

DEPARTMENT OF AGRICULTURE, SOUTH AUSTRALIA

Agronomy Branch Report

1969/70 DISTRIBUTION OF MICE IN SOUTH AUSTRALIA
AND BROAD-ACRE TREATMENT FOR MICE

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INDEXPAGE

SUMMARY

1. BACKGROUND	1
2. DISTRIBUTION AND DENSITY OF MICE IN SOUTH AUSTRALIA - 1969	2
3. BROAD ACRE APPLICATION OF STRYCHNINE	3
4. ALTERNATIVES TO STRYCHNINE FOR BROAD ACRE CONTROL OF MICE	4
5. STRYCHNINE BAITS	4
5.1 Observations in strychnine baited cereal crops	4
5.2 Preparation of strychnine baits	5
5.3 Notes on the ingredients of strychnine baits	7
5.4 Rate of application	7
5.5 Time of application	7
5.6 Cost of treatment	8
5.7 Effects on wild life	8
5.8 Discussion and conclusions	8
6. NATURAL DECLINE IN MOUSE POPULATIONS IN 1970	9
7. ACKNOWLEDGEMENTS	10
8. REFERENCES	10
APPENDIX I - 1969-70 Monthly rainfall (points) for Kadina Sedan and Pinnaroo - areas where mice damage occurred in maturing cereal crops.	
APPENDIX II - Observations made on cereal crops treated with 6 lb. of 0.1 percent strychnine wheaten bait per acre for mouse control in the Murray Plains - Murray Mallee area.	
APPENDIX III - Dosage of strychnine required to kill mice based on the LD50 value for strychnine on mice.	
APPENDIX IV - Distribution of mice, 1969.	

SUMMARY

During 1969, populations of the mouse, Mus musculus L., reached densities considered to be "plague proportions" over large areas in many of the agricultural districts of South Australia. In some areas high densities remained until June, 1970.

Conditions leading to these high densities are described and the distribution of higher than normal densities of mice is outlined. Because of the threat that these high densities of mice could cause extensive damage to maturing cereal crops, the use of strychnine wheaten baits for crop protection was investigated. Recipes for strychnine wheaten baits are given, together with suggestions on the rate of application and timing of treatment to offer maturing cereal crops some protection from mice.

1. BACKGROUND

Newsome (1969) showed that on black cracking soils associated with the heavier red-brown earth soils of the Turretfield Research Centre the numbers of mice, Mus musculus L., in open cereal fields during spring, summer and autumn depended on the number of colonists invading the fields to commence breeding in spring, suitability of the soil for burrowing and food supply. If mice could not build burrows, they did not breed and, without the humid conditions provided by the subsoil moisture in the burrows, the mortality rate of mice was high in the heat of summer. Evidence indicated that plague densities existed in autumn from a particular weather pattern. Good rains in the previous winter and spring were needed to ensure both good subsoil moisture during the summer and seed production sufficient to provide food until autumn. Also, periods hot enough to crack the soil followed by unseasonal rains sufficiently heavy to moisten the soil and allow mice to burrow were necessary during summer.

On light sandy soils, conditions for burrowing by mice were not studied, though it was known that pregnant females would not burrow and give birth if the soil surface was dry, even though there may be suitable moisture levels within an inch of the surface. The other two factors controlling mice numbers in open fields with red-brown earth soils would apply to fields with sandy soil.

Usually, mice begin breeding in the field in spring and die out or seek protective winter niches in late autumn with the onset of the opening rains and cold weather; rains flood the burrows and mice are either drowned or exposed to extremes of cold which they can not withstand. In the 1968-69 summer, there were higher than normal mice populations in the field in many of the agricultural areas of South Australia and there was not the decrease in numbers in the late autumn and early winter, especially on the light sandy soils of the state. Higher numbers of mice were due to the exceptionally high rainfalls recorded in February and March (see Appendix I) and the presence of excess suitable food resulting from the previous spring's excellent pasture growth and the barley and wheat grains shed as a result of wind. (Losses of up to 15 bushels of barley per acre were recorded in the Murray Mallee). Unusually high survival during the 1969 winter was due to a mild winter. The winter rainfall pattern did not cause prolonged periods of flooding of paddocks and this may have benefited survival. With the record grain harvest of 1968, large quantities of grain were stored in the field because bulk handling facilities were not available. Grain was stored in open heaps, clamped heaps, hessian lined mesh silos, iron silos and grain sheds. Deliveries from farms to the Bulk Handling Co-operative continued till May, 1969, and this stored grain provided more food than usual for the mice during early winter.

