

Copyright is owned by the Author of the thesis. Permission is given for a copy to be downloaded by an individual for the purpose of research and private study only. The thesis may not be reproduced elsewhere without the permission of the Author.

A STUDY OF ECOLOGICAL INTERACTION
BETWEEN INTRODUCED AND INDIGENOUS PLANT SPECIES
IN THE MANAWATU DISTRICT, NORTH ISLAND, NEW ZEALAND.

J. A. CARNAHAN.

A Thesis presented at Massey Agricultural College
for the Degree of Doctor of Philosophy
in the University of New Zealand

1957.

CONTENTS

	<u>Page</u>
NOTE	
ACKNOWLEDGEMENTS	
INTRODUCTION	1
I. <u>INTRODUCED AND INDIGENOUS SPECIES</u>	4
(1) DEFINITIONS	4
(2) CRITERIA FOR DISTINCTION	4
(3) PUBLICATIONS ON THE NEW ZEALAND FLORA	6
(4) HYBRIDIZATION	7
II. <u>THE STUDY AREA</u>	8
(1) CHOICE OF AREA	8
(2) PHYSIOGRAPHY	9
(3) CLIMATE	13
(4) SOILS	17
III. <u>THE ORIGINAL VEGETATION</u>	21
(1) FOREST	21
(2) MOUNTAIN SCRUB	23
(3) SWAMP VEGETATION	23
(4) MINOR COMMUNITIES	24
(5) ENVIRONMENT OF THE ORIGINAL VEGETATION	24
IV. <u>HISTORICAL</u>	25
(1) POLYNESIANS	25
(2) EUROPEANS	26
V. <u>THE PRESENT VEGETATION</u>	29
(1) PREVIOUS WORK	29
(i) Vegetation	29
(ii) Environment	29
(2) VEGETATION PATTERN AS A FUNCTION OF MAN'S ACTIVITIES	30
(i) The Pattern of Vegetation	30
(ii) Interpretation	32
VI. <u>FIELD EXAMINATION OF THE PRESENT VEGETATION</u>	36
(1) BASIS	36
(2) EXTENSIVE EXAMINATION	38
(3) METHOD FOR STUDYING UNPLOUGHABLE PASTURE	39
(i) The Unit Area Method	39
(ii) Transect Sampling of Units and of Vegetation of Same	40
(iii) Maps Used in Systematic Examination	43
(iv) Transecting Procedure	47
(v) Re-run of Some Transects	57
(vi) Point Analysis and Frequency Measurements in Chosen Unit Areas	58
(vii) Treatment of Sampling Data	65

	<u>Page</u>
VII. <u>RESULTS OF THE FIELD EXAMINATION</u>	79
(1) <u>PLOUGHABLE PASTURE</u>	79
(i) Weeds of Frequently Cultivated Ground	80
(ii) Analyses of Pasture on Unploughed Land	82
(iii) Indigenous Species of <u>Juncus</u> in Ploughable Pasture	88
(2) <u>UNPLOUGHABLE PASTURE</u>	89
(i) Introduced Species as an Environmental Factor	90
(ii) Indigenous Species	92
Phanerophytes	92
Ferns	96
Large Monocotyledons	98
Sward-forming Species	99
(3) <u>NON-PASTURE</u>	101
(i) Remnant Forests	102
(ii) Successional Vegetation	103
(iii) Cliffs and Stream Banks	106
(iv) Active or Unhealed Erosion Features	107
(v) Watercourses and Stream Beds	107
VIII. <u>DISCUSSION OF RESULTS</u>	112
(1) <u>PLOUGHABLE PASTURE</u>	112
(i) Cultivation	112
(ii) Intensive Pasture Management	112
(iii) Species of <u>Juncus</u>	114
(2) <u>UNPLOUGHABLE PASTURE</u>	116
(i) Relationship of Weeds to Altitude	116
(ii) Indigenous Ferns and Phanerophytes	117
Relationship to Grazing	117
Relationship to the Original Vegetation	118
(iii) Large Indigenous Monocotyledons	121
(iv) Indigenous Sward-forming Species	123
Relationship to Grazing	123
Relationship to Pasture Management	124
Relationship to the Original Vegetation	125
(v) Aggressiveness of Indigenous Weeds	127
(3) <u>NON-PASTURE</u>	128
(4) <u>CONCLUSION</u>	131
(i) General Relationships	131
(ii) Need for Further Work	133
IX. <u>SUMMARY</u>	136
X. <u>LIST OF SPECIES</u>	147
XI. <u>LITERATURE CITED</u>	163
APPENDICES (see p. iv)	171

