

The Rat Poisons, Sodium Fluoroacetate and "Castrix."

By W. A. McDOUGALL, D.Sc., Senior Entomologist, Science Branch, Division of Plant Industry. (Formerly Senior Entomologist, Bureau of Sugar Experiment Stations).

SUMMARY

The rat poisons sodium fluoroacetate ("1080") and "Castrix" were tested against Rattus conatus and Melomys littoralis in cages, and against R. conatus in settled field populations.

Feeding tests show that the L.D.50 for R. conatus and M. littoralis respectively are: sodium fluoroacetate, 1.42 mg/kg, 2.23 mg/kg, "Castrix," 4.46 mg/kg, 5.62 mg/kg. An I.T.F. of 3.5 is obtained at a poison strength of 1:1,000 with "1080," and at 1:250 with "Castrix." Both these white powders, which can be used with grain, are technically good rat poisons.

There are strong indications that the general use of "Castrix" would be more dangerous than that of sodium fluoroacetate. The latter (which is water soluble) at a strength of 1:1,000 could replace, without any loss of efficiency, the expensive thallos sulphate in food baits for use in Queensland canefields.

Though highly toxic, neither of these two new rat poisons can replace yellow phosphorus in bread snap baits.

INTRODUCTION

During the past few years two white powders—sodium fluoroacetate ("1080"), which was developed in the United States of America (Kalmbach, 1945), and "Castrix" (2-chloro-4-dimethylamino-6-methylpyrimidine), a German product—have received some attention as promising new rat poisons. Prior to the initiation of the work reported here only sketchy information and reports of some extension work were available.

The manufacturers of 1080 (Monsanto Chemical Co., 1946) gave tentative information on toxicities to a number of animals and on solubilities and other data, and recommended a poison strength of 1 to 2 oz. of 1080 to 100 lb. of grain (1:800 to 1:1,600) for field rodents. Kalmbach (1945) listed the L.D.50 of 1080 for several small mammals, those for species of rats and mice ranging from 0.1 mg./kg. to 5.0 mg./kg. Wilson (1946), using *R. rattus* L., found the L.D.50 of 1080 to be slightly greater than 1.0 mg./kg.

DuBois *et al.* (1948), in a table covering a range of animal families, gave an L.D.50 of 1.25 mg./kg. (S.E. \pm 0.10) for the laboratory rat when Castrix is administered orally. Diets containing 0.25 per cent. to 1 per cent. of Castrix were found to be "readily eaten . . . and . . . highly toxic." The toxicity of Castrix is considerably reduced when used as the hydrochloride (DuBois and Cochran, 1948),

MATERIALS AND METHODS

Virile adult *Rattus conatus* Thomas and *Melomys littoralis* Lonnberg, the most important rat pest species in Queensland canefields, were the test animals. Specimens of both species were used from dormitory cages and from fields in the Mackay and

Gordonvale districts, but neither the source of supply nor the sex of the test animals made any difference to the results.

The 1080 compound used was a technical grade with label assay of "sodium fluoroacetate 90 per cent. minimum, inert ingredients 10 per cent. maximum." Though contained in a 1 lb. tin with a well fitted lid, this highly deliquescent material had to be stored in a desiccator. The sample of Castrix (lot number 8-RD-90) was supplied for investigational use by J. T. Baker Chemical Co., Phillipsburg, N.J., U.S.A.

The methods for testing rat poisons reported previously (McDougall, 1944, 1947) were used in this investigation. Cage data were obtained on the L.D.50 and mean standard intakes at different poison strengths and the 25-rat unit was used for all single tests. When dealing with 1080, prepared food and whole wheat were used as carriers for the fundamental work with feeding stations and food baits. Castrix, as pointed out by DuBois *et al* (1948), is a stimulant of the central nervous system. At doses near the L.D.50 the convulsions caused by this poison were found to be much more severe than those caused by strychnine. Paper screens helped considerably in collecting the food scattered by the poisoned rats in small test cages. Preliminary tests having indicated little difference in results between finely ground prepared food and whole wheat, the latter was used as the poison carrier for intake data, and both bases for L.D.50 determinations only.

Solutions of sodium fluoroacetate in water were used for treating the wheat. Castrix is insoluble in water, so methylated spirit was substituted; the solution was applied either straight or after dilution (1 : 4) with water. The wetting of grain was always kept at a minimum. Pastes of the poisons in a mixture of golden syrup (a sugar refinery product) and flour on bread were tested as snap baits.