In June, 1969, populations were high in pasture paddocks and self-sown cereals in areas with light soil on the Upper Eyre Peninsula, northern Yorke Peninsula and Lower North districts. Mice moved into newly seeded areas and dug up cereal grain and damaged emerging cereals. Many of the affected areas needed re-seeding. In July, damage to newly sown crops occurred, but, by the end of July, there was a decline in field numbers thought to be caused by frosts and a shortage of paddock feed for the mice. In August, mice were in relatively high numbers in the field on Eyre and Northern Yorke Peninsulas, and in the Lower North and the Murray Mallee districts. On Eyre Peninsula they caused heads to drop in early maturing self-sown wheat crops and in other areas damage occurred in tillering cereal crops. During September mice numbers were very high in the above districts and extensive damage occurred to ripening barley crops in the Murray Mallee and adjoining areas of the Murray Plains. On the lighter soils in the other areas, cereals and, to a much lesser extent, field peas were being damaged by mice.

Farmers in infested districts were concerned about the level of damage which might be caused because early maturing barley crops had been completely stripped in the Purnong-Bow Hill district by the end of September and the main breeding season was yet to come. It was highly likely that there would be "plague" numbers during the next summer because there was a large number of "colonists" to begin breeding and suitable food was becoming available in most of the districts. Increased numbers of mice could cause damage to unreaped cereal crops, stored grain, hay reserves, and, if the numbers continued till the autumn months, more extensive damage might occur to newly sown cereals than occurred in the previous season. A less obvious problem associated with high densities of mice in the field during summer is the removal of pasture species' seed reserves which can affect the quality of the pasture in the next season.

This report discusses the areas affected by mice during the 1969-70 summer and autumn in South Australia and observations made on aerial treatment with strychnine baited wheat for broad-acre control of mice. Control of mice in other situations on the farm has been described by Allen (1969).

2. DISTRIBUTION AND DENSITY OF MICE IN SOUTH AUSTRALIA - 1969

Distribution of larger than normal densities of mice in South Australia during 1969 is shown in Appendix IV. Density of mice was divided into two levels of infestation.

- (a) High density of mice - areas with higher than normal but not "plague" populations.

- (b) Very high density of mice - areas with "plague" populations.

Where infestations occurred, there was a close correlation between the very high density of mice areas and light sandy soils.

Maturing cereal crops in areas with a very high density of mice were damaged by mice and some crops were treated with strychnine baits. Damage to cereal crops in areas with a high density of mice was limited.

3. BROAD-ACRE APPLICATION OF STRYCHNINE

When it was first evident that broad-acre control of mice was necessary, use of strychnine treated grain was not generally accepted because of the suspected risk to native grain feeding mammals and birds and the expected high cost of treatment.

Discussions held with the Director of the Department of Fisheries and Fauna Conservation, Field Naturalists Society and the Ornithological Society resulted in the following comments for control of mice in maturing cereal crops -

- (a) Serious economic loss from mice was occurring
- (b) Strychnine appeared to be the only available and satisfactory bait to use against mice.
- (c) Native birds do not go into maturing cereal crops.
- (d) Quail are at some risk but the above Societies were sympathetic for the need to save productive crops.
- (e) Strychnine would be washed off the poisoned wheat and into the ground before harvest.

Strychnine is not regarded as a "secondary" poison and there is little risk of native animals and birds which feed on mice killed by strychnine being seriously affected. Crows were seen feeding on large quantities of dead mice in a treated cereal crop at Purnong, but there were no reports of dead crows from the district.

At first, public statements about using strychnine for mice control were not made because a suitable bait mixture was not developed, nor was there any knowledge of both the best rates to use and methods of application. Also, it was not known how to assess mice densities to give basic recommendations. Treatment rates and methods were discussed initially with individual farmers. Now, recipes for strychnine baits have been developed and are circularised (Allen 1970), but there is still little information on the densities of mice which require treatment.

4. ALTERNATIVES TO STRYCHNINE FOR BROAD-ACRE CONTROL OF MICE

Sodium fluoro-acetate (1080) is a poison which is used successfully for the broad-acre control of rabbits. Baits containing 0.04-0.08 percent of sodium fluoro-acetate were used in sheds to control mice on Eyre Peninsula but were not as effective as strychnine baits. For this reason, and also because sodium fluoro-acetate is many times more toxic to mammals and birds than strychnine and is a "secondary" poison, it was not recommended for broad-acre control of mice.

