CHAPTER 2

Habitat and morphology of *Egernia whitii* in South Australia

ABSTRACT

Life history characteristics combine to determine how well an organism is adapted to its environment, and provide a blueprint for survival in a challenging environment. Any of the major features of a faunal species' life history, may vary significantly along its distributional range. In a social species like *Egernia whitii,* the dynamics involved in group living depend upon the life history features which characterise the group. In this study *E. whitii* habitat and morphology are analysed to provide essential life history information on *E. whitii* on the South Australian mainland and off-shore islands, so that new scientific evidence concerning behavioural adaptations, scat piling and chemosensory communication can be placed in the context of the species' physical environment and the limitations of its body form and function.

Mainland and off-shore island populations show differences in body dimensions, and sexually dimorphic characteristics also differ between populations. Both Kangaroo Island and Wedge Island populations of *E. whitii* belong to the same clade, but in the short geologic period since separation from the mainland and each other, body dimensions in the two groups have altered. The longer, leaner, and presumably faster body shape of the Wedge Island population is complemented by a reduction in sexually dimorphic traits. Difficulties in determining gender in this population led to the use of discriminant analysis to predict sex, and the predictions were also used to allocate gender to laboratory animals used in chemosensory tests (Chapter 5).

INTRODUCTION

Theoretical assumptions underlying the evolution of life history traits encompass constraints, trade-offs between traits and, essentially, sufficient genetic variation to allow a combination of traits that can facilitate maximisation of some components of fitness (Roff 1992). Life history characteristics combine to determine how well an organism is adapted to its environment, and provide a blueprint for survival in a challenging environment.

In practice this means that any of the major features of a faunal species' life history, including morphological characteristics, growth, age at maturity, reproductive effort (including parental investment), lifespan, size and number of offspring, and social characteristics may vary significantly along its distributional range.

The Scincidae family is the largest and most diverse family of lizards in the world (Greer 1989). Members are characterised by a bony secondary palate dividing air and food passages, and an osteoderm composed of a mosaic of smaller pieces in a symmetrical pattern, underlying each scale (Greer 1989). Skinks comprise 57% of Australian lizard species and fill almost every niche in Australia, showing a huge variety of body form, size and behaviours (Cogger 2000).

Within the *Egernia* genus 30 species are currently recognised with all but *Egernia frerei,* which extends into New Guinea, being endemic to Australia (Chapple 2003). These predominantly social lizards are medium to large in size (Chapple 2003) and several species, including *Egernia whitii,* demonstrate marked clines in morphology along their distributional range (Donnellan *et al.* 2002).

The dynamics involved in group living depend upon the features characterising the individuals that constitute the group. As a consequence, life cycle components such as age to sexual maturity, morphology, reproductive patterns, litter size, longevity, morphological plasticity and juvenile survival rates may all influence activity and motivate interactions within the social group.

Essential life history information on *E. whitii* in South Australia is presented here and in Chapter 3 to place new scientific evidence concerning behavioural adaptations, scat piling and chemosensory communication, in the context of the species' physical environment and the limitations of its body form and function. This paper investigates the habitat utilised by *E. whitii,* explores the morphology of this species at a mid-latitude location within its total distribution, and examines morphological differences between South Australian (SA) populations found on the mainland, and two off-shore islands – Kangaroo Island and Wedge Island. Data from preserved specimens from the South Australian Museum, Adelaide (SAMA) originating on the mainland and on Kangaroo Island, and live specimens from the study site at Wedge Island are analysed to identify any differences in pattern morphology, body dimensions or sexual characteristics between these populations.

HABITAT

Characteristically, *E. whitii* is associated with loose rocky areas (Milton & Hughes 1986) with friable top soil (Hickman 1960) or substrate suitable for burrowing (Ehmann 1976, Green 1984), but have been described by Chapple (2003) as facultative burrowers in suitable habitats and saxicolous in others. The availability of geographically suitable substrate heavily influences location (MacNally & Brown 2001, Jellinek *et al*. 2004, Bellamy 2006) and when it is available, they exhibit a preference for complex habitat with well developed canopy and shrub layers (Milton & Hughes 1986). Arboreal habitat usage (Swan 1990) including climbing trees for late afternoon basking (Hickman 1960) and perching and using saltbush as a launching pad for the capture of insects, seems to be common in the southern regions (pers. obs).

E. whitii are distributed geographically throughout a variety of mesic habitats in south-eastern Australia. The diverse range of habitat complexes utilised by this species throughout its distributional range is exemplified in the Wedge Island population. Here this species is found on coastal shelves, heathland, grassland, dry sclerophyll forest, open woodland and dense scrub or shrubland. On Wedge Island *E. whitii* are found almost everywhere rock is present in the substrate, with the exception of deeply embedded rock lacking soil and vegetation or loose debris. Even extremities along the limestone shelves of the southern and western coast, while denuded of most vegetation, revealed sparse populations of *E. whitii* utilising isolated clumps of ground cover and small rocky pits, with exfoliating shards of rock which are produced by the constant wear of water.

Rocky areas are, in fact, a key characteristic of *E. whitii* habitat reported by researchers (Hickman 1960, Milton & Hughes 1986, Mac Nally & Brown 2001, Donnellan *et al*. 2002, Chapple 2003, Jellinek *et al*. 2004, Bellamy 2006) from a variety of geographically disparate locations. The affinity of this species for rocky areas appears to heavily influence location (Bellamy 2006), and *E. whitii* can be found in somewhat inhospitable areas considering their predilection to burrow (Figures 4 & 5).

