

W 600353

# CONTROL OF RATS AND MICE

R 184,37 F345

VOLUME 1

RATS

EDITED BY

DENNIS CHITTY



13-14-0

OXFORD AT THE CLARENDON PRESS 1954



Oxford University Press, Amen House, London E.C.4
GLASGOW NEW YORK TORONTO MELBOURNE WELLINGTON
BOMBAY CALCUTTA MADRAS KARACHI CAPE TOWN IBADAN
Geoffrey Cumberlege, Publisher to the University

PRINTED IN GREAT BRITAIN

## CONTROL OF RATS AND MICE

#### **PREFACE**

Anyone who wishes to get rid of rats is strongly advised to obtain the government bulletins referred to in Chapter 1. This will be cheaper and better than trying to use the present volumes as a manual on rat control. There are other views, however, about dealing with rats. These views conflict with the official pamphlets (based on research by the Bureau of Animal Population) and are advocated in much more alluring terms. The private individual may take his choice of method; but where public funds and welfare are concerned the decision must be weighed more carefully. These volumes are intended to help those responsible for such decisions and to describe the viewpoint and techniques required to test existing systems and devise better ones.

Most of the chapters were first written in 1946-7, but it took until 1949 to complete the editing. The typescripts were then submitted for publication (as agreed) by the Agricultural Research Council; but because of a change in policy everything was sent back to us 18 months later. The problem of getting the work published at all was solved only through the generosity of the Delegates of the Clarendon Press and of a donor, who wishes to remain anonymous, who gave £2,000. This gift has already been acknowledged with gratitude by the University and I here add the very sincere thanks of my colleagues and myself. It now became necessary, however, to change the style of the work and limit it to about one-third of its original length, a job which few of the authors were in a position to do and which my own university work has delayed until now. I have had to adopt a fairly ruthless policy of cutting texts and depositing tables and must thank the authors for their kind acceptance of the changes. Those who have not actually worked on rat control may think that there is still too much detail; those who have will know that there is too little. The fuller data showed more clearly the complexity of the field work and the difficulty of reaching conclusions. However, workers in this country can consult our files, and others must in any case find out for themselves how far procedures may be applied elsewhere.

The arrangement of the chapters is planned as follows: strategy, materials, field methods, and general results of controlling rats by poison (Chs. 1-4); aspects of behaviour, especially towards baits (Chs. 5-9); results in particular environments (Chs. 10-14). Studies on methods of

control other than by poison have had to be omitted (Ch. 1, § 9) and the literature since 1946 has not been fully covered.

I wish to thank Miss Enid Richardson and Miss Rosemary Rowse for their remarkable ability to read mutilated typescripts.

D. C.

BUREAU OF ANIMAL POPULATION OXFORD

1 September 1952

#### **ABBREVIATIONS**

A.R.C. Agricultural Research Council

A.L.D. Average Lethal Dose Antu α-naphthylthiourea B.S. British Standard

B.S.I. British Standards Institute

B.S.T. British Summer Time (G.M.T.+1 hour)

D.B.S.T. Double British Summer Time

L.A. Local Authority
L.D. Lethal Dose

M.A.F. Ministry of Agriculture and Fisheries

M.O.F. Ministry of Food

M.O.H. Medical Officer of Health M.O.S. Ministry of Supply

P<sub>3</sub> Protected Poison Point

P.L.H.A. Port of London Health Authority

R.C.T. Rat Control Test

S.A.L.A.M. Société Anonyme Levant-Africaine Méditerranée

W.A.E.C. War Agricultural Executive Committee

Jargon has been avoided as much as possible, but certain terms have been used to save space, e.g. 'arsenic' for arsenious oxide, 'rusk' for moist sausage-rusk. The meaning of terms such as these may be found by looking them up in the index and seeing where they are 'defined' or 'described'.

