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# Breeding biology of Gould's petrels pterodroma leucoptera: predicting breeding outcomes from a physiological and morphological appraisal of adults

Terence W. O'Dwyer  
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**BREEDING BIOLOGY OF GOULD'S PETRELS *PTERODROMA*  
*LEUCOPTERA*: PREDICTING BREEDING OUTCOMES FROM A  
PHYSIOLOGICAL AND MORPHOLOGICAL APPRAISAL OF ADULTS**

**A thesis submitted in fulfilment of the requirements for the degree**

**DOCTOR OF PHILOSOPHY**

**from**

**UNIVERSITY OF WOLLONGONG**

**by**

**Terence W. O'Dwyer, BEnvSc (Hons)**

**SCHOOL OF BIOLOGICAL SCIENCES**

**2004**

## CERTIFICATION

I, Terence William O'Dwyer, declare that this thesis, submitted in fulfillment of the requirements for the award of Doctor of Philosophy, in the School of Biological Sciences, University of Wollongong, is wholly my own work unless otherwise referenced or acknowledged. The document has not been submitted for qualifications at any other academic institution.

## ABSTRACT

- 1) The breeding biology of Gould's petrels *Pterodroma leucoptera* was studied at Cabbage Tree Island, New South Wales over three successive breeding seasons from 2000/01. I sought to identify better reproductively performing individuals and to identify indicators of breeding success through a physiological and morphological appraisal of adult characteristics.
  
- 2) Gould's petrels exhibit no sex linked plumage dimorphism, however, knowledge of the sex of both adults and chicks was an integral component of this study. Blood samples were taken from 209 adults and 206 chicks and a polymerase chain reaction (PCR) based molecular technique was used to determine their sex. With the knowledge of the sex of individuals a discriminant function analysis (DFA) based on several skeletal measures was developed. The DFA could predict the sex of adults with an accuracy of about 85% and chicks with an accuracy of 66%.
  
- 3) Relationships between egg laying characteristics and hatching success were assessed. Egg laying occurred over a four week period from early November to early December. Egg volumes ranged from 30-42 ml and averaged approximately 37 ml in both years. Hatching success was 76% (78 of 102) and 65% (60 of 93) in 2001/02 and 2002/03 respectively. Incubation periods ranged from 42 to 64 days with an average of approximately 49 days. There were no significant relationships between either laying date and hatching success or egg volume and hatching success. There was, however, significant

interyear repeatability in individual laying dates and in egg volumes, and egg volume significantly influenced hatchling mass and size.

- 4) The influences of circulating levels of prolactin (PRL) and testosterone (T) on hatching success were examined. Throughout incubation females tended to have higher levels of PRL than males. After the onset of incubation, PRL concentration increased significantly from pre-laying levels of  $2.7 \pm 0.6$  ng/ml in males and  $3.1 \pm 0.6$  in females to  $26.3 \pm 0.7$  ng/ml and  $28.8 \pm 0.5$  ng/ml, respectively. PRL levels were significantly higher in breeding pairs that successfully hatched an egg compared to those whose egg failed to hatch. The pattern of male T secretion was typical for a species with high levels of male parental care and low male-male aggression, with T levels decreasing after the onset of incubation and then remaining relatively low up to chick fledging. Although not statistically significant, failed breeders had a tendency to have higher T levels than successful breeders.
  
- 5) Adult body condition and blood haemoglobin levels were measured throughout the breeding cycle. A body condition index (BCI) was calculated for each individual based on its body mass relative to structural size. The influence of BCI on hatching success was examined and interyear repeatability in BCI was assessed. There was no relationship between parental condition and egg hatchability. There was, however, a significant positive relationship between female body condition and egg volume and between male body condition and PRL level. There was also significant interyear repeatability in the body condition of both males and females.