Figure 4: Sandstone and concrete piles with minimal vegetation and substrate on the cliff edges of Wedge Island make suitable habitat for *E. whitii*.

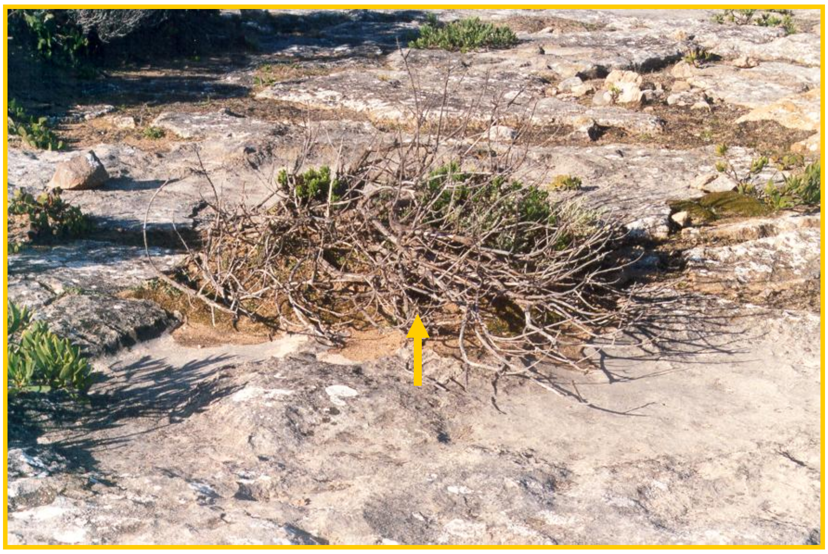

Figure 5: Embedded rock with an island of vegetated loam forms a suitable burrow habitat for one *E. whitii*. Burrow opening indicated with arrow.

However, in the vast majority of microhabitats, loamy or sandy soils underly the rocky areas. The excavation of short burrows beneath exfoliating or shallow embedded rock lying amongst vegetative cover is characteristic of *E. whitii* on Wedge Island. Girardi (1996) reports from experimental trials in Tasmania that most burrows possess more than two branches and entrances. Burrow openings are usually well disguised, and in more open habitat they may be longer and exhibit multiple tunnels leading to 2-3 escape holes.

E. whitii is a very secretive and cryptic species, well camouflaged in native Australian habitat. The highest densities of skinks are found in microhabitats of the most complex structure, such as old Dryland Tea-tree (*Melaleuca lanceolata*) woodland located in sandstone areas with loam substrate and littered with fallen timber and thick ground cover.

One other area supporting a reasonably high density was located immediately adjacent to salt marshes in an inland drainage depression in rock strewn former pasture land where amongst the annual grasses there were numerous small shrubs and ground-covers bearing quantities of small orange or red edible berries over summer. This occurrence was unexpected because it has been demonstrated that *E. whitii* is highly susceptible to habitat fragmentation (Mac Nally & Brown 2001, Jellinek *et al.* 2004) and this particular area lacked substantial cover and included small areas of poisoned vegetation plus patches of severely burned land covered in fine ash, which all skinks avoided.

Pattern morphology

E. whitii are polymorphic in colour pattern, with three pattern morphs represented. Fully patterned individuals display dorsal and lateral patterning, and comprise the most abundant morph (Milton 1990, Donnellan *et al.* 2002, Chapple *et al.* 2005). Partially patterned individuals retain lateral patterning but lack dorsal patterning, and there is a patternless morph which is extremely uncommon and occurs in distinct regions (Donnellan *et al.* 2002).

In SA all three pattern morphs are present. However SA has more than 150 off-shore islands (Robinson *et al.* 1996), the largest being Kangaroo Island. While all patterns morphs are present on Kangaroo Island and the mainland, on Wedge Island in the Spencer Gulf only one individual *E. whitii* from more than 500 animals observed has been recorded with a plain back (pers. obs.). No individuals of the patternless morph have been sighted, the remainder being fully patterned laterally and dorsally. Despite these pattern differences, populations on Kangaroo Island and Wedge Island have been identified as belonging to a single clade in phylogenetic analyses (Chapple *et al*. 2005).

MATERIALS AND METHODS

Wherever possible live captures were used to gain life history information or to supplement SAMA data based on preserved specimens. No live animals were sacrificed during the study.

South Australian Museum specimens

The study began with a systematic examination and analysis of the preserved specimens in the South Australian Museum, Adelaide (SAMA). Mainland and island specimens were measured externally for general data on size, and island specimens were measured internally in addition to external examination, for reproductive information. Information gleaned from these specimens on sexual dimorphism, age to maturity, gonad activity, and size and number of offspring gained from the island specimens was used as a guide for the study population on Wedge Island. In all, 208 *E. whitii* specimens collected over a 90 year span were used. Of these 95 were from the mainland (Figure 2: Clades 2 & 3), and 113 were from island populations, primarily Kangaroo Island (N= 93) but including Thistle Island located 7.4 km east of the southern tip of Eyre Peninsula (N = 2), Wedge Island (N= 10), and West Island located in Encounter Bay, Fleurieu Peninsula (N = 8).