The use of anticoagulant poisons (warfarin, coumatetralyl, chlorphacinone) were not considered for broad-acre control of mice. These rodenticides depend on continuous free feeding for 5 to 7 days which means that baits would have to be supplied and kept fresh for this period of time. This treatment would be uneconomic in cereal crops or pastures.

Endrin and mevinphos (Phosdrin^(R)) treated wheat control mice. Endrin, a highly persistent, organic chlorine compound, is not recommended because of the inherent residue problems in primary products which is associated with its broad-acre use. Mevinphos is not recommended since it has a much higher mammalian toxicity than strychnine and is a greater hazard to operators; a report was received of two operators needing hospitalisation after handling mevinphos baits for mouse control in the Lower North, even after they had been advised not to use that material.

5. STRYCHNINE BAITS

5.1 Observations in Strychnine Baited Cereal Crops

Replicated trials were not carried out to test the efficiency of different strengths of strychnine baits at different rates of application for controlling mice in maturing cereals.

The first broad-acre treatment of mice with strychnine in 1969 was in a barley crop at Purnong in mid-September where 0.1 percent strychnine bait was applied at 2 lb of bait per acre from and aircraft. Inspection a week after treatment showed that up to a 100 percent of heads were affected in many parts of the crop and, though there were dead mice present, evidence of fresh damage was plentiful.

The rate of application of 0.1 percent bait was increased to 6 lb of bait per acre for future paddocks treated (Appendix II) but it was difficult to interpret the true economic effect of these

baits. This was due to two factors:

- there was no practical method of estimating mice densities in a paddock, hence the effects of the treatments could not be measured directly.
- there was a significant natural decline in mice densities after treatment. The decline was thought to be due to the very dry October (Appendix I).

Crops were treated at Freeling with 0.3 percent strychnine bait applied at 4 to 6 lb of bait per acre in early October. This bait was considered to give the crop sufficient protection from mice but a true assessment was clouded by the natural decline in mice similar to that found in the Murray Plains-Murray Mallee districts.

Mice increased in numbers during November and December but at this stage most cereal crops were fully matured and it was too late for treatment.

Observations made on results from treating maturing cereal crops with strychnine baits for mouse control were not decisive enough to make a confident recommendation for mouse control. It was considered that better control would be obtained if a stronger bait than 0.1 percent strychnine was used. This resulted from both field observations and the fact that strychnine is a "one-shot" poison. If an animal takes a sub-lethal dose of a "one-shot" poison with its first feed it usually becomes bait shy. With an 0.1 percent bait, mice need to consume at least ten grains of wheat for a lethal dose, while with a 0.3 percent bait, this quantity is reduced to three to four grains (Appendix III). The amount of grain consumed by a mouse each time it feeds is not known, but it is a more efficient baiting technique if the amount to be eaten is kept to a minimum. In this case, cost of treatment does not become prohibitive by increasing the percentage active ingredient of the bait to 0.3 percent when it is applied at 4 to 6 lb per acre.

5.2 Preparation of Strychnine Baits

The following two baits were developed from information from the New South Wales Department of Agriculture, Northern Territory Administration, Queensland Department of Primary Industries, C.S.I.R.O, Division of Wildlife and local spray contractors, and from observations made in the field and a knowledge of the toxicity of strychnine to mice. Both baits contain 0.3 percent strychnine.

Bait No. 1

Ingredients

1 oz strychnine

$\frac{1}{2}$ fl oz of 36 percent hydrochloric acid (spirits of salts)

1 cup honey or 8 oz sugar plus 3 oz flour

$\frac{1}{2}$ - 1 pint hot water

20 lb wheat

Mixing procedure

- mix strychnine and hydrochloric acid with a small quantity of hot water to form a smooth paste.
- add honey to rest of hot water and mix well. If sugar and flour used, dissolve the sugar in the rest of the hot water and then add the flour slowly to form a smooth paste.
- add the strychnine paste to the honey or sugar mixture.
- add the mixture to the wheat in a concrete mixer and mix thoroughly.
- allow bait to dry for 4 to 12 hours before use. Time to dry depends on the quantity of water used.