### CONTENTS

#### VOLUME 1

LIST	OF TABLES							•	xxi
LIST	OF PLATES							. 2	xviii
LIST	OF FIGURES								xxx
ABBR	REVIATIONS								xxxii
1. RE	SEARCH ON R ANIMAL POPU								
	By Charles Elto								I
	1. Introduction								I
	2. Staff .								2
	3. Rat and mous	e infesta	tions in	Britain					3
	4. Rat and mous	e control	in Brit	ain befor	re 1940				5
	5. Reconnaissand	ce		·					6
	6. Poison supplie	es							9
	7. Field methods	s of poiso	on baitin	ıg					II
	8. Operational re	esearch							14
	9. Subsidiary con	ntrol met	thods						16
	10. The biology of	f rat pop	ulations					¥	17
	11. Research on t	he house	mouse	(Mus mi	ısculus)				19
	12. The processin	g and di	ssemina	tion of r	esearch	results			19
	13. Extension of 1	esearch :	abroad						21
	14. Special acknow	wledgem	ents						22
	References								23
2. PR	OPERTIES OF TROL. By R. B.	FREEMA	N, in co	ollaborat	ion with	C. ELT	on, P. I		
	Leslie, R. M. Ra		RZOSKA,	ana HA	RRY V.	I HOMPSO	ON	٠	25
	I. General introd							•	25
	<ul><li>(a) Outline of t</li><li>(b) History</li></ul>	reatment					•	٠	25 26
	(c) Choice of p		•	•	•		•	•	27
	(d) Purity of sa								28
	(e) Other prope (i) Stability, (	erties	:1:+ (:::	Torio	· (iv)	Viold of			
	(f) Danger		· (11)	·	. (IV)	·	·		28
	(i) Man, (ii) A	Animals							31

#### Contents

4.	Wiethous of bloassay		•	•	•	•	•	33
	(a) Introduction							33
	(b) Experimental meth-	ods						33
	(c) Statistical methods							35
	(d) Variations in suscep							38
	(i) Design of the experior (iii) Susceptibility	riments, after Ju	(ii) Resp ly 1944	onse of t	he stock	in 1942–	4,	
3.	Arsenious oxide.							41
	(a) Introduction							41
	(b) Physical and chemi	cal prop	erties					42
	(c) Relationship betwe (i) Technique, (ii) Ex of particle size, (v	pressing	the resu			iv) Effe	ect	46
	(d) Added colouring m	atter						56
	(e) Field tests .							58
	(f) Symptoms and pos	t-morter	m findin	gs				58
	(g) Danger .							59
	(h) Antidotes .							60
	(i) Summary .							61
4.	Red squill .							62
	(a) Introduction							62
	(b) Botany and industr (i) Botany, (ii) Prepar (iv) Methods of ex	ration of straction	powder,	(iii) Che periment	mical coal extrac	nstituen tions	ts,	63
	(c) Toxicity of powder (i) Range of toxicities (iv) Colour, (v) Se	s, (ii) Bio	oassays, ( i) Proces	(iii) Geog	graphica i) Age	l variatio	n,	74
	(d) Toxicity of extracts	3 .						85
	(e) Field tests .							88
	(f) Symptoms and pos	st-morte	m findin	gs				88
	(g) Danger . (i) General, (ii) Mar (v) Dogs, (vi) Cats			Sheep,	cattle, a	nd hors	es,	89
	(h) Summary .							98
5.	Zinc phosphide.							100
	(a) Introduction							100
	(b) Physical and chemi	ical prop	perties					100
	(c) Toxicity and efficie	ency in t	he field					102
	(d) Symptoms and pos	t-morte	n finding	gs.				103
	(e) Danger . (i) Man, (ii) Farm an	nimals, (	iii) Cats	(iv) Ge	neral			104
	(f) Antidotes .							108
	(g) Summary .							108
6.	Barium carbonate							109
	(a) Introduction							109
	(b) Chemical and phys	ical pro	perties					110
	(c) Toxicity . (i) Published information	,		avs				III
	(d) Symptoms and pos					,		114

