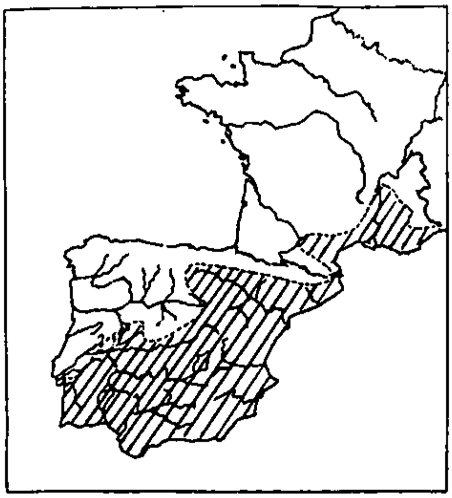

Figure 1. The Mediterranean vole's distribution in western Europe.

BIOLOGY OF THE MEDITERRANEAN VOLE

The Mediterranean vole is a small rodent, grey when young and golden brown when adult. It weighs 20 to 30 grams and measures 10 to 14.5 centimeters, including a 2 to 2.5-cm-long tail. In light and alluvial soils, it builds a burrow made of superficial and deeper runs and a nest whose composition varies according to the specific constituents of the surrounding flora. The presence of the Mediterranean vole is easily recognized by the gradual development of small mole hills of various sizes and distances between one another, made of the soil displaced while building the burrow.

However, in certain crops, the vole may be only detected through the appearance of damage (drying plants), with the mole hills being hidden under the vegetation.

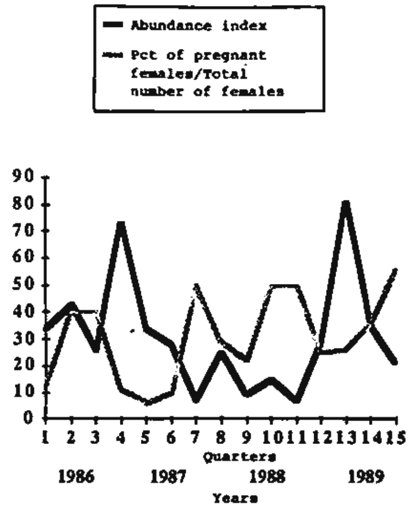

Figure 2. The abundance index and rate (i.e., percent) of pregnant females in a population of Mediterranean voles measured quarterly in an apple orchard (Gard, France) from January 1986 to September 1989.

The Mediterranean vole mainly breeds in the spring and the fall, but pregnant or lactating females and juveniles can be trapped year-round, especially if the climatic conditions in the winter are favorable. This also depends on the farming practices in summer, particularly in reference to irrigation or watering (Fig. 2). The species seems to present a low breeding potential in terms of litter size (averaging 2 to 3 young). But neither the number of litters per female nor the life expectation has been determined yet, which does not allow confirmation of this hypothesis. Tests currently being carried out would answer these unknowns.

CURRENT METHODS OF CONTROL

Our aim here is not to develop the methods, which have already been described (Guedon et al. 1990, in press), but to underline that the rodenticides used to date (chlorophacinone and bromadiolone, LIPHA) in an integrated pest control program were both very effective (Table 1) and to recall that manual distribution of baits directly in the vole runs hinders the success of large-scale collective treatments.

The struggle against another rodent, the terrestrial vole (Arvicola terrestris), carried out for several years through bait distributing burrow builders (called "mole ploughs") in average altitude meadows in Franche-Comté and Central Massif provides a good example of mechanized bait distribution and the collective control achieved (Meylan 1977, Halbert 1981, inter alia). This has provided encouragement to explore and use this type of mechanized bait application.

Table 1. The results of field efficacy tests with chlorophacinone and bromadiolone baits evaluated in apple orchards during 1987-88 and 1988-89 campaigns (Herault and Gard, France).

Rodenticide	Baits Active constituent in bait (mg/kg)	Treatment effectiveness (%) for the different tests: after 12 days	Treatment effectiveness (%) for the different tests: after 21 days	Treatment effectiveness (%) average: after 12 days	Treatment effectiveness (%) average: after 21 days
Chlorophacinone	Wheat	100	98		
	(75 mg/kg)	96.2	100		
		83	97	91	97.6
		-	98		
		85	95		
Chlorophacinone	Muloxyl pellet	100	100		
	(75 mg/kg)	89	87	95	87.7
		92	72		
		99	92		
Bromadiolone	Wheat	99	100	99	100
	(50 mg/kg)				
Bromadiolone	Dehulled oats	85	100		
	(50 mg/kg)	85	83	85	94.3
		-	100		

MECHANIZATION EXPERIMENTS

Tests were carried out in February 1989 with 1 or 2 ploughshare ploughs belonging to arboriculturists. Some of these devices had no packing wheel behind the coulter. The light soils, relatively dry for the season, did not allow the building of artificial runs because the soil was too crumbly and collapsed. However, in a plot with a more humid (i.e., moist) soil, runs could be obtained. The results, although limited, left some hope for the system's reliability, provided that it was used in relatively humid soils. New tests were then scheduled for fall 1989, the most suitable period for the fight against the Mediterranean vole based on its breeding cycle.