Bait No. 2

Ingredients

1 oz of powdered strychnine

8 oz sugar

3 oz flour

1 oz sodium bicarbonate (baking soda)

$\frac{1}{2}$ - 1 pint hot water

20 lb wheat

Mixing procedure

- mix strychnine, sugar and sodium bicarbonate in the hot water
- add flour slowly to form a smooth paste
- add the mixture to the wheat in a concrete mixer and mix

- allow bait to dry for 4 to 12 hours before use. Time to dry depends on the quantity of water used.

Only sufficient bait for one application at any one time should be mixed to prevent accidental poisoning.

5.3 Notes on the Ingredients of Strychnine Baits

Honey, sugar and sodium bicarbonate were used to mask the bitter taste of strychnine. Flour was used as an adhesive to stick the mixtures to the grain; this was not needed when honey was used.

Hydrochloric acid reacted with strychnine to give strychnine hydrochloride, a compound which is 200 times more water soluble than strychnine alkaloid - the commercial preparation of strychnine used in the recipes. Using the more soluble salt of strychnine may help to provide a more even coating of strychnine over the grain and will probably reduce residue problems because it is more easily leached. The amount of water used in Bait No. 1 is not sufficient to dissolve all the strychnine hydrochloride. At least two pints of water is required to dissolve all the strychnine hydrochloride when 1 oz of strychnine is used; this quantity of water per 20 lb of wheat made the baits too moist for aerial application. The use of only a half to one pint of water gave an even cover of strychnine hydrochloride over the seed even though it was not all dissolved.

5.4 Rate of Application

For field application, evenly apply the 0.3 percent strychnine baits at 4 to 6 lb per acre from aircraft or ground equipment. It is important that these baits are applied evenly over a paddock since mice will not move far to forage for food when there is abundant food around them, as occurs in maturing or newly sown cereals. Aerial application with equipment inadequate to provide an even distribution of bait was seen. The changes of good mouse control with poorly designed equipment are reduced. Lower rates of application apply mainly to treatment of newly sown cereals.

5.5 Time of Application

Methods were not developed to give a practical assessment of mice densities in a paddock or to correlate mice densities with damage to maturing cereal crops. Inspection of damage in maturing cereal crops showed that the amount of damage

was not related to the number of mouse-holes in the field. Decisions on when to treat for mice could not be made by assessing the number of holes per unit area.

On some properties treatment was carried out too late for two reasons. First, most of the damage had been done and there was little value in saving the remainder of the crop, and secondly, the crops had matured to a stage where grain was dry enough to be acceptable food for mice and so competed with the baits.

If wheaten baits are applied to paddocks while the maturing grain is in the milky ripe and mealy ripe stages, the baits will be more acceptable to the mice than the maturing grain.

Before treating maturing cereal crops, assess the rate of damage by inspecting crops regularly. Where damage is judged to be increasing, treatment may be worth while to provide the crop some protection against mice.

5.6 Cost of Treatment

Cost of strychnine for treatment with 0.3 percent baits varied from \$0-60 to \$1-00 per acre, depending on the rate of application. Cost of application by aircraft varied from \$0-50 to about \$0-85, depending on the area to be treated and the operator.

5.7 Effects on Wild life

There were no substantiated reports of wild life being affected in areas where broad-acre treatment with strychnine baits was carried out.

5.8 Discussion and Conclusions

Because of the urgency for suitable baits to control mice in maturing cereal crops, there was not time to develop techniques for assessing mice densities in a paddock which would be used in replicated trials to test the effect of different treatments on mice. Paddocks which were treated aerially with strychnine baits were inspected before and after treatment and were compared with infested paddocks not treated in similar areas. The true effect of the strychnine baiting could not be assessed because there was a significant natural decline in mice numbers soon after treatment thought to be caused by the very dry October.

From some field experience and the use of the oral LD50 value of

strychnine for mice, it was reasoned that it was better to use at least a 0.3 percent strychnine bait than lower percentages. This would help to prevent bait shyness which can occur with sub-lethal doses of "one-shot" poisons such as strychnine.

Baits were formulated which included 0.3 percent strychnine. In one bait, the strychnine was first dissolved in hydrochloric acid to give the water soluble salt, strychnine hydrochloride. This form of strychnine probably reduces residue problems since it is leached more easily. It is suggested that this type of bait should be used for treatment of mice in the spring rather than in autumn when there is more chance for rain to wash the strychnine hydrochloride away before it has a chance to be effective. The other bait, incorporating strychnine alkaloid, would be more effective in autumn.