Contents									
(e) Danger						115			
(f) Antidotes						117			
(g) Summary						117			
7. Other poisons						118			
(a) Phosphorus						118			
(b) Thallium sulphate .						120			
(c) α-naphthylthiourea .						122			
(d) Sodium fluoroacetate						124			
(e) Sodium arsenite .			•			125			
(f) Strychnine (g) Summary			*,,,,			127			
(3)						140			
Appendix 1. The toxicity of arsenious Thompson and P. H. Leslie	oxide to	o wild b	rown ra	ts. By H	L. V.	130			
APPENDIX 2. The fate of residual rat pois	one in			B FDEE	******************				
	SOIIS III	com-mc	ks. by K	. D. PREE	WAIN	132			
References		•				136			
3. CONTAINERS FOR BAITING.	By Cı	HARLES	ELTON	and the	late				
R. M. RANSON						147			
1. Introduction						147			
(a) Containers for semi-perma	nent p	oison ba	its .			147			
2. The protected poison point, or	r P3					149			
(a) General design .						149			
(b) Safety						152			
(c) Patenting and manufacture	е.					153			
<ul><li>(d) Behaviour of rats</li><li>(i) Lag in entry, (ii) Use of baiting efficiency</li></ul>	cover,	(iii) Sto	oring, (iv	) Relatio	n to	154			
3. Pipes						156			
4. Other bait containers .						157			
5. Summary						158			
References									
References						159			
4. THE STUDY OF THE BROWN	RAT	AND I	TS CO	NTROL	BY				
POISON. By Dennis Chitty						160			
1. General introduction .						160			
(a) Aims						160			
(b) Acknowledgements.		•				160			
Part 1. Methods of Me.	ASURING	RAT P	OPULATI	ONS					
2. Introduction						161			
3. Review of various methods of	f study					162			
(a) 'Census' by killing.						162			
<ul><li>(b) 'Census' without killing</li><li>(i) Counts of individuals, trapping, marking, and r</li></ul>					.ive-	163			
<ul><li>(c) Other techniques .</li><li>(i) Miscellaneous, (ii) Rese</li></ul>						167			
(d) Conclusions .						171			

4.	Census and poison baiting at the same sites				171
	<ul><li>(a) History and terminology</li><li>(i) Surplus prebaiting, (ii) Token prebaiting</li></ul>	g ·			172
	<ul><li>(b) Errors in census</li><li>(i) Sampling errors, (ii) Place shyness, (iii)</li></ul>	Bait bas	se shyn	ess ·	173
	(c) Research in Hawaii				176
	(d) Conclusions				178
5.	Independent census and poison baiting				179
	(a) Characteristics of the data				179
	(b) Expressing the results				182
	(c) Summary				185
6.	Factors affecting the take				185
	(a) Difference between take and intake. (i) Recording the daily take, (ii) Waste, (iii)	Hoard	ing		185
	<ul> <li>(b) Variations in intake of bait .</li> <li>(i) Miscellaneous factors, (ii) Variability (iii) Abundance of natural food, (iv) Scar</li> </ul>	of na	itural	food, food	192
	(c) Summary				195
7.	Food and water requirements				195
•	(a) Introduction				195
	(b) Growth and reproduction on a wheat diet (i) Nutritive value of wheat, (ii) Added sa (iii) Effect of proteins and energy, (iv) Gro (v) Reproduction	alts and	vitami	n A, lults,	196
	(c) Normal relationships between takes of foo (i) White rats, (ii) Brown rats	od and	water		200
	(d) Effects of restricted food or water.	·	·		203
	(i) Literature, (ii) Food taken during refeed: during and after food restriction, (iv) water restriction				4-3
	(e) Summary				208
8.	Design and validity of tests with census baiting	ng.			209
	(a) Effects of changed diet				209
	(i) Miscellaneous effects, (ii) Interval (iii) Checks on procedure	before	poiso	ning,	
	(b) Choice of census bait		**		211
	(c) Refusal to enter containers.				211
	(d) Overcrowding				212
	(e) Restricted census				214
	(f) Incomplete poison distribution .				214
	(g) Reduced competition for food and water				215
	(h) Growth and breeding				215
	(i) Movements				216
	(j) Differential mortality				216
	(k) Illness				217
	(l) Discussion				218
	<ul><li>(m) Summary of procedure for field testing</li><li>(i) Choice of infestation, (ii) Census points</li><li>(iv) Census, (v) Control treatment, (vi) P</li></ul>				221
0	Relation of census baiting to numbers				222

