Population Trends, Life History Traits and Feeding Ecology of the Tussock Skink, *Pseudemoia pagenstecheri*

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ABSTRACT

This study investigated population trends, important life history patterns and the general ecology of the Tussock Skink, *Pseudemoia pagenstecheri*. The study was conducted at the former Albion Explosives Factory site, an area which provides both remnant native and exotic-dominated grassland habitat. Tussock Skinks were collected using pit-fall trapping techniques and dietary analysis was performed by use of scat (faecal pellet) analysis.

Tussock Skinks demonstrated characteristics such as small body size, rapid growth rates, early reproductive maturity and high reproductive output, traits associated with 'r-selected' species in life history theory. Dietary preferences indicate that the species is a opportunistic arthopod feeder which utilises both surface active and sedentary prey. Spiders, crickets and bugs were common in the diet of the Tussock Skink.

There was a trend of declining capture rates of Tussock Skinks at the site. Given the threatened status of the habitat of Tussock Skinks in Western Victoria and the endangered status of other small Victorian grassland lizards, this trend is of concern. The Tussock Skink is currently considered locally common. However, the trend of decline observed in the Albion population indicates that the conservation status of the Tussock Skink may require review in the near future.

DISCUSSION

This study provided definitive information about important life history traits of the Tussock Skink. It was also able to detail dietary preferences of Tussock Skinks which have not been studied previously. The study also provided insights into the monthly activity patterns and demographics of Tussock Skinks in the Albion population. However, possibly the most important finding of this study is the overall major decline of the Tussock Skink population at the study site.

Morphology

Snout-Vent Length

The snout-vent length (SVL) of Tussock Skinks in this study tended to be greater than those reported in other studies of this species. Thompson and Stewart (1994) found adult females in their sample of 34 individuals from Grundy Trig, northern New South Wales ranged from 49 – 65 mm SVL with a mean 56.5 mm and standard error ± 0.7. Samples from the current study tended to be approximately 5mm greater. SVL at the study site is also greater than figures for both adult females and males of the basalt plains of Victoria presented by Hutchinson and Donnellan (1992) : SVL of adult males ranged from 39-59 mm (mean = 49.3), adult females ranged from 40-62 mm (mean = 51 mm).

A trend of size sexual dimorphism is shown by the Albion population of Tussock Skinks. Females appear to be slightly larger than adult males. This size dimorphism was also seen in basalt plain samples discussed in Hutchinson and Donnellan (1992). Hudson (1997) described similar trends of sexual dimorphism in samples of Tussock Skinks from both Laverton, and the Shaw's Creek population in the central highlands of Victoria.

The size dimorphism in SVL suggests that females have more elongate bodies than males. A more elongate body means a longer abdomen which will allow for more offspring per clutch. This fits the general life history pattern where litter or offspring size increases with maternal body size (Dunham et al. 1988). The relatively small body size of the Tussock Skinks fits the life history theory model for a 'r-selected' species (Begon *et al.* 1996).

Growth

Hudson (1997) used mark-recapture data and skeletochronology to determine growth rates of a population of Tussock Skinks at Shaw's Creek in the central highlands of Victoria. Using these two techniques, Hudson (1997) also determined important life history traits for females at Shaw's Creek such as size and age at maturity and longevity. Results for these life history traits in the Albion population show trends that are in contrast to those of the Shaw's Creek population.

The results of the dissection suggest that parturition for the summer of 1998/99 was in progress by mid-December. Two juveniles of snout-vent 24mm captured in mid-December 1998 were also likely to be neonates representative of the annual recruitment of Tussock Skinks at Albion.

The data suggests that neonatal Tussock Skinks experience rapid growth in the January, February and March of their first season. By attaining SVL around 50mm by the end of March, juveniles resemble adults in size. This rapid growth was also documented by Hudson (1997). However, in the Shaw's Creek population juveniles take a period of 12 months to attain a body size of 40mm SVL.

Size and Age at Maturity

The rapid growth of juveniles in the Albion population is interesting in light of the reproductive cycle of the Tussock Skink. The adult-like proportions displayed by juvenile Tussock Skinks by the end of March in their first season may have an influence over life history traits such as size and age of maturity.

Hudson (1997) concluded that the minimum size at maturity for females in the Shaw's Creek population was 48mm SVL. Females in the Shaw's Creek population attained minimum SVL of 48mm by the end of their second year. It takes a juvenile female from the Shaw's Creek population twenty-four months to attain the same size as a female from the Albion population after approximately three months.

