

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.

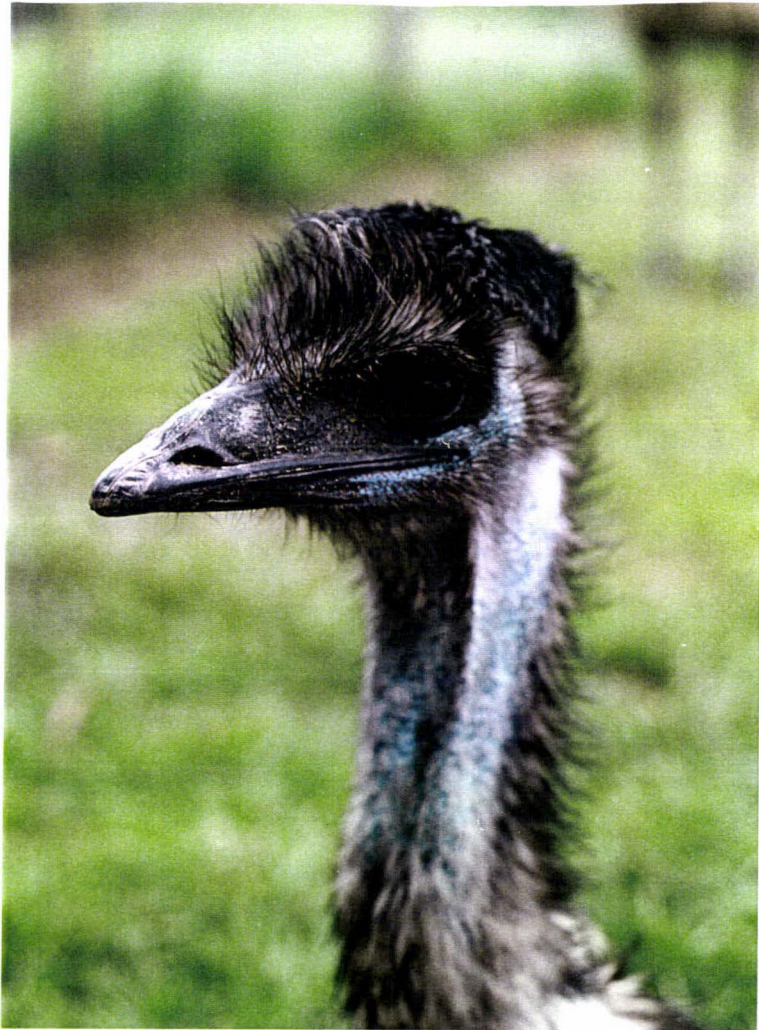
**PRODUCTION AND INCUBATION
IN FARMED EMU
(*Dromaius novaehollandiae*)**

Suzanne M. Bassett

1996

**A thesis presented in partial fulfilment
of the requirements for the the degree of
Masters of Science in Ecology
at Massey University,
Palmerston North, New Zealand.**

I would like to dedicate this thesis to the memory of my Grandfather, Theo Zurcher,
for whom I had deep respect and admiration,
and
to Willie, Albert, Map and Kate.



“In the confrontation between the stream and the rock,
the stream always wins -
not through strength but by perseverance”

- H. Jackson Brown, Jr.

Abstract

The breeding, egg laying, incubation, chick survival and growth of emu (*Dromaius novaehollandiae*) were studied in a farmed population. Eggs were laid every 3 - 5 days between May to October with a peak in July. Birds laid in vegetation, or where absent, near fence lines or by artificial shelters. Clutch size was highly variable (range: 2 - 45) between individuals, and between seasons, and variability increased with the age of the hen. The fate of 578 artificially incubated eggs were recorded. Fertility levels were high (90%) but hatching success was lower. Embryonic mortality was greatest during the first trimester with a second smaller peak at the end of incubation. 434 chicks hatched, representing 68% of all eggs set and 83% of fertile eggs. Weight loss for the entire incubation period was 12.5% and was not correlated with embryo mortality. X-ray and ultrasound equipment were unsuccessful in determining egg fertility. Natural incubation was studied in two emu nests. Egg temperatures averaging 34.1°C and 31.7°C were lower and more variable than those used in artificial incubators. Eggs hatched after 51 - 54 days. In one nest, deserted eggs cooled to 12.2°C hatched when incubated artificially. Rates of egg turning varied, and two thirds of all egg turns were 90° or less, and only 12% were turned between 158.5° - 202.5°. Water loss during incubation was 10% of the initial egg weight and was greatest at the end of incubation. Males lost up to 30% of body weight during incubation. Survival, sex ratios and growth rates were determined for emu chicks hatching from 637 artificially incubated New Zealand eggs, and 105 eggs imported from Canada for incubation under class 1 quarantine conditions. Survival rates to three months were high (88%). Mortality due to hatch-related problems was restricted to the first week of rearing, and to weeks 8 - 12 when bone deformities became evident. Sex ratios were 50:50. The chicks lost weight after hatching but thereafter grew exponentially. There was no significant difference between male and female hatch weights, or rates of growth, but females grew faster and were heavier up to 18 months. Most birds that grew significantly slower from three weeks of age died within three months. The genetic identity and development of twin emu was described. DNA analysis indicated the twins were identical.