- 6) Interannual variation in feeding frequencies and meal sizes were determined and the influence of parental body condition on provisioning rates was investigated. Mean meal sizes varied significantly between years, which suggest there are variations in food availability within Gould's petrel's foraging range. On average, foraging trips averaged approximately three days and chicks were fed every second day. Parents that went on longer foraging trips provided larger meals to their chicks. However, parents that went on shorter trips provided more food per day spent foraging, which suggests they were more effective foragers. Moreover, in 2001/02 when meal sizes suggest food was less abundant, parents that were in better body condition during incubation were the more efficient foragers. These results suggest that parental condition has an important influence on chick provisioning rates, especially when environmental conditions are suboptimal.
- 7) Interannual variations in chick growth and nestling blood haemoglobin accumulation were examined in relation to parental body condition. Chick mass and skeletal growth rate varied significantly between years. The mean age of fledglings was  $90 \pm 1$  days in both years and fledging mass was  $175 \pm 2$  g and  $177 \pm 2$  g in 2001/02 and 2002/03, respectively. There was a significant positive relationship between the body condition of parents and the body condition of chicks at their peak mass ( $BCI_{pm}$ ) of their chick. Parental body condition also influenced chick growth rate (g/day) and was inversely related to fledging age of the chick. There were significant positive interyear correlations between the body condition of chicks from the same parents.

Also, if parents produced a good quality chick in 2001/02 they were in relatively good body condition during incubation in 2002/03. Furthermore, these parents went on to again produce a good quality chick in 2002/03. These results suggest that good parental body condition is important for reproductive success and that certain parents are consistently able to acquire more resources that can be allocated to both self-maintenance and reproduction and are, consequently, better reproductive performers.



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## TABLE OF CONTENTS

<b>CERTIFICATION</b>	<b>II</b>
<b>ABSTRACT</b>	<b>III</b>
<b>ACKNOWLEDGEMENTS</b>	<b>VII</b>
<b>CHAPTER 1 INTRODUCTION</b>	<b>1</b>
1.1 Life history theory	1
1.2 Study species	5
1.2.1 Species description	5
1.2.2 Mating system	5
1.2.3 Breeding location	6
1.2.4 Species status	7
1.2.5 Aims	9
<b>CHAPTER 2 SEXING GOULD'S PETRELS USING MOLECULAR METHODS AND DISCRIMINANT FUNCTION ANALYSIS</b>	<b>11</b>
2.1 Introduction	11
2.2 Methods	13
2.2.1 Molecular sexing	13
2.2.2 Discriminant function analysis	15
2.2.3 Assortative mating	17
2.2.4 Sex ratio	17
2.3 Results	18
2.3.1 Molecular sexing	18
2.3.2 Discriminant function analysis	19
2.3.2.1 Adults	19
2.3.2.2 Chicks	24
2.3.3 Assortative mating	28
2.3.4 Hatchling sex ratio	28
2.4 Discussion	29
<b>CHAPTER 3 VARIABILITY IN EGG-LAYING CHARACTERISTICS OF GOULD'S PETRELS AND THEIR UTILITY AS PREDICTORS OF BREEDING OUTCOMES</b>	<b>35</b>
3.1 Introduction	35
3.2 Methods	37

<b>3.3</b>	<b>Results</b>	<b>40</b>
3.3.1	Laying dates	40
3.3.2	Egg sizes	40
3.3.3	Age prediction	41
3.3.4	Incubation period	43
3.3.5	Hatchling mass and size	44
3.3.6	Interannual repeatability in egg laying characteristics	45
3.3.7	Relationships between laying date, egg volume, hatching success, and incubation period	47
<b>3.4</b>	<b>Discussion</b>	<b>49</b>
<b>3.5</b>	<b>Conclusions</b>	<b>53</b>
 <b>CHAPTER 4 THE INFLUENCE OF PARENTAL PROLACTIN AND TESTOSTERONE LEVELS ON HATCHING SUCCESS</b>		 <b>55</b>
<b>4.1</b>	<b>Introduction</b>	<b>55</b>
<b>4.2</b>	<b>Methods</b>	<b>57</b>
4.2.1	Blood sampling and handling	57
4.2.2	Hormone assays	58
<b>4.3</b>	<b>Results</b>	<b>59</b>
<b>4.4</b>	<b>Discussion</b>	<b>65</b>
 <b>CHAPTER 5 CHANGES IN BODY MASS AND BLOOD HAEMOGLOBIN CONCENTRATION DURING BREEDING IN GOULD'S PETRELS</b>		 <b>72</b>
<b>5.1</b>	<b>Introduction</b>	<b>72</b>
<b>5.2</b>	<b>Methods</b>	<b>76</b>
<b>5.3</b>	<b>Results</b>	<b>79</b>
5.3.1	Body mass changes	79
5.3.2	Haemoglobin changes	82
5.3.3	Maintenance of BCI throughout incubation	84
5.3.4	Relationships between BCI and blood constituents	86
5.3.5	Interannual repeatability of body condition and Hb concentration	87
5.3.6	Influence of adult body size and BCI on egg volume	90
5.3.7	Intrapair body condition relations	90
<b>5.4</b>	<b>Discussion</b>	<b>92</b>
5.4.1	Changes in body mass during incubation	92
5.4.2	Changes in haemoglobin during incubation	95
5.4.3	Changes in body condition indices throughout incubation	97
5.4.4	Relationships between BCI and Hb	99
5.4.5	Relationships between BCI and prolactin	100
5.4.6	Interyear repeatability of body condition	101
5.4.7	Assortative mating	102