The identification number, date of capture when available, location, weight, snout to vent length (SVL), tail length, tail regeneration, head length, head width, head depth and combined hind leg and foot measurement for each specimen was recorded. SVL and tail length were measured from snout tip to vent and vent to tail tip respectively, by stretching the skink along a metal ruler. Tail regeneration was measured from the line of scale and pattern change to the tail tip and recent autotomy events were recorded as 1.0mm to distinguish between these individuals and those with intact tails (intact = 0.0mm regeneration).

Hind leg and foot measurements were taken with the limb straightened, from the under-arm position to the tip of the longest (4th toe), not including the toe nail. A dial calliper was used to record head dimensions. Head length was measured from the lower ear to the snout tip, head width was measured transversely in line with the anterior interparietal scale, and head depth was measured centrally from the interparietal scale to a point on the neck directly in line below.

Each intact offshore island specimen which had a recorded month of capture (N = 97: female = 48, male = 49), was examined internally for signs of reproductive activity. Gonad size and limb to limb length was measured in both sexes. The quantity of enlarged follicles or embryos and evidence of post-partum changes for female specimens, and stretching of epididymes for male specimens were documented.

All specimens preserved in a 70% alcohol solution were drained and blotted with absorbent paper immediately prior to weighing, and re-sprayed during examination to prevent drying. Some of them were very fragile and the preserving process had caused some dehydration. Where any dimensions were obviously distorted as a result of age, compression, or condition, missing values were recorded for analyses.

Wedge Island population

The field study was conducted between March 2001 and March 2004 at Wedge Island in the Spencer Gulf of South Australia (35°09'S, 136°27'E). The island, which has been separated from the SA mainland for over 9,000 years (Robinson *et al.* 1996), has a temperate Mediterranean climate with hot, dry summers and cool, wet winters. Much of the original woodland has been cleared but some healthy patches of *Melaleuca lanceolata* (Dryland Tea-tree) woodland persist where the substrate is covered with loose and embedded rocks. There are large areas of coastal heath and vegetated sand dunes and there are salt marshes in an inland drainage depression in the island's north-west. Relatively flat cliff-top platforms with embedded, loose and exfoliating rocks exist around approximately ¾ of the island's perimeter.

The rest of the island has generally sandy, sandy-loam or loam soils with occasional rocky patches. There is no permanent water resource on the island although rainwater storage tanks are attached to the dwellings. Since the early 1990's the island has been cleared of all domestic grazing animals and there are now no permanent human inhabitants or pastoral activities. The introduction of common pest animals such as rabbits and foxes has been avoided and management practices now preclude any domestic or non-native fauna and flora introductions, although several endangered native mammal species have been introduced by the Department for Environment and Heritage.

Feral foxes and cats, and native snakes, quolls and birds of prey are the only known predators for the *Egernia* genus (Chapple 2003). The absence of all of these from Wedge Island except birds of prey, the lack of a permanent human population, and the abundance of lizards make it an ideal site for herpetological study.

During a study on Wedge Island between March 2001 and March 2004 north-south sampling transects at 200 metre intervals across the island were conducted, and several areas were sampled intensively. Three hundred and sixty five lizards were captured and processed. A laboratory colony of 98 skinks from the transect captures was retained for experimental trials and the remainder were released at the point of capture. A description of location, habitat, weather conditions, sampling for DNA and parasites, and social proximity was recorded for each individual skink along with weight, snout to vent length (SVL), tail length, evidence of tail regeneration, hind leg and foot length, head length, head width and head depth. In addition detailed physical descriptions of damage and scarring were completed.

Discriminant analysis

There was considerable difficulty encountered in determining the sex of many Wedge Island captures based on direct observation of genital morphology, yet there was a need to know the sex of many individuals for other aspects of the research. I therefore explored the use of Discriminant analysis in SPSS 11.5 for Windows, to predict sex.

Wedge Island field captures (N= 365) and their laboratory born progeny (N = 26) were used as the data base for this analysis. On Wedge Island skinks reach maturity in their third or fourth year after reaching 70 mm SVL (Chapter 3). Therefore only skinks ≥ 70mm SVL were selected from the original group for gender discrimination (N = 280). Individuals of this size were expected to display secondary sexual characteristics. Thirty positively identified males and females were included in the group (F = 16, M = 14), and missing values were excluded pairwise. Variables used in the analysis were mass, SVL, tail length, tail regrowth after autotomy, hind leg and foot length, head length, head width and head depth.

The range of variables within the selected population is described in Table 1.

Table 1: Wedge Island captures and laboratory born progeny = or > 70 mm SVL (N = 280)

Variables	Minimum	Maximum	Mean	Std. Error
Mass (g)	6.3	23.4	12.48	0.19
SVL (mm)	70	92	80.21	0.33
Tail length	50	158	112.10	1.21
Tail regeneration	0	91	27.01	1.67
Hind leg and foot length	16	32	28.26	0.11
Head length	13.4	19.2	16.89	0.06
Head width	9.0	14.6	11.82	0.06
Head depth	7.5	13.2	10.59	0.06

Individual data sets with missing variables (mass or hind leg and foot length) caused by equipment failure in the field or trauma were re-entered separately at the completion of the first analysis, with the original data set, but with the affected independent variable removed from the analysis. The results for all individuals with a SVL greater than 70 mm and with a probability classification of 85% or over were accepted.