Table of Contents

	Page
Abstract	<i>iii</i>
List of figures	<i>vii</i>
List of tables	<i>ix</i>
List of plates	<i>xi</i>
Chapter 1 General Introduction	1
Chapter 2 The breeding season and egg laying behaviour of captive emu	5
Abstract	5
Introduction	5
Methods	5
Statistical analyses	8
Results	9
Breeding season	9
Egg laying sites	10
Egg laying behaviour	11
Egg laying times and intervals between eggs	12
Clutch size	14
Egg measurements	16
Egg sequence and hatching success	18
Discussion	19
Breeding season	19
Egg laying sites	19
Egg laying behaviour	20
Intervals between eggs	20
Clutch size	21
Egg measurements	22
Factors affecting egg production	23
Conclusions	25
References	25
Chapter 3 Artificial incubation of emu eggs	29
Abstract	29
Introduction	29
Methods	31
Egg collection and storage	31
Egg weight loss	31
Hatching success, hatchability and fertility	32
Embryos	32
Embryonic mortality	33

Chapter 5	Chick survival and growth rates in captive emu	84
Abstract		84
Introduction		84
Methods		86
New Zealand eggs and chicks		86
Canadian eggs and chicks		86
Statistical analyses		87
Results		88
Chick survivorship		88
Leg deformities		89
Sex ratios		90
Hatch weights		90
Growth rates		92
Discussion		95
Chick survival		95
Leg rotation		98
Sex ratios		100
Hatch weights		100
Growth rates		100
Conclusions		101
References		102
Chapter 6	The occurrence and development of twin emu chicks	106
Abstract		106
Introduction		106
Methods		107
DNA analysis		108
Statistical analyses		109
Results and Discussion		109
Weights and measurements		109
Growth rates		114
DNA analysis		115
Twinning mechanisms		117
Twin sex		118
Conclusions		119
References		119
Chapter 7	General discussion and recommendations	122
Acknowledgments		125
Appendices		
i	National emu breeding questionnaire	126
ii	National emu breeding survey results	132
iii	Measurements of emu embryos	142
iv	Similarity Coefficient Statistics	144
v	Similarity Coefficient distribution chart	145

List of Figures

Figure		Page
2.1	Distribution of egg laying dates for farmed emu during the 1994 and 1995 breeding seasons, at Colyton, New Zealand.	9
2.2	Egg laying intervals and clutch size for 2 year old birds, and birds aged 3, 4 and 5+ years in 1995.	13
2.3	Average clutch size in relation to age of the female in 1994 and 1995 at Colyton, New Zealand.	15
2.4	Egg measurements from three individual breeding females, and one trio at Colyton, New Zealand.	17
2.5	Proportion of fertile eggs that hatched in relation to initial egg weight, and the number of eggs in each weight category.	18
3.1	Patterns of embryonic mortality and hatchability of 578 artificially incubated emu eggs at Colyton, New Zealand, in 1994 and 1995.	36
3.2	Incubation outcomes of clutches from individual female emu during 1994 and 1995, at Colyton, New Zealand.	40
3.3	Total weight loss and hatchability of all emu eggs at Colyton, New Zealand, in 1994 and 1995.	42
3.4	Proportion of unhatched fertile egg and number of eggs laid in relation to total egg weight loss during incubation at Colyton, New Zealand, in 1994 and 1995.	43
4.1	Mean daily temperature of two telemetric emu eggs over the course of natural incubation in two emu nest during 1995, at Colyton, New Zealand.	63
4.2	Average hourly temperatures of two telemetric eggs, three days before nest desertion by Male 2 at Colyton, New Zealand, in 1995.	64
4.3	The frequency and magnitude of egg turns by Male 1 and Male 2 during natural incubation of two clutches of eggs at Colyton, New Zealand, in 1995.	66