5.4.8	Female condition and egg size	104
<b>5.5</b>	<b>Conclusions</b>	<b>105</b>
<b>CHAPTER 6 CHICK PROVISIONING RATES AND MEAL SIZES AND THE INFLUENCE OF ADULT CONDITION ON PROVISIONING PERFORMANCE</b>		<b>107</b>
<b>6.1</b>	<b>Introduction</b>	<b>107</b>
<b>6.2</b>	<b>Methods</b>	<b>109</b>
6.2.1	Chick handling	109
6.2.2	Calculation of meal sizes and provisioning rates	110
<b>6.3</b>	<b>Results</b>	<b>111</b>
<b>6.4</b>	<b>Discussion</b>	<b>115</b>
<b>6.5</b>	<b>Conclusions</b>	<b>118</b>
<b>CHAPTER 7 POSTNATAL DEVELOPMENT OF GOULD'S PETRELS</b>		<b>120</b>
<b>7.1</b>	<b>Introduction</b>	<b>120</b>
<b>7.2</b>	<b>Methods</b>	<b>123</b>
<b>7.3</b>	<b>Results</b>	<b>128</b>
7.3.1	Chick growth	128
7.3.2	Haemoglobin	139
<b>7.4</b>	<b>Discussion</b>	<b>141</b>
7.4.1	The effects of adult handling	141
7.4.2	Growth characteristics	142
7.4.3	Interannual differences in growth characteristics	144
7.4.4	Nestling haemoglobin development	145
7.4.5	Fledgling characteristics	147
7.4.6	Effects of adult condition on chick growth	148
7.4.7	Interyear repeatability in chick growth	149
<b>7.5</b>	<b>Conclusions</b>	<b>151</b>
<b>CHAPTER 8 SUMMARY OF MAJOR FINDINGS AND DIRECTIONS FOR FUTURE RESEARCH</b>		<b>153</b>
<b>REFERENCES</b>		<b>160</b>

## List of Figures

Figure 2.1 Determination of the sex of Gould’s petrels using primers P2 and P3. The bands at 110 bp in lanes 2, 3, and 4 are the uncut CHD-W fragments and are, therefore, female. Lanes 1, 5 and 6 show bands at 65 bp and at 45 bp. These are the CHD-NW fragments that have been cut by <i>HaeIII</i> and are, therefore male..	19
Figure 2.2 Frequency histogram of the probability scores of an adult Gould’s petrel being male. The histogram of female scores (left) show that the majority of birds have scores below 0.5. The male histogram (right) shows that the majority of birds have scores above 0.5. ....	23
Figure 2.3 Frequency histogram of the probability scores of Gould’s petrel chicks being male. Females are on the left - males are on the right. ....	27
Figure 2.4 The fledgling sex ratio for each year of the study and for the three years combined. Males are unfilled columns, females are filled columns. Sample sizes are 76, 74, 56, and 206 respectively. Sex ratios did not differ from parity in any year or in the three years combined. ....	29
Figure 3.1 Regression of PC1 (head-bill, tarsus, and middle toe lengths) against age of birds of known hatching date in 2001/02. ( $PC1 = -2.294 + 0.353Age$ , $r^2 = 0.93$ , $p < 0.0001$ ).....	42
Figure 3.2 Comparison of actual versus estimated incubation duration of Gould’s petrels. Numbers above columns indicate sample size and error bars represent standard error. ....	43
Figure 3.3 Mean incubation period of Gould’s petrels in each year of the study. Numbers above columns indicate sample size and error bars represent standard error.....	44
Figure 3.4 Relationships between egg volumes and the mass and size (PC1 from PCA of head-bill, tarsus, and middle toe lengths) of chicks on the day of hatching. A) $r = 0.597$ , $p = 0.015$ , $n = 16$ . B) $r = 0.502$ , $p = 0.024$ , $n = 20$ . C) $r = 0.835$ , $p < 0.001$ , $n = 16$ . D) $r = 0.510$ , $p = 0.021$ , $n = 20$ .....	45
Figure 3.5 Interannual repeatability in the date of egg laying ( $r = 0.59$ , $n = 87$ , $p < 0.0001$ ). Day 1 is the first day eggs were laid in the colony. ....	46
Figure 3.6 Interannual repeatability in egg volumes ( $r = 0.93$ , $n = 87$ , $p < 0.0001$ ). ...	46