RESULTS

General morphology of preserved and live specimens

Tables 2 and 3 show minimum and maximum body dimensions and indicate the size range of preserved specimens from mainland and off-shore islands in South Australia (SA), and live animals on Wedge Island.

Table 2: SA mainland and off-shore island SAMA preserved specimens. Sample size N = 208

Morphological measurements	Minimum	Maximum
Mass (g)	1.2	20.8
SVL (mm)	35	92
Tail length	7	151
Tail regeneration	1	89
Hind leg and foot length	12	31
Head length	9.5	19.2
Head width	6.3	14.9
Head depth	4.8	14.3

Table 3: Wedge Island live captures. Sample size N = 365

Morphological measurements	Minimum	Maximum
Mass (g)	1.4	20.3
SVL (mm)	39	92
Tail length	16	155
Tail regeneration	0	91
Hind leg and foot length	15	32
Head length	10.1	19.2
Head width	6.8	14.5
Head depth	5.8	13.2

Morphological differences in geographic populations

In the initial phase of the investigation SAMA specimens were examined independently of live specimens. Morphological differences between SA off-shore island and mainland specimens were discovered. The relationship between body mass and snout vent length was examined using a scatter plot in which island and mainland data are indicated using filled triangles and hollow circles respectively (Figure 6). This indicated that body mass increased non-linearly with snout-vent length and body mass was subsequently $\log_{10}$ transformed in an attempt to produce linearity. The resulting data are graphed in Figure 7 which suggested a linear relationship between the transformed mass and snout vent length.

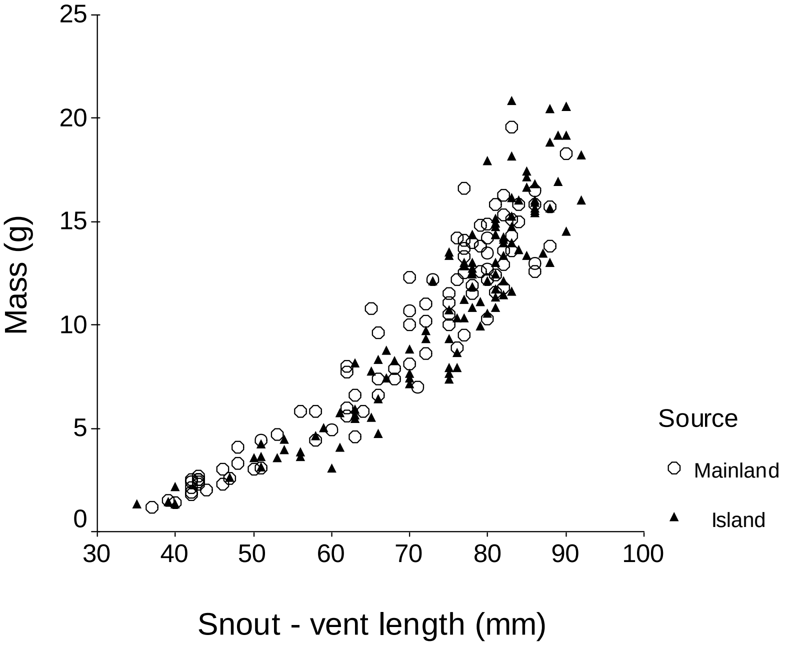

Figure 6: The relationship between body mass and snout to vent length. Island and mainland data are indicated using filled triangles and hollow circles respectively.

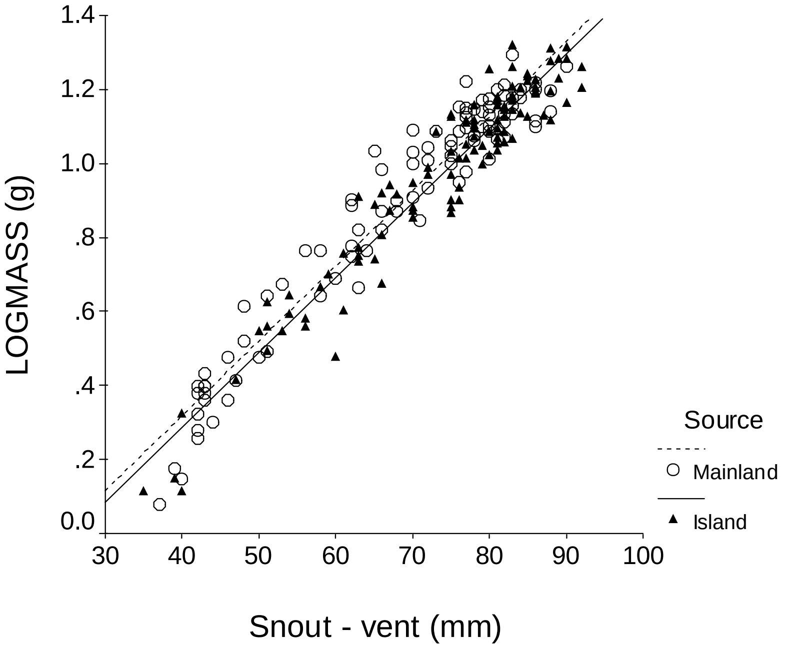

Figure 7: Relationship of body mass ($\log_{10}$ transformed) and snout to vent length with separate regression lines fitted to the two specimen groups. Island and mainland data are indicated by using filled triangles and hollow circles respectively.