All field testing was on multiple or twin 10-yd. feeding station grids in settled *R. conatus* populations with the requisite checks. The standard poisoned food was 1 : 300 thalious sulphate wheat.

RESULTS

Cage Results with Sodium Fluoroacetate

At poison strengths lower than 1 : 4,000 for *R. conatus*, and below 1 : 4,500 for *M. littoralis*, and when a lethal dose is approached at higher strengths, excessive urination takes place. Successful repeat poisonings after sub-lethal doses are difficult and are very rare within one week of the initial poison intakes. However, as this characteristic of a poison has little practical significance in the field poisoning of cane rats, it does not detract from the value of 1080.

Sodium fluoroacetate acts very quickly. Ninety-eight per cent. of the test animals died within 10 hours of taking a lethal dose, though occasionally a specimen lingered for as long as five days. Rats showing illness following the intake of 1080 have an even chance of recovery, which is in marked contrast to the inevitable death following thalious sulphate.

When excess poisoned food is presented, complete kills can be expected with poison strengths of 1 : 2,000 for *R. conatus* and 1 : 3,000 for *M. littoralis*. The intake depression curves due to poison strength are set out in Figure 1; and from these and the L.D.50 data in Table 1 it is seen that the necessary Intake-Toxicity-Factor (I.T.F.)* of 3.5 for the successful field poisoning of cane rats in settled populations is attained at a strength closely approximating 0.1 per cent. (1 : 1,000). This figure applies to both species, as the higher intakes of *M. littoralis* are balanced by the lower L.D.50.

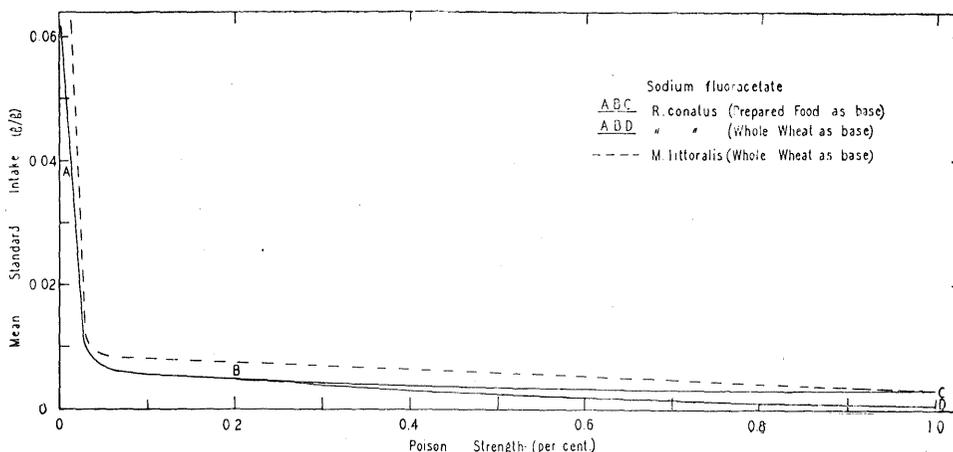


Figure 1.
Intake depression curves due to poison strengths of sodium fluoroacetate.

Table 1
TOXICITY OF SODIUM FLUOROACETATE—PROBIT ANALYSES.

Species	Poison Strength	L.D.50		
		log. dose	mg./kg.	95 per cent. fiducial limit (mg./kg.)
<i>R. conatus</i>	≥ 1 : 3,500	.153 ± .054	1.42	1.11 — 1.82
	≥ 1 : 4,000	.897 ± .134	7.89	4.32 — 14.43
<i>M. littoralis</i>	≥ 1 : 4,000	.348 ± .060	2.23	1.70 — 2.92
	≥ 1 : 4,500	.648 ± .084	4.45	3.05 — 6.50

Whole wheat treated with sodium fluoroacetate has been stored in paper bags for six months without appreciable loss of toxicity or other deterioration.

Pastes on bread ranging in poison content from 0.5 per cent. to 20 per cent. were tested thoroughly. The kills, with a recorded maximum of 81.2 per cent., do not compare favourably with those by yellow phosphorus pastes. It was concluded, therefore, that field trials with 1080 as a snap bait were not warranted.

$$* \text{ I.T.F.} = \frac{\text{Mean standard intake (g./g.)} \times 10^6}{\text{Poison strength} \times \text{L.D.50 (mg./kg.)}}$$

Cage Results with Castrix

In contradistinction to I080, there is no distinct change in the L.D.₅₀ of Castrix at the lower poison strengths. However, the fiducial limits (see Table 2) are much wider than those for sodium fluoroacetate. In fact, occasional large specimens of *R. conatus* survived Castrix intakes of 24-30 mg./kg. after being very sick and weak for some days. There is no evidence of acquired tolerance to or cumulative action of this rapidly acting and apparently cruel poison.