Figure 3.7 The relationship between the incubation period in 2001/02 and the time of egg laying of the same breeding pair the following year.....48

Figure 3.8 Mean volumes of eggs from successful versus failed breeding attempts (open bars = successful eggs; cross-hatched bars = unsuccessful eggs). Numbers above columns indicate sample size and error bars represent standard error.....48

Figure 4.1 Changes in male and female PRL concentration throughout incubation. A) Mean PRL by week relative to laying date; Males open columns, Females speckled columns. B) Regression of PRL concentration on breeding day. Males broken line, open symbols; females solid line, filled symbols. Breeding day 0 = laying day. Approximate male and female incubation shifts are shown as dashed and solid lines respectively. Numbers above columns indicate sample size and error bars are standard deviation.....61

Figure 4.2 A: Mean male plasma testosterone (T) concentrations throughout incubation. Numbers above columns represent sample size and error bars are standard deviation. B: Relation between T and day of breeding with respect to egg laying date. Breeding day 0 = laying day.....62

Figure 4.3 Differences in plasma PRL concentrations of failed versus successful breeders. Successful breeders filled symbols, solid line; failed breeders open symbols, broken line. 0 = laying day.....63

Figure 4.4 Changes in plasma testosterone concentration over the course of breeding. Successful breeders filled symbols, solid line; failed breeders open symbols, broken line.....64

Figure 4.5 A) Mean PRL residual index of successful versus failed breeders. B) Mean T residual index of successful versus failed breeders. Successful – open columns. Failed – shaded columns. Sample sizes are above columns and error bars represent standard error.....64

Figure 4.6 Mean incubation shift of 31 species of Procellariiformes in relation to body mass. Gould's petrels are indicated by filled symbol, all other species by crosses.  $y = 1.33x^{0.262}$ ,  $r^2 = 0.316$ ,  $p = 0.001$ . Data from Warham (1990). 95% confidence limits are also shown.....65

Figure 5.1 Morphometrics used to calculate body condition index of Gould's petrels .....77

Figure 5.2 Changes in body mass of adult Gould’s petrels throughout the breeding cycle in 2001/02. Male – solid line, filled symbols; female – broken line, open symbols. Day 0 is the day of egg laying. ....	80
Figure 5.3 Changes in body mass of adult Gould’s petrels throughout the breeding cycle in 2002/03. Male – solid line, filled symbols; female – broken line, open symbols. Day 0 is the day of egg laying. ....	81
Figure 5.4 Changes in haemoglobin concentration in adult Gould’s petrels during the breeding cycle in 2001/02.. Males – solid line, filled symbols; Females – broken line, open symbols. Day 0 is the day of egg laying. ....	83
Figure 5.5 Changes in haemoglobin concentration in adult Gould’s petrels during the breeding cycle in 2002/03. Males – solid line, filled symbols; Females – broken line, open symbols. Day 0 is the day of egg laying. ....	84
Figure 5.6 Relationships between body condition indices measured at various stages of incubation. A Males 2001/02 ( $r = 0.576, p < 0.001, n = 70$ ); B) Males 2002/03 ( $r = 0.409, p = 0.002, n = 57$ ); C) Females 2001/02 ( $r = 0.593, p = 0.005, n = 21$ ); D) Females 2002/03 ( $r = 0.459, p = 0.018, n = 26$ ).....	85
Figure 5.7 The relationships between body condition indices (BCI) and haemoglobin (Hb) concentrations at the start of incubation. A) Males 2001/02. B) Males 2002/03. C) Females 2001/02. D) Females 2002/03. ....	87
Figure 5.8 Repeatability of BCI in successive years. A) Average condition of pair throughout incubation: $r = 0.462, p < 0.001, n = 87$ , B) Males and females at the pre-breeding stage: $r = 0.490, p = 0.028, n = 20$ , C) Males at the beginning of their first incubation shift: $r = 0.470, p < 0.001, n = 73$ , D) Females at the beginning of their first incubation shift: $r = 0.201, p = 0.102, n = 67$ ).....	88
Figure 5.9 Repeatability of haemoglobin concentrations (Hb) in successive years. A) Males and females at the pre-breeding stage ( $r = 0.458, p = 0.060, n = 18$ ); B) Males at the beginning of their first incubation shift ( $r = 0.410, p < 0.001, n = 69$ ); C) Males during their first incubation shift ( $r = 0.476, p = 0.008, n = 30$ ); D) Females at the beginning of their first incubation shift ( $r = 0.700, p < 0.001, n = 68$ ). ....	89
Figure 5.10 The relationship between female body condition at the pre-breeding stage and egg volumes. 2001/02: $r = 0.407, p = 0.043, n = 25$ . 2002/03: $r = 0.489, p = 0.003, n = 34$ . ....	90