I was therefore able to investigate whether the island and mainland populations differed by using ANCOVA where source of the skinks (mainland or island) was the treatment and snout vent length was the covariate. A Levene's test indicated that variances were homoscedastic ($F_{1,23} = 0.342$, $P = 0.597$) and the interaction between source and snout-vent length was non-significant ($F_{1,45} = 9.443$, $P = 0.234$). The interaction was therefore removed from the model and the resulting ANCOVA indicated a highly significant effect of both source ($F_{1,56} = 23.567$, $P = 0.004$) and snout vent length ($F_{1,56} = 34.567$, $P < 0.001$). Consequently mass increases with snout vent length, as expected, and inspection of Figure 7 indicates that the mainland population has a greater mass per unit SVL.

A sample group of 121 adults (Island N = 75, Mainland N = 46) was examined for morphological differences. At minimum reproductive size (≥74mm SVL) the two populations showed significant differences in hindleg and foot length, and head depth (Figures 8 & 9).

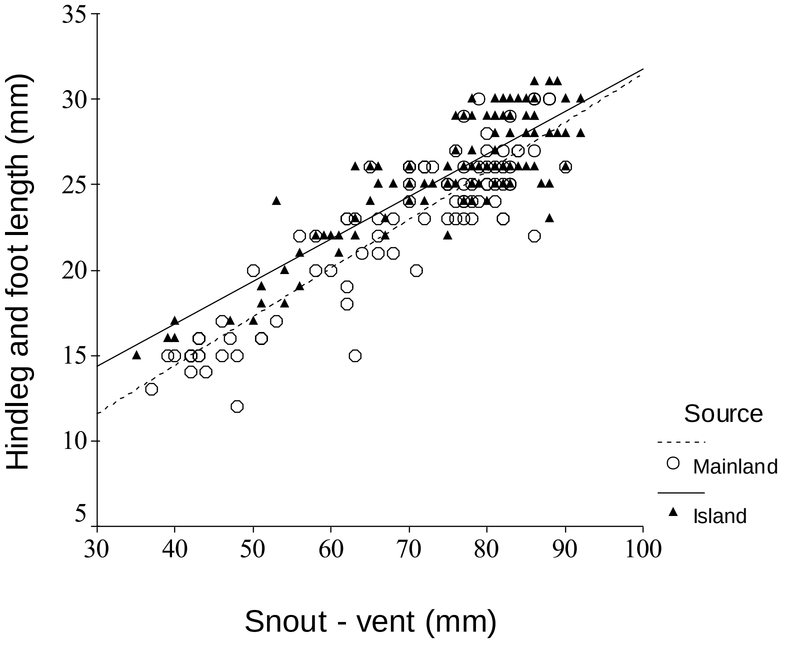

Figure 8: Hind leg and foot differences between island and mainland populations of *E. whitii* (regression lines fitted).

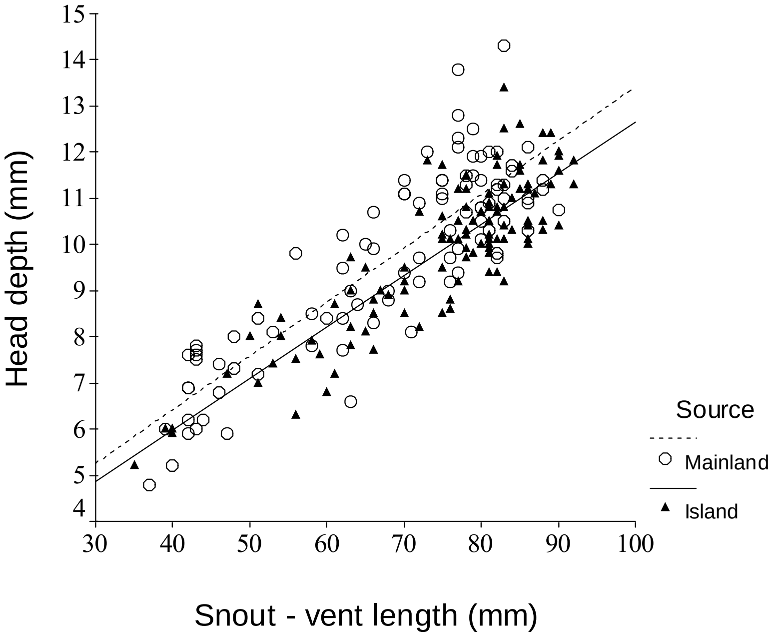

Figure 9: Head depth differences between island and mainland populations of *E. whitii* (regression lines fitted).

However, there were no significant differences between SA mainland and island populations in mass, snout to vent length, tail length and tail regeneration, despite a trend towards differences in snout to vent length and head length. The following results are presented in consecutive pairs for comparison (Table 4).

Table 4: Independent samples t-tests indicate morphological differences in body shape between island and mainland *Egernia whitii* ≥ 74 mm SVL.