APPENDICES

	<u>Page</u>
I. ENVIRONMENTAL ANALYSIS OF LENGTH-GROUP DISTRIBUTION OF TRANSECTS	
A. Original Transects	171
B. Re-run Transects	173
II. ENVIRONMENTAL ANALYSIS OF FREQUENCY OF SPECIES AND CATEGORIES	
A. Original Transects	175
B. Re-run Transects	186
III. FREQUENCY OF MINOR SPECIES AND CATEGORIES	
A. Original Transects	188
B. Re-run Transects	193
IV. MEAN ABUNDANCE OF SPECIES AND CATEGORIES, BY LENGTH-GROUPS	
A. Original Transects	194
B. Re-run Transects	199
V. MEAN ABUNDANCE OF CERTAIN SPECIES AND CATEGORIES, FOR DIFFERENT ORIENTATIONS AND SOIL TYPES, BY LENGTH-GROUPS	200
VI. MEAN PERCENTAGE COVER, MEAN PERCENTAGE TOP COVER, AND MEAN PERCENTAGE FREQUENCY OF SPECIES AND CATEGORIES	204
VII. ENVIRONMENTAL ANALYSIS OF MEAN PERCENTAGE COVER (upper line) AND MEAN PERCENTAGE FREQUENCY (lower line) OF CERTAIN SPECIES	
A. Soil Type and Orientation	211
B. Altitude, Slope, Sheep Grazing, and Cattle Grazing	213
VIII. PERCENTAGE COVER AND PERCENTAGE TOP COVER FOR THREE AREAS OF SWAMPY GROUND	215

TABLES

	<u>Page</u>
I. RAINFALL STATIONS IN THE MANAWATU DISTRICT	16
II. CLASSIFICATION OF TRANSECTS OF UNIT AREAS	67
III. RELATION OF LENGTH OF TRANSECT TO NUMBER OF SPECIES	69
IV. ENVIRONMENTAL ANALYSIS OF NUMBER OF TRANSECTS IN EACH IMPORTANT SOIL TYPE	73
V. FREQUENCY OF OCCURRENCE OF SPECIES IN HORTI- CULTURAL WEED COLLECTIONS	81
VI. FREQUENCY AND ABUNDANCE OF WEED SPECIES ON CULTIVATED GROUND	83
VII. PERCENTAGE COVER, PERCENTAGE TOP COVER, AND PERCENTAGE FREQUENCY OF SPECIES IN UNPLOUGHED PASTURE UNITS	86
VIII. "PERCENTAGE COVER" IN THREE PASTURES IN DECEMBER (MERRY)	87
IX. DOMINANT SPECIES OF UNIT AREAS OF IMPENETRABLE VEGETATION, BY SOIL TYPES	105
X. DOMINANT SPECIES OF VEGETATED CLIFFS AND STREAM BANKS	108
XI. IMPORTANT SPECIES OF WATERCOURSES AND STREAM BEDS	110

MAPS AND ILLUSTRATIONS

<u>Fig.</u>		<u>Page</u>
1	PHYSICAL MAP OF STUDY AREA (FROM NZMS 19A)	10
2	SOIL MAP OF STUDY AREA (N.Z. SOIL BUREAU)	18
3	PRESENT VEGETATION OF STUDY AREA (MADDEN)	31
4	NZMS 1, SHEET N.149 (PALMERSTON NORTH)	45
5	NZMS 3, SHEET N.149/5 (WHAKARONGO)	46
6	FLOUGHABLE PASTURE. DENSE SWARD OF <u>LOLIUM PERENNE</u> AND <u>TRIFOLIUM REPENS</u>	139
7	INFESTATION OF FLOUGHABLE PASTURE BY INDIGENOUS SPECIES OF <u>JUNCUS</u>	139
8	<u>LEPTOSPERMUM SCOPARIUM</u> SPREADING IN UNFLOUGHABLE PASTURE	140
9	<u>BRACHYGLOTTIS REPANDA</u> AND <u>ARUNDO KAKAHO</u> REPLACING PASTURE ON STEEP SLOPE	140
10	<u>BRACHYGLOTTIS REPANDA</u> AND <u>PTERIDIUM ESCULENTUM</u> INVADING RANK PASTURE	141
11	LATE STAGE IN REPLACEMENT OF UNFLOUGHABLE PASTURE BY <u>DICKSONIA SQUARROSA</u>	141
12	CUSHION FORM OF <u>METROSIDEROS DIFFUSA</u>	142
13	<u>PSEUDOWINTERA COLORATA</u> FORMING THICKETS AT ABOUT 1800 FT.	142
14	<u>PAESIA SCABERULA</u> UNDER RELATIVELY LIGHT GRAZING	143
15	<u>BLECHNUM FLUVIATILE</u> ADOPTING LOW-GROWING FORM IN PASTURE	143
16	REPLACEMENT OF UNFLOUGHABLE PASTURE BY FERNS	144
17	<u>POLYSTICHUM VESTITUM</u> AT ABOUT 2000 FT.	144
18	OPEN SWARD CONTAINING LARGE PROPORTION OF INDIGENOUS HERBS	145
19	<u>HELICHRYSUM FILICAULE</u> IN FAIRLY RANK PASTURE	145
20	<u>HYDROCOTYLE</u> SPP. IN UNFLOUGHABLE PASTURE	146
21	NON-PASTURE VEGETATION. <u>LEPTOSPERMUM SCOPARIUM</u> REPLACING <u>ULEX EUROPAEUS</u>	146

NOTE.

The writer is a member of the teaching staff of Massey Agricultural College, Palmerston North, enrolled as a "staff candidate" for Ph.D., under the supervision of Dr. J.S. Yeates. The major part of the field work was carried out in 1954, during a year's leave from teaching duties.

ACKNOWLEDGEMENTS.

Thanks are due to Dr. J.S. Yeates for reading and criticizing the script; also to Dr. L.H. Millener for his criticism of part of the script; to Messrs. A.F. Greenall and D. Hamilton for making available their unpublished Soil Conservation Survey; and to Prof. A.L. Rae for making available A.J. Gibson's unpublished Survey of Hill Sheepfarming.