Figure 5.11 The relationships between the body condition indices of pairs during their respective incubation shifts. A) Females at the beginning of their incubation shift against males during their first incubation shift ( $r = 0.254, p = 0.147, n = 34$ ). B) Males at the beginning of their second incubation shift against females during their incubation shift ( $r = 0.377, p = 0.014, n = 42$ ).....	91
Figure 6.1 Frequency distribution of Gould's petrel meal sizes over two consecutive breeding years. ....	112
Figure 6.2 The mean time between meals (days), and the mean foraging period duration per adult (days) of Gould's petrels in 2001/02 (open columns) and 2002/03 (speckled columns). Sample sizes are shown above columns. Error bars represent $\pm$ standard error .....	113
Figure 6.3 The relationship between meal sizes and the time between meals. 2001/02: $r = 0.486, p < 0.001, n = 71$ ; 2002/03: $r = 0.642, p = 0.001, n = 52$ .....	114
Figure 6.4 The relationships between the amounts of food provided per day spent foraging and the time between meals. 2001/02: $r = -0.803, p < 0.001, n = 71$ ; 2002/03: $r = -0.668, p < 0.001, n = 52$ .....	114
Figure 6.5 The relationships between the average body condition index of both parents and provisioning performance in consecutive breeding years. ....	115
Figure 7.1 Growth curves of body mass and selected body structures of Gould's petrel chicks from the 2000/01 breeding season ( $n = 32$ ; males and females combined). ....	129
Figure 7.2 The relationship between hatching body mass and $BCI_{pm}$ ; A) 2001/02; $r = 0.462, p = 0.112, n = 13$ ; B) 2002/03, $r = 0.331, p = 0.195, n = 17$ ).....	134
Figure 7.3 The relationship between $BCI_{pm}$ and fledging BCI of chicks: A) 2001/02; $r = 0.534, p < 0.001, n = 70$ . B) 2002/03; $r = 0.324, p = 0.025, n = 48$ . ....	134
Figure 7.4 The relationship between fledging BCI and fledging age: A) 2001/02; $r = -0.508, p < 0.001, n = 70$ . B) 2002/03; $r = -0.500, p = 0.001, n = 48$ .....	135
Figure 7.5 The relationships between parental body condition and growth characteristics of their chicks in 2001/02. (A, E) Average condition of both parents during incubation; $r = 0.332, p = 0.004, n = 71$ and $r = 0.250, p = 0.05, n = 62$ , respectively. (B) Average condition of the male during incubation; $r = 0.250, p = 0.036, n = 71$ . (C, D, F) Condition of the male during its first incubation shift; $r = 0.409, p = 0.009, n = 40, r = 0.458, p = 0.003, n = 40$ , and $r = -0.421, p = 0.009, n = 40$ , respectively. ....	136

Figure 7.6 Repeatability of sibling chick growth parameters in 2001/02 and 2002/03  
(Mass:  $r = -0.115, p = 0.482, n = 40$ ; BCI:  $r = 0.584, p < 0.001, n = 40$ ; Head:  $r = 0.200, p = 0.215, n = 40$ ; Culmen:  $r = 0.436, p = 0.005, n = 40$ ; Tarsus:  $r = 0.239, p = 0.138, n = 40$ ; Middle toe:  $r = 0.352, p = 0.026, n = 40$ )..... 137