Dimension	Independent samples t test	Island	Mainland
Mass	P = 0.451		
Snout to vent length	P = 0.070	Trend to longer	
Tail length	P = 0.365		
Regeneration	P = 0.436		
Hind leg and foot length	P = 0.001	Sig. longer	
Head length	P = 0.084	Trend to longer	
Head width	P = 0.301		
Head depth	P = 0.007		Sig. deeper

Sexual dimorphism

South Australian Museum specimens

Preserved specimens from Kangaroo Island ≥ 70 mm SVL were analysed for sexually dimorphic traits. Specimens originating on Wedge Island (N = 7) and West Island (N = 5) were excluded from the group. There were 62 adults originating on Kangaroo Island (Females = 33, males = 29) with sizes ranging from 70 – 92 mm SVL in the female group and 74 – 92 mm SVL in the male group.

Analysis of covariance (ANCOVA) was conducted, where the body measurement was the dependent variable and the fixed factor was sex. SVL was used as the covariate in this analysis. Mass was $\log_{10}$ transformed to produce linearity. Preliminary checks conducted on the remaining variables ensured that there was no violation of the assumptions of normality, linearity, homogeneity of regression slopes and reliable measurement of the covariate.

Head length violated the assumptions in the Levene's test and was removed from the analysis. The interaction between sex and SVL was not significant for the remaining variables, and was removed from the model. Head width and head depth recorded significant differences in mean size between males and females. The following results are presented in consecutive pairs for comparison (Table 5).

Table 5: Sexually dimorphic traits between SAMA Kangaroo Island male and female *E. whitii*

Dimension	Independent samples t-test	Males & females
$\log_{10}$ mass	P = 0.154	Nil sig.
Tail length	P = 0.915	Nil sig.
Tail regrowth	P = 0.674	Nil sig.
Hind leg and foot length	P = 0.068	Nil sig.
Head width	P <0.001	Males wider than females
Head depth	P = 0.041	Males deeper than females

Wedge Island population

I selected only pregnant females, and males in which hemipenes had been sighted, to use in the analysis for sexual dimorphism in the Wedge Island population. There were 32 adults in this category (Females = 16, males = 16) with sizes ranging from

80 – 90 mm SVL in the female group and 69 – 91 mm SVL in the male group. A one-way between-groups analysis of covariance (ANCOVA) was conducted where the body measurement was the dependent variable and the fixed factor was sex. SVL was used as the covariate in this analysis. The variable mass was Log_{10} transformed to produce a linear relationship. Assumptions in the Levene's test were not violated, and, the interaction affect between sex and SVL was not significant and the interaction was removed from the model. Males and females recorded significant differences in mean size head length and head width. The following results are presented in consecutive pairs for comparison (Table 6).

Table 6: Sexually dimorphic traits on Wedge Island

Dimension	Independent samples t- test	Female	Male
Log_{10} mass	P = 0.423	Nil sig.	
Tail length	P = 0.316	Nil sig.	
Regeneration	P = 0.363	Nil sig.	
Hind leg and foot length	P = 0.634	Nil sig.	
Head length	P <0.001		Highly significant
Head width	P = 0.007		Significant
Head depth	P = 0.099	Nil sig.	

Figures 10 and 11 show the relative head sizes of Wedge Island skinks and Kangaroo Island skinks. Head sizes on Wedge Island are larger than on Kangaroo Island and show some differentiation in shape.

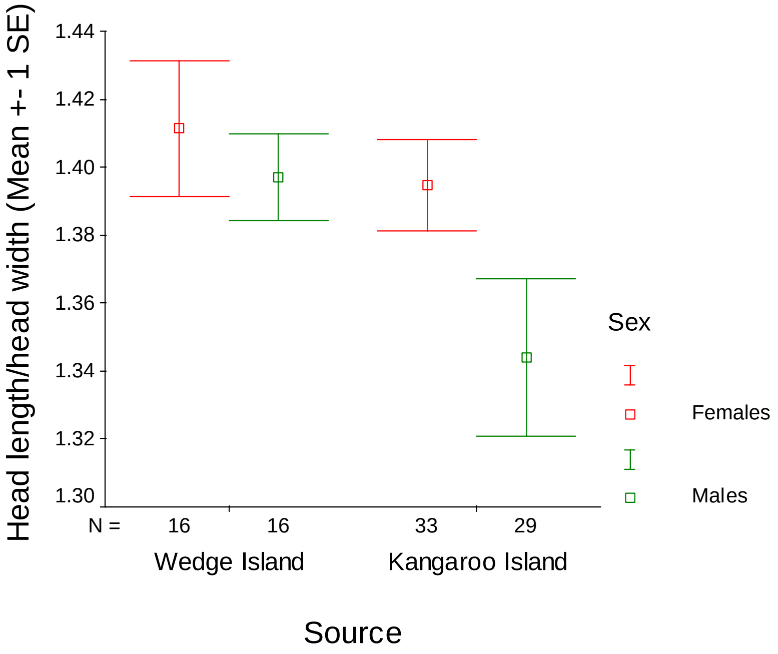

Figure 10: Head width as a proportion of head length in Wedge Island and Kangaroo Island populations of males and females.