	Gontents				Α.
10.	Summary of Part 1				226
	PART 2. RESPONSE TO BAITS USED IN CO	NTROL			
II.	The comparative efficiency of the poisons				226
	(a) Variables other than the poison .				227
	(i) Control methods and environment, (ii) Co	ensus me	ethods		
	(b) Arsenic				229
	(i) Early tests, (ii) Refined Canadian arsenic,	(iii) Oth	ner grade	es	
	(c) Zinc phosphide			٠	230
	(d) Red squill powder				231
	(i) Normal toxicity, (ii) Low toxicity (e) Red squill extract				226
	(f) Barium carbonate		•		232
	(g) Compounds of thiourea	•	•		232
	(i) α-naphthylthiourea, (ii) 2-biphenylthioure	· ea		•	233
	(h) Conclusions				234
12.	Direct poisoning				234
	(a) Miscellaneous poisons				235
	(b) Zinc phosphide				235
	(i) Measured tests, (ii) Other evidence				
	(c) α-naphthylthiourea				236
	(d) Discussion.				237
13.	Problems of poison baiting				240
	(a) Factors limiting success				240
	(b) Effects of prebaiting			٠	242
	(c) Summary			٠	246
14.	Prebaiting in holes and containers .			٠	246
	(a) Advantages of hole baiting			•	246
	(b) Empirical results with containers .				248
	(c) Summary			•	249
15.				٠	250
	(a) Feeding behaviour of a marked population			•	250
	(i) Methods, (ii) Results, (iii) Discussion				
	<ul><li>(b) Speed of feeding on different bases.</li><li>(c) Choice tests</li></ul>		•	•	259
	(d) Literature on bait preferences .	•		•	266
	(e) Discussion			•	268
-6	Environmental and other factors .			•	
10.	(a) Age of poison bait		•	•	269
	(b) Operator				269
	(c) Size of infestation			•	270
	(d) Environment	•		•	271
	(i) 'General' habitats, (ii) 'Special' habitats			•	272
	(e) Conclusions				276
17.	Behaviour towards successive poison baits				278
	(a) Introduction				278
	(b) Results				279
	(i) Field tests, (ii) Tests in outdoor cages				
	(c) Discussion				283



X1	1	

xii			Cont	ents					
	18.	Summary of Part 2							287
			PART	г 3					
	19.	Review of selected asp							287
APPEN	DIX	1. Field tests of poison	ing						292
		2. Analysis of a marked		tion					296
II I LII	Daza		грории			7			
		References .	•					•	299
		7	VOLU:	ME 2					
LIST	OF	TABLES .							xi
LIST	OF	PLATES .							xiv
LIST	OF	FIGURES .							xv
5. TH		REACTION OF THE							
	IN	ITS ENVIRONMEN	T. By M	IONICA S	HORTEN	(Mrs. A	. Vizoso	)	307
	I	Introduction .							307
	(	(a) General remarks	,						307
		(b) Deterrents .							309
		Senses of the brown rat							310
	3.	Factors causing 'new ol	oject read	ction'					311
	(	(a) Methods of observa	tion						311
	(	(b) New objects near a	food sup	ply					312
		(c) Food in newly place		ners					315
		(d) Moving a familiar of							316
		(e) Reaction to new foo							318
		(f) Changes in illumina	ation						320
		(g) Noise .							321
		(h) General changes in		ronment					322
		(i) Removing a new ob				*			322
		(j) The effect of distan							323
		(k) Alternative sources		iliar food	1				325
	(	(l) Summary and discu	ission						328
	4.	'New object reaction' in	control	work					329
	(	(a) Summary of princip	oles						329
	(	<ul><li>(b) Examples .</li><li>(i) 'Lag' in entering</li></ul>	the Pa	(ii) 'Lag	in ente	ring nin			330
		(c) Failures in poisoning		(11) 1148	111 01160	bib			22 T
		(d) Rattus norvegicus an		tus					331 332
		Summary .				-	-		
		References .			•				332
		itticitiets .							333