Figure		Page
4.4	The frequency of egg turning in relation to the actual time the egg was turned by Male 1 and Male 2 during natural incubation of two clutches of eggs at Colyton, New Zealand, in 1995.	66
5.1	Relationship between initial egg weight and weight of emu chicks at hatching.	91
5.2	Growth rates of New Zealand chicks hatched at Colyton, New Zealand, in 1995.	93
5.3	Weights of healthy and unwell emu chicks during 1995 at Colyton, New Zealand.	94
5.4	Growth rates of emu chicks hatched during 1994 at Colyton, New Zealand.	95
6.1	Size Relationship between the twin-bearing egg and other eggs in the clutch.	110
6.2	Size relationship between the width and length of the twin-bearing egg and all other 1994 eggs.	111
6.3	Relationship between emu chicks weights at hatching and the initial weight of the eggs, individual twin chick weights, and the combined twin weight.	114
6.4	The individual weights of Twin One and Twin Two in comparison to other 1994 chicks.	115
6.5	Minisatellite DNA profiles of genetically identical emu twins, the twins' parents, and other emu and chicken DNA.	116

List of Tables

Table	Page
2.1 Egg laying preferences in captive emu at Colyton, New Zealand.	10
2.2 Variation in individual clutch size at Colyton, New Zealand, during two successive breeding seasons (1994 and 1995).	15
2.3 Measurements of New Zealand eggs in 1994 and 1995 at Colyton, and imported Canadian eggs.	16
3.1 Productivity and hatching success in the 1994 and 1995 emu breeding seasons at Colyton, New Zealand.	35
3.2 Embryo measurements of unhatched fertile emu eggs after artificial incubation at Colyton, New Zealand in 1994 and 1995.	36
4.1 Frequency of egg turning events per day and the interval between egg turns in two clutches of eggs naturally incubated at Colyton, New Zealand in 1995.	65
4.2 Egg weight loss and chick hatch weights of six emu eggs naturally incubated at Colyton, New Zealand in 1995.	68
4.3 Change in body weight of two male emu before and after natural incubation in 1995 at Colyton, New Zealand.	69
5.1 Survival of emu chicks to three months of age from all chicks hatched at Colyton, New Zealand, during 1994 and 1995, and from imported Canadian eggs hatched in quarantine.	88
5.2 Post-hatch mortalities of emu chicks from New Zealand and Canadian stock in 1994 and 1995 at Colyton, New Zealand.	88
5.3 The incidence of leg rotation in two clutches of New Zealand eggs at Colyton, New Zealand in 1995.	90
5.4 Sexes of emu chicks surviving to three months of age from those hatched at Colyton, New Zealand during 1994 and 1995, and from imported Canadian eggs hatched in quarantine.	90
5.5 Average weight at hatching for emu chicks in 1994 and 1995 at Colyton, New Zealand, and from imported Canadian eggs hatched in quarantine.	92

Table		Page
6.1	Twin egg measurements in comparison to the other 17 eggs in the clutch.	109
6.2	Weight of the emu twins and their egg compared with other chicks and eggs in the same clutch, and with all the other 1994 eggs.	113

List of Plates

Plate	Page
Frontispiece 18 month old male emu at New Zealand Emu Limited, Colyton, New Zealand.	
Chapter page Adult emu feather.	
3.1 Emu embryonic mortality during artificial incubation. A Early embryonic mortality, and B Late embryonic mortality.	37
3.2 Early emu embryonic mortality during artificial incubation. A Unusual embryo development, and B Normal embryo development.	39
4.1 ATS DCCII data-logger and SirTemp decoder connected to an ATS R2100 receiver.	59
4.2 Male 1 A incubating at the nest in September, and B crouching at the nest in October, at Colyton, New Zealand.	62
6.1 Two day old twin emu chicks hatched from a single egg in 1994 at Colyton, New Zealand.	112