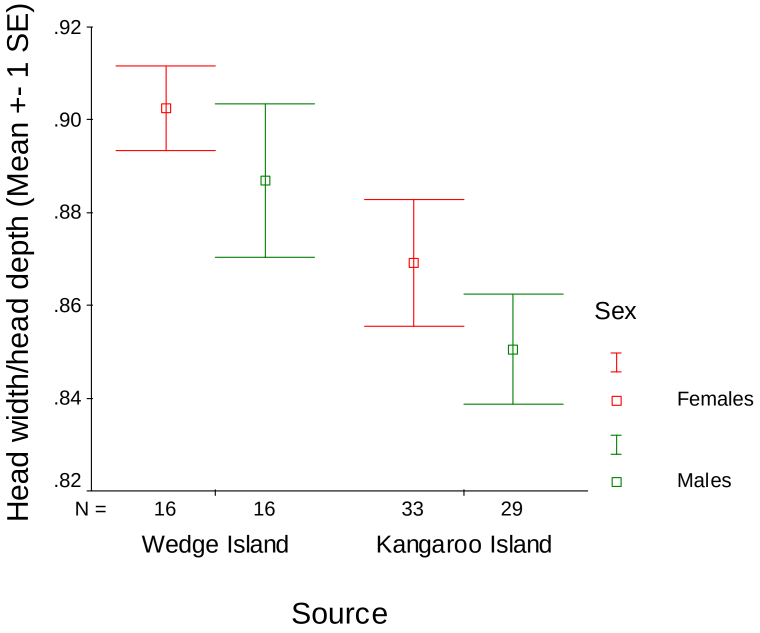

Figure 11: Head depth as a proportion of head width in Wedge Island and Kangaroo Island populations of males and females.

Discriminant analysis

The total number of individuals used in the analysis was 280, comprising 30 individuals (10.7%) whose sex was known, one individual who was missing one or more values for the variables used in the discriminant analysis (0.4%), 13 individuals who were missing values for one or more variables used in the analysis and whose sex was unknown (4.6%), and 236 individuals who had all variables recorded but whose sex was unknown (84.3%).

An Eigenvalue of 1.367 with a Canonical correlation of 0.760 and a Wilks' Lambda test of function with a significance of 0.008 were recorded in the analysis. Table 7 shows the eight variables used in the analysis, and records the values of correlations with discriminant function, and discriminant function coefficients.

Table 7:

Measurement variables	Correlation with discriminant function	Discriminant function coefficient
Head length (mm)	-0.381	-1.384
Head width (mm)	-0.283	0.310
Head depth (mm)	-0.204	-0.583
Tail length (mm)	0.202	0.612
Tail regrowth length (mm)	0.194	0.387
SVL (mm)	0.151	1.783
Hind leg and foot length (mm)	0.082	-0.412
Mass (g)	-0.013	-0.562

Once the discriminant function had been calculated it was used to predict gender membership of individuals whose sex was already known as well as those whose sex was undetermined. Classification results showed that 90% of the originally grouped cases had been correctly classified by the discriminant function, with a breakdown of 93.8% females and 85.7% of males correctly classified. Of the ungrouped cases 54.7% were predicted to be females and 45.3% were predicted to be males.

Figures 12 and 13 are scatter graphs for nominated group members and predictions from ungrouped cases respectively, where females are represented by hollow circles, males are represented by filled triangles, and regression lines have been fitted for subgroups. A comparison of these figures shows similarity.

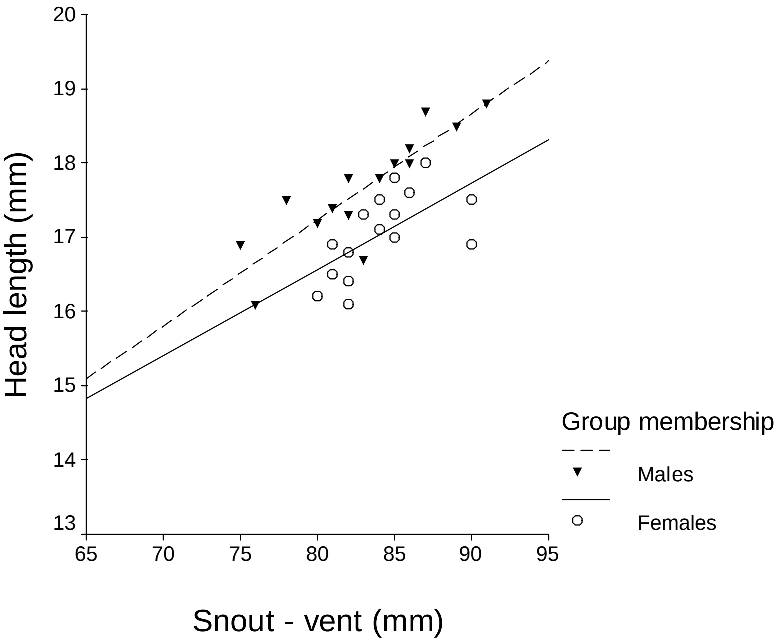

Figure 12: Identified female and males skinks from Wedge Island. Regression lines have been fitted to subgroups.