Contents	xiii

	AMOUNT C								
	AT. <i>By</i> P. H. Li	ESLIE and	d the late	R. M. I	RANSON.	With an o	appendix	by	
	. B. Freeman	•			•	•		٠	335
I.	Introduction							•	335
2.	. Methods and r	esults		• ,,					335
3.	. Analysis of res								339
	(a) Whole and			_	cages			•	339
	(b) Whole who			777				٠	339
	(c) Compariso				_	•	•	•	341
	Average consu					•	•	•	343
	. Comparison w	ith hum	an rood	require	ments				345
6.	. Summary					•		٠	348
	References								349
Appendi	x. Comparison	with pre	vious es	timates	in the li	terature		٠	350
7. THE	CONSUMPT	ION O	F PLA	IN AN	D POI	SONED	CERE	AL	
В	AITS BY THE	BROW	N RAT	. <i>By</i> H	ARRY V.	Тномряс	ON		352
		P	ART I. P	LAIN BA	AITS				
1	. Introduction							1	352
2	. The comparat	ive take	of whea	t and of	her hait	hases			353
~	(a) Soaked wh		or writer						353
	(b) Sausage-ru	sk							355
	(c) Bread mass	h.							356
	(d) Sugar-mea	1.			,				358
3	. Discussion								359
4-	Summary								360
		$\mathbf{P}_{A}$	RT 2. Po	DISON B.	AITS				
5	Introduction								360
6	. Experiments								360
	(a) Nature of	the data							360
	(b) Influence (i) Miscellan			Takes	of wet a	nd dry p	oison ba	nits	361
	(c) Takes of p		-						363
	(d) Takes of w		_	bait					365
	(e) Effect of to	oken bar	ting	•			•	٠	366
7.	Discussion	•							367
	<ul><li>(a) General</li><li>(b) Efficiency</li></ul>	n relati	on to co	ncentrat	ion of -	·		٠	367
	(c) Population					OISOIL		٠	368
0	Summary	Jize ail	a tune UI	Poisoil	Dait				371
0.	References					•		•	372
	recreteffees								373

xiv Contents

8. THE	BEHAVIOUR	OF 7	WHITE	RATS	TOW	ARDS	POISO	N	
$\mathbf{B}^{A}$	AITS. By J. Rzó	SKA							374
I.	Introduction								374
2.	Methods								374
3.	Influence of foo	d in the	e stomacl	h					375
4.	Results with ars	enic							376
	(a) Hesitation								376
	(b) Refusal								377
	(c) Statistical and								378
	(d) Additional (i) Brown rat illness, (iv) of particle	s, (ii) I Time o	Lack of v						379
5.	Other results				•			•	382
	(a) Barium carl (i) General re test, (iv) Co	sults, (		and dea	th, (iii)	A surpl	us feedi	ng	382
	(b) Zinc phospl							•	384
	(c) Red squill				•	*	•	٠	385
	<ul><li>(d) α-naphthylt</li><li>(e) Sodium silie</li></ul>			•		•		•	386
,	Discussion	conuori	ae		•			•	387
							•		387
7.	Summary				٠.	•	•	٠	388
APPENDI	x 1. The persiste	nce of	bait-shyn	iess					390
APPENDI	x 2. Intake accor	ding to	concenti	ration of	poison	•			392
	References								394
9. STO	MACH ANALY	SIS O	F BROW	VN RAT	'S POIS	SONED	IN TH	ΙE	
F	IELD. By J. Rzo	ÓSKA							395
I.	Introduction								395
2.	Methods								396
3.	Results .								397
	(a) Relation to	food in	the ston	nach					397
	(b) Relation to	body w	eight						398
	(c) Differences (i) Mean dete	ctable is			surable i	ntakes,	(iii) Coef	fi-	401
	(d) Relation to		erations						404
4.	Conditions of b								407
	(a) External fac				,				407
	(b) Response of	f the an	imals						408
	(c) Discussion								409
5.	Earth in the sto	mach							411
6.	Summary								412
	References								413