Table 2
TOXICITY OF CASTRIX—PROBIT ANALYSES.

Species	L.D. ₅₀		
	log. dose	mg./kg.	95 per cent. fiducial limits (mg./kg.)
<i>R. conatus</i>65 ± .170	4.46	2.07 — 9.59
<i>M. littoralis</i>75 ± .194	5.62	2.35 — 13.47

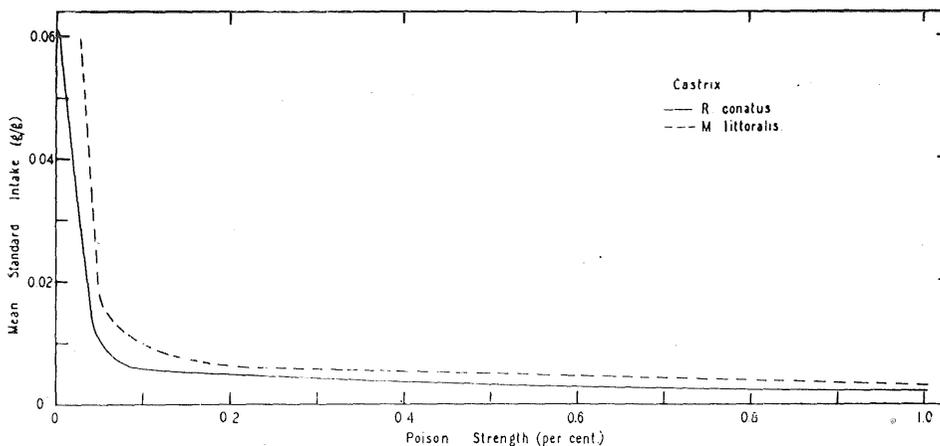


Figure 2.
Intake depression curves due to poison strengths of Castrix.

Using excess whole wheat, the best possible kills can be expected at minimum strengths closely approximating to 1 : 1,000. The intake depression curves due to poison strength are plotted in Figure 2 and from these and the L.D.₅₀ data in Table 2 an I.T.F. of 3.5 is attained at a strength of 0.4 per cent. (1 : 250).

A definite deterioration of Castrix wheat baits after storage for six weeks was detected by statistically sound bio-assay methods. It was found also that linseed oil slowly takes up the white powder with consequent reduction in toxicity.

Working with one 25-rat series of *M. littoralis*, an L.D. 50 of 20 ± 2 mg./kg. for Castrix hydrochloride was recorded. With *R. conatus*, sub-lethal doses of 33.90 mg./kg., 36.4 mg./kg. and 39.2 mg./kg. were taken; intakes at 1 : 500 were irregular and mostly poor.

Castrix pastes as snap baits, similar in preparation and range of poison content to those tested with 1080, gave poor kills and were not taken to the field.

Field Results with Both Poisons

Each test included in Table 3 was carried out on a standard grid, with grid population systems varying from 9 ± 3 to 30 ± 6 active rats per grid base. The percentage kills by Castrix and sodium fluoroacetate at correct strengths compare favourably with those by the standard thallous sulphate.

Table 3

THE EFFICACIES OF THE POISONS AGAINST *R. CONATUS* AT SUITABLE POISON STRENGTHS.

Poison	Number of Tests	Poison Strength	Percentage Kills
Thallous sulphate ..	6	1 : 300	91.0 — 100
Sodium fluoroacetate ..	4	1 : 1,800	40.2 — 75.0
	6	1 : 1,000	85.8 — 100
Castrix	4	1 : 400	48.0 — 62.7
	5	1 : 250	80.4 — 95.3

In Table 4, typical results are given from multiple grids designed to ascertain the intake of the rat poisons by other animals under natural field conditions. The estimated intakes by rats are based on mean standard intakes in cages. The final intakes of unpoisoned wheat, following the removal of all rats, indicates that Castrix at the strength required for successful rat poisoning could be very severe on the canefield fauna as a whole.

Many of the rats poisoned in dormitory cages were made available to cats and dogs. No secondary poisoning occurred when using poison strengths suitable for commercial purposes, but one half-grown cat died after eating rats killed by 1080 at a strength of 1 : 100.