Figure 7.7 (A) The relationships between the BCI<sub>pm</sub> of chicks in 2001/02 and the BCI of their male parent the following breeding season;  $r = 0.304, p = 0.017, n = 61$ .  
(B) The relationship between male BCI during breeding in 2002/03 and BCI<sub>pm</sub> of its subsequent chick;  $r = 0.295, p = 0.032, n = 54$ ..... 138

Figure 7.8 Changes in haemoglobin concentration of chicks during development.  
Numbers above columns indicate sample sizes and error bars represent  $\pm$  standard error. .... 139

Figure 7.9 Changes in chick haemoglobin content during development in 2001/02.  
Repeated measures of 72 chicks. .... 140

Figure 7.10 Relationships between age, haemoglobin concentration, and fledging BCI of chicks that fledged in 2002/03. (A)  $r = 0.508, p < 0.001, n = 48$ . (B)  $r = -0.500, p < 0.001, n = 48$  ..... 140

## List of Tables

Table 2.1 Sample sizes, ranges, means, standard errors, and results of t-tests of variables considered for the DFA of Gould’s petrels. All birds were sexed using molecular methods. ....	21
Table 2.2 Pooled within sex correlation matrix and the variance inflation factor (VIF) of the variables of 104 females and 105 males used in the DFA. ....	21
Table 2.3 Fishers linear discriminant functions obtained from SPSS discriminant output. ....	22
Table 2.4 Results of the DFA for adult Gould’s petrels. Original are the predictions based on a DFA derived from all of the birds sexed from molecular methods. Cross validation is the prediction of an individual based on DFA derived from all other birds excluding the individual being predicted. ....	24
Table 2.5 Summary of morphometric measurements of male and female pre-fledging chicks and their level of statistical difference. All chicks were sexed using molecular methods. ....	25
Table 2.6 Pooled within sex correlation matrix and the variance inflation factor (VIF) of variables of 105 females and 101 males used for the chick DFA. ....	25
Table 2.7 Fishers linear discriminant functions for chicks obtained from SPSS discriminant output. ....	26
Table 2.8 Results of the DFA for Gould’s petrel chicks. Original are the predictions based on a DFA derived from all of the chicks sexed from molecular methods. Cross validation is the prediction of an individual based on the DFA derived from all other birds excluding the individual being predicted. ....	27
Table 2.9 Correlation analyses of morphometrics of Gould’s petrel breeding pairs ...	28
Table 3.1 Ranges and means of egg measurements in each year of the study. Egg volumes were calculated from $\text{Volume (ml)} = \text{Length (cm)} * \text{Breadth}^2 \text{(cm)} * 0.51$ (Hoyt 1979); Egg masses were calculated from Warham 1990 ( $\text{Mass (g)} = \text{Length (cm)} * \text{Breadth}^2 \text{(cm)} * 0.551$ ) ....	41
Table 3.2 Comparison of variables used to predict the age of chicks where hatching date was unknown. * Denotes regression with the highest $r^2$ value each year. ....	42
Table 6.1 Provisioning characteristics of Gould's petrels.....	113
Table 7.1 Comparison of growth characteristics of chicks whose parents were handled during incubation (AH) and chicks whose parents were not handled (ANH). $K_L$	

is the logistic growth rate constant,  $A_L$  is the estimated asymptote (g or mm),  $KA/4$  is the maximum growth rate attained at the point of inflection (g or mm/day),  $G_L$  is growth over the linear portion of the growth curve from 10 to 40 days of age, and %Ad is the asymptote as a percentage of adult size. .... 130

Table 7.2 Comparison of growth characteristics of female and male chicks for all breeding seasons (2001-2003) combined.  $K_L$  is the logistic growth rate constant,  $A_L$  is the estimated asymptote (g or mm),  $KA/4$  is the maximum growth rate attained at the point of inflection (g or mm/day),  $G_L$  is growth over the linear portion of the growth curve from 10 to 40 days of age, and %Ad is the asymptote as a percentage of adult size. \* Denotes significant difference ..... 131

Table 7.3 Comparisons of growth characteristics between years.  $K_L$  is the logistic growth rate constant,  $A_L$  is the estimated asymptote (g or mm),  $KA/4$  is the maximum growth rate attained at the point of inflection (g or mm/day),  $G_L$  is measured from 10 to 40 days of age when the growth curve is close to linear (g/day), and %Ad is the asymptote as a percentage of adult size.  $n = 32$  for all years. \* Denotes significant difference ..... 132