Because mice do not travel far for food when there is an abundance of food around them, e.g. in a maturing cereal crop, baits should be spread evenly over the area treated to cover the foraging area of most mice in the paddock. Early treatment would give more efficient results since the bait is more acceptable than the maturing grain and minimum damage has occurred.

Baiting techniques developed during this period of very high mouse densities are not meant to be a conclusive recommendation for broad-acre mouse control, since they were not properly tested. But they do provide a background to assist in protecting crops from mice in the advent of future infestations. Use of these baits was not a major threat to wild life.

6. NATURAL DECLINE IN MOUSE POPULATIONS IN 1970

Mice were not found in very high densities on Eyre Peninsula after September, 1969; the decline in density was thought to be due to frosts which occurred during that month on Eyre Peninsula. In early 1970, mice were still in very high densities on Yorke Peninsula and in the Lower North and Murray Mallee areas shown in Appendix IV for 1969. During January, February and March, mice damaged haystacks, bagged grain and cereal stubbles, and pasture seed residues were being reduced in these areas. In April, mice were active but, with the onset of colder weather, they were leaving fields and invading buildings to seek protective winter niches. Minor damage occurred in newly sown cereal crops on Yorke Peninsula and in the Lower North during May and this became more significant only on Yorke Peninsula (Maitland-Minlaton) during June. By July there were only low densities of mice in the open fields in South Australia and there were no further reports of broad-acre mouse damage.

7. ACKNOWLEDGEMENTS

The authors wish to thank the District Agricultural Advisers in mouse infested areas for information on the distribution of mice and extent of damage caused by mice.

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APPENDIX I

1969-70 Monthly Rainfall (points) for Kadina, Sedan and Pinnaroo - areas where mice damage occurred in maturing cereal crops

		Jan.	Feb.	Mch.	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.
Kadina	1969	37	257	106	70	318	119	289	151	204	14	71	104
	1970	37	0	5	179	159	147	117	198	257	4	98	77
	Mean	58	66	78	142	194	207	191	180	146	132	86	70
Sedan	1969	40	488	143	48	89	36	165	91	114	5	29	110
	1970	38	0	26	56	68	49	23	161	244	14	162	75
	Mean	57	67	64	90	129	141	120	141	122	115	72	71
Pinnaroo	1969	6	645	258	32	189	28	202	57	145	0	59	112
	1970	60	8	44	248	76	124	49	144	156	47	271	106
	Mean	64	90	75	90	145	145	131	144	140	131	102	84

APPENDIX II

Observations made on cereal crops treated with 6 lb of 0.1 percent strychnine wheaten bait per acre for mouse control in the Murray Plains - Murray Mallee area

Property	Date Treated	Date Inspected	Remarks
C. Marks - Purnong	*17/ 9/69	25/ 9/69	Up to 100 percent of heads damaged. Many dead mice followed baiting but evidence of fresh damage plentiful.
E. Hage - Bowhill	25/ 9/69	1/10/69	Appeared to have about the same number of active holes before and after treatment. Damage still occurred but did not seem sufficient for the mice population. Bait still present.
	27/ 9/69	1/10/69	Evidence of fresh damage reduced but fresh holes still being dug. Uneten bait easily found.
J. Cockshell - Bowhill	Early August	1/10/69	No damage in crop. Mice infestation appeared to have been very light. Treatment earlier than most.
M. Rosensweig - Perponda		1/10/69	Greatest density of holes seen, bait not all eaten, 30 percent heads affected.
J. Maxwell - Sanderson	29/ 9/69	1/10/69	Large quantities of bait present. Fresh diggings reduced compared to diggings seen on 17/9/69.
Webber - Bowhill	27/10/69	1/10/69	Damage 10 to 15 percent. No fresh damage after treatment but natural decline in mice in district.

* Treated with 2 lb of 0.1 percent strychnine wheaten bait per acre.

APPENDIX III

Dosage of strychnine required to kill mice based on the LD50 value for strychnine on mice

Oral LD50 value for strychnine on mice = 15 mg/Kg of body weight.

Average lethal dose for an adult mouse = 0.45 mg.

0.1 percent strychnine wheaten bait has approximately 0.046 mg strychnine per grain.

Hence "average" mouse has to eat approximately 10 grains of 0.1 percent bait for a lethal dose.