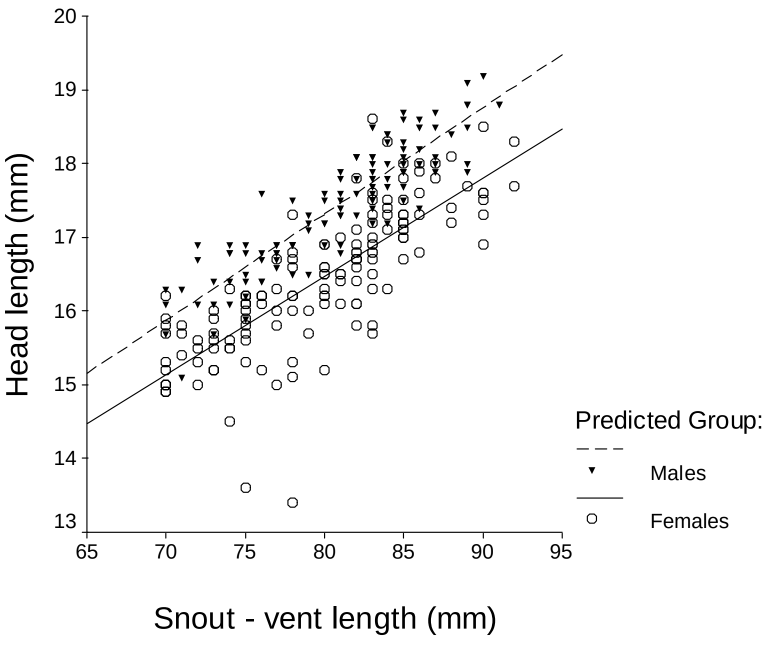

Figure 13: Male and female gender predictions from ungrouped cases. Regression lines have been fitted to subgroups.

DISCUSSION

Historically, the islands off the SA coastline are remnants of the continental landmass, formed by the eroding and isolating effects of rising sea levels over the last 17,000 years, when they were connected to the mainland at the height of the most recent glaciation (Robinson *et al*. 1996). The alternately rising and falling seas prior to this time are likely to have severed and re-established links between various islands, and island groups and the mainland at a number of different stages.

It is possible that this process led to the leakage between, and then rebreeding of different populations. The colour pattern morph of Wedge Island is interesting geologically from this point of view. While all three colour pattern morphs are present on Kangaroo Island, the fully patterned morph is dominant on Wedge Island with only one recorded specimen with a plain back being found to date. Any presumed allele coding for this trait is therefore extremely rare at this location, and the plain morph is absent.

The difference in morphological traits between the two islands, which share a similar history and geology, and the lack of pattern polymorphism on Wedge Island, may reflect random drift, negative selection, founder effects or genetic bottlenecks. However it is possible that there is no genetic component and the Wedge Island population is simply reflecting environmental differences in growth, as may be the case with some Australian offshore Varanids (Case & Schwaner 1993).

Both island populations of *E. whitii* belong to the same clade, but in the geologically short period since their separation from the mainland and each other, body dimensions in the two groups have altered or else there had been a latitudinal cline that has been subsequently captured into two discrete populations. Each population has experienced a unique set of environmental changes in its recent history, but it is too soon to establish whether morphological changes between the groups are a result of adaptation to environmental conditions or another cause.

This species has been characterised previously as temperate-adapted and rock associated, but it also burrows in all known habitats on Wedge Island. The patchy east Gippsland distribution of *E. whitii* in sandy coastal heathland habitats reported by Chapple *et al*. (2005) provides some indication of substrate preference and fossorial habits. *Egernia multiscutata* are not found as far east as Gippsland. In a series of substrate choice experiments Bellamy (2006) found that the first choice for an over-night refuge of both *E. whitii* and *E. multiscutata*, sympatric species on Wedge Island, was to create a burrow in sand, rather than use a provided rocky refuge. Perhaps when free of competition provided by the heavier *E. multiscutata* on Wedge Island, *E. whitii* can choose substrate more suitable for burrowing. Habitats with some potential for burrowing, plus loose rock, appear to be essential requirements for survival in the *E. whitii* species. A thorough investigation of the social system used by *E. whitii* may reveal other criteria.

Research on the morphological differences between *E. whitii* found on SA's off-shore islands and the mainland used preserved specimens from SAMA. These specimens were directly comparable because all had received the same treatment. When differences between preserved specimens from Kangaroo Island and live specimens from Wedge Island were made, mass measurement may have been affected by slight dehydration in the preserved specimens. In Figures 8 & 9, head dimensions are presented as a proportional value. These measurements appear to be a robust measurement directly comparable between both the preserved and the live specimens.

The longer, leaner, and presumably faster body shape of the Wedge Island population is complemented by a reduction in sexually dimorphic traits. Difficulties in determining the sex of these skinks led to the use of discriminant analysis to predict sex. Discriminant analysis proved a useful technique in this context, and was used to allocate gender to the laboratory animals used in chemosensory tests (Chapter 5).

It was not possible to compare the SVL's between the sexes in either the Kangaroo Island group or the Wedge Island group because of the size difference between the males and the females in both populations. However by using ANCOVA, with SVL as the covariate, it was possible to test for interactions between sex and SVL before the groups were analysed further, to ensure the tests were equitable.

Populations of *E. whitii* vary in the genetic marker ND4 throughout the species distributional range - between the northern and southern populations, and between clades within these populations. It is therefore not surprising to discover aspects of life history and morphology that differ between and within clades and populations, especially those separated by tracts of water. The variety of habitats populated by this species could give rise to a general acceptance that it is unlikely to face decline because of its enhanced adaptability. However a great deal still remains to be discovered about the social and life history characteristics of *E. whitii* before we can conclude that we have sufficient knowledge to predict a secure future for this species.

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