MATERIAL AND METHODS

Crop and Plot Selection

Apple orchards represent the agronomical production which is the most subject to Mediterranean vole attacks (survey in progress). Therefore they were selected for the tests, knowing that no soil treatment would then disturb the animals during the test period.

The plots necessary for the tests were chosen subject to two criteria: 1) a high degree of overrunning, witnessed by a large density of recent mole hills and 2) cropping techniques to be representative of what is usually carried out by the arboriculturists. These include: artificial meadow between the tree lines, tree plantation on variable size hills, mound weeding, and summer watering by aspersion.

Bait Distribution Equipment

From the observations made during the earlier tests in February 1989, a prototype plough was constructed by the OSELLA Pére & Fils company (Société OSELLA Pére & Fils, Route de Saint Andiol, 13440 Cabannes), which had previously supplied a burrow-building plough. This prototype plough was designed with a new and unique ploughshare; the supplier surmised that a device with two (i.e., double) ploughshares had limitations in apple orchards, especially for maneuvering around the ends of the rows.

Several modifications of the existing devices have been made. The tubular ploughshare, around 7 cm in diameter, is longer, starting from under the packing wheel. An extra packing wheel has been added behind the coulter. It can be adjusted in height and thus allows adapting the deepness of the ploughshare and ensuring the compactness of the runroof. The front disk, adjustable in height, and the coulter above the ploughshare are as sharp as possible to allow good penetration into the soil to neatly cut the roots and ensure the efficiency of the packing wheel. The risk of any bait spillage on top of the ground must be strongly avoided. The ploughshare-wheel-disk-coulter-feeder system can slide along an axis and the plough is carried on the three-point linkage of a tractor.

The first technical tests of this plough have confirmed its ability for building quasi-perfect runs in humid but well-dried-out soils in the 20-cm superficial layer, whether they are planted with grass or not.

The running principle is as follows: The bait, coming from the feeder, passes through a tube at the coulter level and is placed into the artificial run through the tubular ploughshare, open on its inferior side. This bait (grain or pellets) is distributed in small amounts every 60th centimeter. This bait distribution rhythm of the feeder system is produced by the disk on which two masses are fixed and thus the baiting distance is determined by half a circumference (60 cm) of the feeder disk. The bait drops through the door of the feeder and down the tubular ploughshare.

Bait

For the test, a wheat/chlorophacinone mixture (75 mg of chlorophacinone per kg of bait) was selected from the bait-rodenticide combinations tested since 1987. Wheat, as with most of the cereals, has an excellent resistance to moisture that is indispensable for this type of distribution. The use of chlorophacinone was based on the fact that the Mediterranean vole is more sensitive to chlorophacinone than to bromadiolone.

Treatment Characteristics

Two types of treatments were carried out (Fig. 3): (1) making 2 runs in every interrow space; 50 runs per hectare (trial 1) and (2) making 2 runs in every second interrow space (trial 2). Each run was 70 cm distant from the tree rows. In both cases, the ploughshare was maintained around 15 cm deep. The results of the different treatments are given in Table 2.

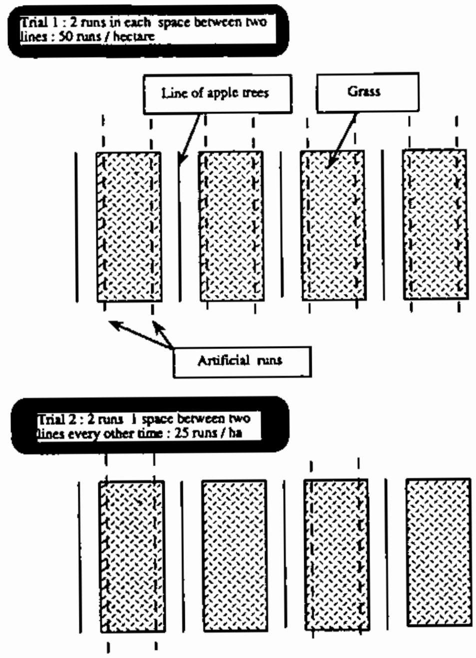

Figure 3. Variation in run numbers and spacing per hectare for treatments through a burrow builder.

The grass was cut prior to the treatment in order to facilitate the disk and coulter action with the formation of a firm runroof through the packing wheel.