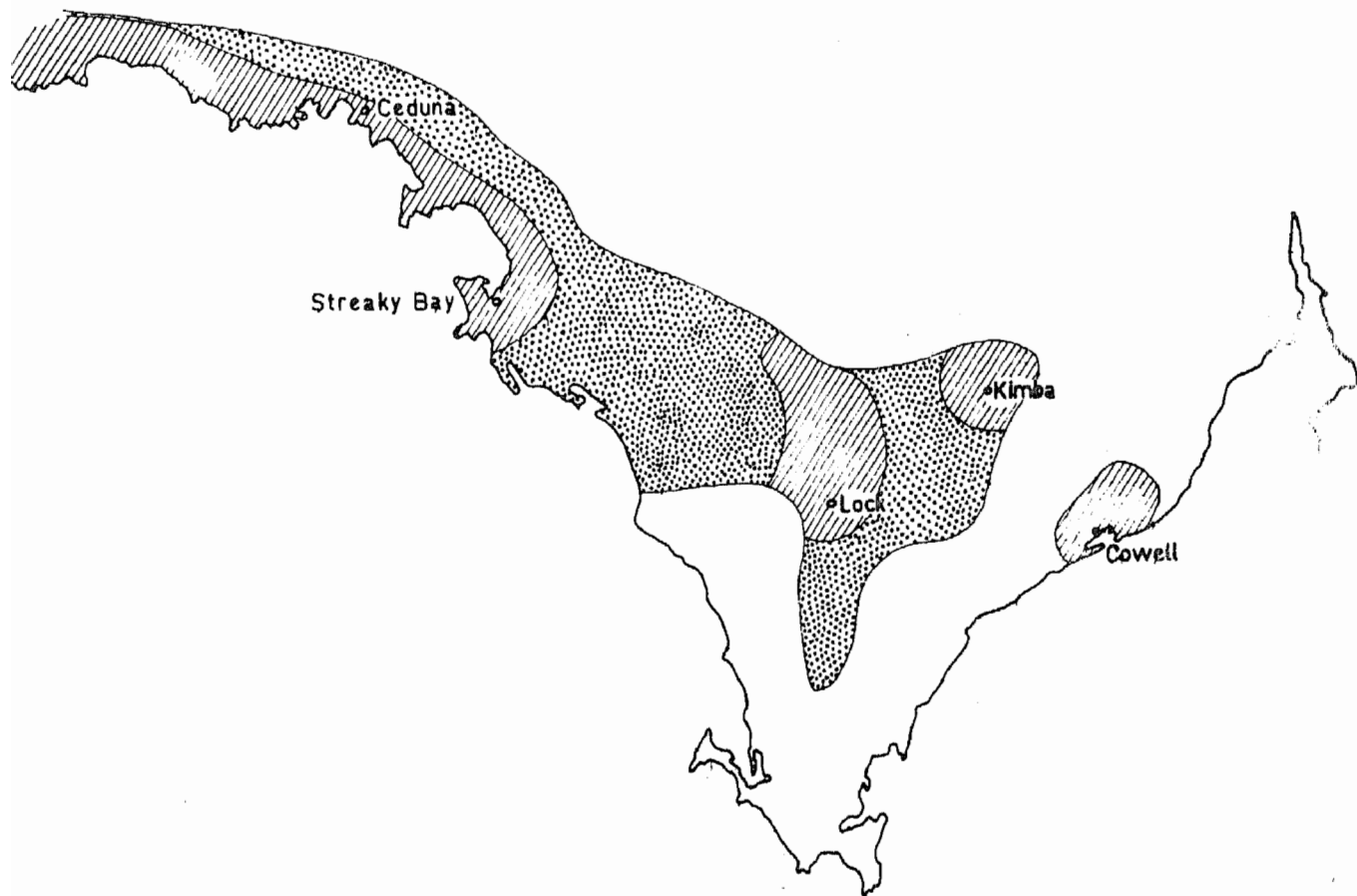
0.3 percent strychnine wheaten bait has approximately 0.138 mg strychnine per grain

Hence, "average" mouse has to eat approximately 3-4 grains of 0.3 percent bait for a lethal dose.

6 lb of wheaten bait per acre is approximately equivalent to 13 grains per square yard.

APPENDIX IV

DISTRIBUTION OF MICE 1969



HIGH DENSITIES OF MICE



VERY HIGH DENSITIES OF MICE

APPENDIX IV

DISTRIBUTION OF MICE 1969