Greer (1989) concluded that size appears to be the determining factor for reproductive maturity in skinks. If this general life history trait of skinks applies in the case of the Tussock Skink then it is reasonable to expect juveniles of the Albion population that display similar proportions to reproductive females in the Shaw's Creek population to be participating in mating activity by early winter of their first season.

If these juveniles successfully mate at the end of their first summer then the age of maturity of female Tussock Skinks in the two populations will differ. Instead of the age of first mating being between 13 to 15 months, it will be 3 to 5 months. Hence, age at maturity will be 12 months, rather than 24 months.

The differences in the growth rates and predicted onset of maturity in the two populations could be related to their locations. The western (basalt) plains experience higher mean temperatures than the central highlands and this may influence a range of proximate factors such as potential access to food resources and the harnessing of necessary thermal energy for the animals in each population.

The characteristics of rapid growth and early reproductive maturity displayed by Tussock Skinks at Albion are life history traits associated with 'r-selected' species which are located at the fast extreme of the continuum of life history strategies (Stearns 1992).

Population Demographics

Age Structure

The relative high capture rate of juveniles compared to adults may be explained by two major considerations. Firstly, the timing of the trapping period in each year coincides with the expected time of births of juvenile skinks. Therefore, if one mature female produces 2 to 11 offspring and all (or almost all) mature females are gravid each year (Hudson 1997), then even though the proportion of adult females to males is relatively low (see Sex Ratios), juvenile capture rates would be expected to be higher than those of adults.

In addition, trap shyness (see below) may occur in adult Tussock Skinks who are more likely to have experienced pit-fall traps in previous seasons. Conversely, juveniles will be encountering pit fall traps for the first time and are unlikely to have any learned aversion to the trap.

Sex Ratios

The consistent sex ratio bias towards males in the Albion population of Tussock Skinks is unusual. Due to the lack of information on the sex ratios found in other populations of the species it is difficult to conclude what has caused this result.

However, there are several possible ways in which the biased sex ratio may be interpreted.

It is possible that a behavioural difference between male and female Tussock Skinks has been reflected in the sex ratios rather than an accurate picture of the populations demographics. For example, given that pit-fall traps can only trap surface active animals, if males are more active than females during the trapping period, the results would be skewed towards male captures.

A second explanation for the male bias in the current study could relate to the method used to sex individuals from the Albion population. The presence or absence of a red mid-lateral stripe was used to determine sex. This was reported by Hutchinson and Donnellan (1992) as a sexually dimorphic trait in the Tussock Skink. However, a more accurate technique widely used in studies of lizards is partial eversion of the hemipenes. Further comparative studies of these two techniques for sexing the Tussock Skink are required to clarify whether the presence of the dichromatic mid-lateral stripe as a reliable guide to sex.

Conversely, the trend may also be interpreted as a true occurrence in the population. If the ratio is a real phenomenon then it may be related to theories on 'cost' of reproduction for female Tussock Skinks. Gravid viviparous lizards such as the Tussock Skink are known to bask more frequently than conspecific males (Swarzkopf and Shine 1991; Melville and Swain 1997; Shine and Downes, in press). Increased basking activity causes greater exposure to predators. With increased body size through added clutch mass, the ability of females to escape by fleeing swiftly is compromised. This creates a significant 'cost' of reproduction (Shine 1980). While this behaviour in females could only have evolved if the fitness benefits outweigh the risks, introduced predators may interfere with the equilibrium. With increased predator levels, females may be more vulnerable during the late stages of gestation. If females are heavily preyed upon then the number of females in the population will decrease and create a male bias in the population.

Activity Patterns

Patterns of adult activity are difficult to interpret from the available data as no significant difference in monthly activity was found in the analysis. However, a strong trend of increasing capture rates across months was shown by juveniles indicating increased activity. Parturition occurs in the December-January period (Hutchinson and Donnellan 1992), therefore an increase in juvenile numbers after January could be expected. By February and March the new cohort of juvenile Tussock Skinks would be mixed into the broader population and could be expected to be highly active, engaging in fundamental activities such as foraging. Juveniles in related species such as *Niveoscinus microlepidotus* are known to spend significant amounts of time foraging in early autumn months (Melville and Swain 1997). By investing time in foraging *N. microlepidotus* juveniles are able to built up fat reserves for the winter months (Melville and Swain 1997). It is possible that juvenile Tussock Skinks participate in similar behaviours, therefore explaining the relative high capture rate of juvenile skinks in March.