Treatment Efficiency Measurement

The effectiveness of the treatment was measured by a method based on vole trapping and following the linear sampling method (Guedon 1987, 1988). It consists of establishing a 100-m long by 5-m wide sampling strip, subdivided into unit squares, 5 m by 5 m each. Every square receives 0 to 2 trapping stations, depending on the overrunning stage, each of which is made of 1 to 3 dead traps, depending on the number of runs found. The trapping operation lasts 3 days and 2 nights. Eight trap collections are made at 3-hour intervals. The total number of captures per trapping strip (all age categories included) thus gives an abundance index of the rodent.

Table 2. Mechanized treatment and plot characteristics for the two trials.

Plot characteristics and treatment	Trial 1	Trial 2
Treated plot area	3 ha (Mudaison - Hérault)	1.7 ha (Lansargues - Hérault)
Dimension: Length (tree row) x Width	300 m x 100 m	120 m x 140 m
Distance between two consecutive tree rows	4 m	4 m
Soil nature	clay with alluvium	clay with limestone
Presence of stones	No	Yes
Type of plot overrunning	rather on tree row	rather in the interrow space
Treatment duration per hectare	3 h 00	1 h 30
Distributed quantity per hectare	30 kg	13 kg

The populations of the treated plots can then be compared to the population of a pilot plot before and after treatment. Actually, some captures were made on the whole test area prior to the treatment (from Nov. 2, 1989).

The two trapping series were made after the treatment, t (the latter being carried out on Nov. 28 for trial 1 and December 5 for trial 2): 1) at time t + 14 days: the result is the direct evaluation of the efficiency and quickness of the used product and 2) at time t + 21 days: normally all the animals having absorbed the toxic feed would be dead. If living animals are left, three reasons can be found: 1) new overrunning on the tested plot from surrounding plots, 2) residual nests of voles not being related to the artificial galleries, and 3) insufficient absorption of product.

Trial Running

The trapping was made in good climatic conditions throughout the test. The populations, high in concentration, allowed obtaining high abundance indexes, thus increasing the reliability of the results, especially on the pilot plot. Abundant and regular rainfall delayed the treatment from the first part of the experiment. However, there was the advantage that humid and well-dried-out soil favored the building of good artificial runs. No disturbance occurred between the control trapping at t + 14 and at t + 21 days.

RESULTS AND DISCUSSION

The trapping results and the treatment effectiveness is expressed in percentages, as per the Henderson and Tilton formula (1955), and are presented in Table 3.

Table 3. Effectiveness of treatments made with a burrow builder.

Plots	Abundance Index			Effectiveness[a] %	
	Prior to treatment	After treatment			
		à t + 14 days	à t + 21 days	à t + 14 days	à t + 21 days
Pilot (untreated)	72	90	94	-	-
Trial 1 2 runs every interrow space	64	10	3	87.5	96.4
Trial 2 2 runs in every second interrow space	52	19	9	70.8	86.7

[a] $E = 100 \times \left(1 - \frac{N_{Ta} \times N_{tb}}{N_{Tb} \times N_{ta}} \right)$

N = Abundance index
a = prior to treatment b = after treatment
T = pilot plot t = treated plot

This table confirms the very good efficacy of the mechanically applied treatments against the Mediterranean vole. Three weeks after the treatment, the results are similar to the ones obtained by manual treatment (Guedon et al. 1990, in press). The efficiency gap between the trapping at t + 14 days and t + 21 days can probably be explained by the fact that the vole needs more time to find the bait in the artificial run (mechanical treatment) than in the burrow (manual treatment).

The efficiency gap between trial 1 and trial 2 may be due to two factors: (1) in trial 2, the voles have half as much chance to meet an artificial run and (2) in the same trial, the soil was sometimes drier, which led to run collapses. The trapping at time t + 21 days revealed an intact nest of animals having probably not consumed any bait.

CONCLUSION AND PROSPECTS

The bait distributing burrow builder appears to be a good application technique for controlling the Mediterranean vole in orchards. The duration of the treatment, divided by 3 to 6, depending on the number of runs in the interrow spaces compared to the manual treatment, allows us to consider possible collective control on a large scale (incorporating vineyards, along with fallow lands when possible). Sensitive crop protection would then be achieved. However, this should not prevent the checking of the plots 1 month after the treatment and possibly a manual treatment of some residual or new nests. If a second mechanical treatment happens to be necessary in the same season, it would be recommended not to go through the same runs, as the runs would then not form well (Guedon 1986). The treatments, which were often only possible at the end of fall or in winter due to the harvesting operations, could then be made in late summer. If the soil were too dry, watering would restore the necessary moisture.

As for the drawbacks of the mechanical treatment, it is true that necessary amounts of baits are greater and that a plough has to be purchased (although it is sometimes possible to use it in common). But this extra cost is largely counterbalanced by the drop in necessary labor and above all by the avoided damage. This technique could be extended to other crops: nursery crops (alfalfa, clover), vegetable crops, and, of course, vineyards, a major vole-sheltering vegetal cover. Tests should be scheduled in asparagus fields, as this production is not subject to the same farming practices. Lastly, treatments with pelleted baits should be considered.

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