DISCUSSION AND CONCLUSIONS

Sodium fluoroacetate and Castrix are both technically good rat poisons, which can be presented on grain after simple preparation.

There are many popular reports, mostly concerned with work in built-up and closely populated areas, on the dangers of sodium fluoroacetate as a rat poison, but reliable evidence is lacking. It would appear that the high toxicity of the substance and the fact that there is no known antidote have been given much greater prominence than have practical suggestions for the reasonably safe general use of the poison. In Queensland canefields the distribution of rat baits is well controlled, their manufacture is usually under strict and informed supervision, and in recent years only grain has been used as the base for packetted food baits of standardized and known poison strengths. Under these conditions, sodium fluoroacetate, at a strength of 1 : 1,000 on grain, may be used to replace the expensive thallous sulphate without loss of efficiency or safety.

Table 4

POISON INTAKES BY RATS AND OTHER ANIMALS ON THE TEST GRIDS

Grid	Popula- tion by tag- trapping	Pre-poison treatment and results			Poison treatment and results								Post-poison treat- ment and results
		Whole wheat feeding stations for 3 nights			Poisoned wheat at feeding stations for 1 night						Trap-out (3 nights) number of rats taken	Percent. kill by poisons	Whole wheat feeding stations for 3 nights
		Total intake*	Estimated intake by rats	Intake by other animals	Poison	Poison strength	Total intake	Estimated intake by rats	Intake by other animals	Intake by other animals			
A	10 ± 3	707	250	457	Sodium fluoro- acetate	1 : 1,000	416	7	409	1	92.31	231	
B	9 ± 3	988	230	758	Check					11		430	
C	14 ± 4	764	346	418	Thalious sulphate	1 : 300	317	67	250	1	94.44	271	
D	14 ± 4	1208	236	862	Check					15		498	
E	9 ± 3	826	230	596	Sodium fluoro- acetate	1 : 1,800	405	8	397	3	75.0	340	
F	10 ± 3	712	250	462	Castrix	1 : 250	437	4	433	2	84.62	48	

* All intakes in grams.

With regard to Castrix, Thomson (1948) has remarked:—"In spite of the availability of an antidote, sodium pentobarbital (Nembutal), it can be anticipated that accidental poisoning of man and domestic animals will occur with widespread use of the rodenticide." A comparatively high poison content is necessary when using Castrix, field poisoning requirements are exceeded excessively, and the poison has no special commendable qualities. Therefore, the use of Castrix in canefields is not warranted.

ACKNOWLEDGMENT

The author is indebted to Mr. P. B. McGovern, Biometrician in the Division of Plant Industry, for the probit analyses for Tables 1 and 2.

REFERENCES

- DuBois, K. P., and Cochran, K. W. 1948. Studies on the toxicity of Castrix hydrochloride. In Aust. Sci. Res. Liaison Office, Washington, D.C., U.S.A., mimeo. Apr. 30.
- , and Thomson, J. F. 1948. Rodenticidal action of 2-chloro-4-dimethylamino-6-methylpyrimidine (Castrix). Proc. Soc. Exptl. Bio. Med. 67: 169-71.
- Kalmbach, E. R. 1945. "Ten-eighty," a war-produced rodenticide. Science 102 (2644): 232.
- McDougall, W. A. 1944. An investigation of the rat pest problem in Queensland canefields: 3. Laboratory experiments in food intake and toxicity. Qld. J. Agric. Sci. 1 (3): 1-31.
- . 1947. An investigation of the rat pest problem in Queensland canefields: 6. Controls and conclusions. Qld. J. Agric. Sci. 4: 79-139.
- MONSANTO CHEMICAL COMPANY. 1946. Instructions for using the compound 1080 (sodium fluoroacetate) as a rodent poison. Monsanto Chemical Co., St. Louis, Missouri (mimeo. rev. July, 1946).
- Thomson, J. F. 1948. Studies on 2-chloro-4-dimethylamino-6-methylpyrimidine. I. Spectrophotometric estimation of Castrix in blood and urine. In Aust. Sci. Res. Liaison Office, Washington, D.C., U.S.A., mimeo. April 30.
- Wilson, G. 1946. "1080" (sodium fluoroacetate) as a rat poison. Rept. Minutes and Proc. Cane Pests and Diseases Control Boards Conf. Tully, Qld., Aug. 29. (Unpublished).