Diet

The analysis of the Tussock skink scats in the current study produced slightly different results to the analysis of the diet of *Pseudemoia entrecasteauxii*, the Southern Grass Skink, its sibling species (Brown 1988). The differences can be attributed to the different habitats and general behaviours of the two species. Unlike the Tussock Skink, the Southern Grass Skink has a tendency to climb. It forages on logs and in piles of fallen branches (Hutchinson and Donnellan 1992) which provide a different microhabitat and therefore different potential prey items.

In scats collected in the trapping years of 1998 and 1999, the most frequently occurring prey items were Araneae (spiders). Gryllidae (crickets), Blattodae (cockroaches) and Hemiptera (bugs) were other main prey items.

Two families of spiders were identified : the Lycosidae (wolf spider) family and the Salticidae (jumping spider). Other diet constituents included larvae and adult Lepidoptera (moth), Coleoptera (beetle) and unidentified winged insects.

Interestingly, evidence of lizard scales (possibly reptile slough) was found in three scats.

Reptile slough has also found in samples of small south-eastern Australian skinks (Brown 1991). The small percentage presence of this material supports the suggestion

by Brown (1991) that slough ingestion occurs accidentally when the lizard has used its mouth and jaws to expedite the shedding of skin during the moult.

Foraging style

The prey items found in the scats of Tussock Skinks of the current study including spiders, crickets and bugs, are active invertebrates. However, prey such as moth larvae, and diurnally inactive cockroaches, are more sedentary. This diversity in the activity of potential prey items leads to difficulties in determining whether the Tussock skink is a widely foraging or sit-and-wait type predator. Personal observations suggest that the Tussock Skink demonstrates widely foraging predator behaviour because it flees when disturbed in the field and presumably when pursued by a predator (Perry *et al.*1990).

It is possible however, that the Tussock skink is an example of a species that can utilise a range of foraging modes (see Heatwole and Taylor 1987) and supports arguments such as those forwarded by Magnusson *et al.* (1985) who argued that a foraging continuum operates rather than individual species displaying one particular foraging mode. The variety of prey in the diet also may support the theory of an intermediate foraging mode championed by O' Brien *et al.* (1990).
The inclusion of both sedentary and active prey in the diet of the Tussock Skink makes strong conclusions based on the information available to the current study difficult. It is apparent that studies specifically designed to answer the question of foraging mode are required to clarify this issue.

Population Trends

The 1998/99 trapping season yielded similar results to previous surveys at Albion in terms of the range of species captured in pit-fall traps. This suggests that the trapping technique has remained effective for this type of fauna. While the range of species did not change, captures of the Tussock Skink did display a distinctive trend of decline across the years of the study.
The Tussock Skink is currently listed as locally common. However, any clearly documented population decline is a concerning result at a time when species are often being added to the vulnerable and endangered species list. It is therefore important to ascertain whether the population is truly experiencing a decline as certain species

behaviours, trapping technique, and methodology, may incorrectly suggest low population numbers of a species. The specific behaviour which may result in artificial population decline in this study was trap shyness. The trapping techniques and methodology which may also suggest incorrect population declines include: the type of trapping, trap configuration and location, and time of trapping.

Trap shyness has been acknowledged as a problem for the pit-fall trapping technique (Kutt 1992). Trap shyness is an observed behaviour in particular species which actively avoid traps (Coulson 1990). There is no documented evidence on trap shy behaviour in the Tussock Skink, however, observations in this study of adult tussock skinks avoiding pits (pers. obs.) and relative differences in trapping success with old and new drift fences suggest that trap shyness may be occurring. Adult skinks were observed twice to run along the drift fence until the pit where they used the fence to climb passed the pit. It is not known how often this behaviour occurs. Further study would be required to determine if this is a common behaviour in this species.

Pit fall traps included pits and drift fences. All traps in 1996 had recently been installed. Similarly, more than half of the traps used in 1997 were constructed in the months immediately preceding the trapping period. However, in the 1998 and 1999 years only previously used traps were in operation and many of the drift fences were left intact over the non-trapping months. It is expected that if the traps are functioning effectively that the animals are more likely to encounter the drift fence before falling into the pit. Higher relative capture rates in mini-grids where fences were new compared to those left intact over the non-trapping period indicates that the Tussock Skink is avoiding the traps that have been left in place for one or more years.
Trap shyness may be particularly important in understanding adult Tussock Skink captures. Hudson (1997) argued that Tussock Skinks were likely to live until for about six years, providing repeated opportunities to trap each individual. Therefore, adult Tussocks Skinks captured at Albion in the first year of data collection may be present in the population in the subsequent years and may have encountered traps in a previous trapping period. Adult skinks would then have an opportunity to learn to avoid the pits.
However, relative capture rates of adult Tussock Skinks across months, within each of the trapping periods was variable. Some months had greater trapping success than others, and there was no pattern. This would suggest that adults are not exhibiting