		C	ontents					XV
10. RUR	AL RAT CON	ΓROL. By	A. D. I	MIDDLET	ON.			414
	Rat control before				,			414
	Environment .							415
	(a) Farm buildir							416
	(b) Corn-ricks .							418
	(c) Sites of thres							419
	(d) Hedge-banks							419
	(e) Root stores							421
	(f) Rubbish dun							421
								421
9	Poisoning rats in							424
7'	(a) Introduction							424
								426
	(c) Results							426
	Statistical an							
	(d) Other metho							429
	(e) Summary an		ons .					430
5.	Block control					•	*	431
	(a) Introduction					•		431
	(b) Methods						*	432
	(c) Treatments							432
	(i) Farm build		orn-ricks	, (iii) Fie	ld sites			
	(d) Discussion (i) Population	. (::) T -1-		1 .	. (:::\ D			435
	units, (iv) N	s, (11) Lab Taintenance	our and	materiais	s, (III) K	at-iree	larin	
	(e) Summary							441
6	Organization of				•			442
	C		ittioi.	•		•	•	
7.			•	•	•	•	•	447
	References				٠	•	•	447
APPENDIX	. Baits for rural	rat control					•	448
44 1 0	AMDIT OFFICE	TO OF DA	DOC ANTE	TIOTIC	D MICI	7 INT IN	NTC	
	AMPLE CENSU							
	SH CORN-RIC					1943-7.	Ву	
				•	•			449
	Introduction			•	•		•	449
	Methods of surv				•	•		449
3.	Results of the po	_	urvey					452
	(a) Rick types							452
	(b) Geographica			•			•	456
	(c) Seasonal diff			. 11	191	1.90	3.00	457
	(d) Year to year			generall	у .			459
	(e) Populations			*	•	*	•	460
	(f) Changes in o				at a face	*	•	461
	Estimate of min							462
	The total size of	corn-rick	rat popul	ations in	England			465
6.	Summary							467
	References							468

12.	THE C	ONTROL C	F RAT	S IN S	EWERS.	By J. S	. Perry			469
	ı. Int	roduction								469
	(a)	Sewer syste	ms							469
	(b)	Bait deposit	tor				•			470
	(c)	Review of e	experime	ents						470
	2. Se	wers as a hal	oitat for	rats						471
	3. Ra	t movements	S .							474
		Between se								474
	(b)	Movements (i) Foraging	within range, (i	the sew	ers ion, (iii) l	Re-invas	ion	•	٠	475
	4. Bo	mb damage								477
	5. Po	ison baiting								480
	(a)	Experiment	ts with o	direct po	isoning					480
	(b)	Results of s	standard	. treatme	ents					484
	6. Ba	it trays								487
	7. Su	mmary								489
	Re	eferences								489
12	CONTE		TE CIT	ייי א מ	(DATT	TIC DA	TTIIO	INI I ON	т	
13.		ROL OF THE $B_y$ J. S.						IN LOP	4-	100
				•	•	•	•	•	•	490
			• 1-	•	•	•	•	•	•	490
		iting method				•	•		•	491
	-	its and poiso					•			492
	-	large-scale to			ıng	•			٠	495
		aintenance of			•	•	•		٠	498
		immary and	conclusi	ons		•	•	•	•	498
	Re	eferences	•			*		•	•	499
14.	EXPER	RIMENTS C	N RAT	CONT	ROL IN	PALES	TINE A	ND TH	Œ	
		AN. By J.								500
		troduction								500
		periments								501
		) Description	of loca	lities				÷		501
	V-5.	(i) Haifa an (iv) Khart	d distri	ict, (ii)	Nahalal,	(iii) Af	ikim an	d distric	ct,	301
	(b)	Bait prefer (i) Choice te		Consecu	tive bait	tests, (ii	i) Concl	usions	٠	503
	(c)	Initial pois (i) Methods,	onings (ii) Res	sults		•	٠	•		507
	(d	) Follow-up (i) Soaked co in England	rushed b		Khartou	ım, (ii) S	Soaked c	ereal ba	its	510
	3. C	imate.								512
	(a	) General								512
	(b)	) Temperatu	ire							515
	(c)	Saturation	deficien	су						515