trap shyness within a trapping period so it is very unlikely for them to be trap shy in consecutive years. Therefore, while trap shyness in adults does appear to be occurring, the impact of trap shyness on the four years of data cannot be the determining factor in any perceived decline in the population at Albion. Moreover, the decline in captures of juvenile skinks over time strongly suggests that there is a real decline in the population rather than trap shyness. Juveniles will not have experienced traps in previous years and could not have developed trap shyness.

All other factors raised above as possible influences which lead to a conclusion of decline that is artificial may be discounted on the basis of experimental design. The trap technique, configuration, location, and timing of the trapping period were consistent across years. The uniformity eliminates any contribution that these factors may have made to a perceived rather than a real population decline. Taking all this into consideration we can conclude that there is a Tussock Skink population decline at Albion. What are the causes of the decline?

Habitat Loss

While the size of the study site and therefore the trapping area at Albion has not changed, the quality of the native grassland has deteriorated. Since 1996, endemic Kangaroo Grass, *Themeda triandra* which was once a distinguishing feature of the site has begun senescence. Furthermore, photopoint comparisons attest to the well-formed native tussocks that were previously characteristic of Albion no longer being apparent (C. Hocking, pers. comm). In addition, a comparison of mean capture rates for traps in the native and exotic dominated grassland habitats demonstrates a preference for exotic habitat at Albion. This is a surprising result for a species that has a distribution exclusive to remnant native tussock grassland.

However, the recent senescence of the native tussock grass may be contributing to this apparent preference for exotic-dominated grassland habitat. Walton (1995) recorded higher capture rates of Tussock Skinks in well formed Kangaroo grass or native-dominated grassland and decreasing trap success as levels of good quality Kangaroo grass tussocks decreased. Native tussock forming grasses provide suitable shelter and basking sites for the Tussock Skink (Hutchinson and Donnellan 1992). While undergoing senescence the important role of the native grasses may not be fulfilled.

Conversely, tussock grasses such as Chilean Needle grass and Serrated Tussock grass with well-formed tussocks which have invaded to replace senescent Kangaroo grass across significant parts of the study site, may offer suitable substitute habitat for Tussock Skinks. The decline in capture numbers may therefore be related to this structural change of the native grassland that appear to define the distribution of the Tussock Skink.

Predation

The likely predators of the Tussock Skink are bird of prey such as kites, ravens and eagles, snakes, and the introduced fox and cat. While no data was collected on predator activity at the site, evidence of both foxes and cats was observed during the study period. Furthermore, Tussock Skink remains have been recorded as constituents of fox scats collected from Albion (M.O'Shea, pers. comm.).

Cats are known predators of native wildlife (Buchanan and Lord 1998). Reptiles (Coman and Brunner 1972; Fitzgerald 1988; Barrett 1995) and more specifically skinks are known to occur in the diet of both feral and domestic cats (Jones and Coman 1981; Fitzgerald 1988). Given domestic cats are known to roam up to 800 m from their home base (Barrett 1995), the suburban development surrounding the study site allows both stray and domestic cats to access Albion and thereby contribute to increased predation on Tussock Skinks at the study site.

The current plans for a large housing estate to be constructed on the site may have some serious ramifications for the Tussock Skink population in terms of predator numbers. Increased urbanisation bordering the study site is likely to increase the number of cats with access to the Tussock Skink population unless suitable measures are taken to prevent this event.

With evidence of fox activity and the known effects of cats of native fauna it is apparent that increasing numbers of introduced predators combined with natural predators could have contributed to the trend of decline in population numbers at the study site.

Population Trends and Conservation

There is no doubt that the primary Victorian population of the Tussock Skink occurs in a habitat that is under serious threat. Similarly, other small lizards that occur in native grassland such as the Southern Lined Earless Dragon, *Tympanocryptis lineata*

pinguicolla and the Striped Legless Lizard, *Delma impar* are listed as endangered (Baker-Gabb 1993). In contrast, however, the Tussock Skink is currently considered locally common (Larwill 1995). The trend of decline reported in this project indicates that the conservation status of the Tussock Skink may not be as secure as the classification of 'locally common' implies. The results of the current study suggest that a review of the conservation status of the Tussock Skink is required in the near future.