GESTATION, PARTURITION AND NEONATAL BEHAVIOUR IN THE BLOTCHED BLUE-TONGUED LIZARD, *TILIQUA NIGROLUTEA*, IN CAPTIVITY: OBSERVATIONS OF MATERNAL CARE IN A VIVIPAROUS LIZARD

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INTRODUCTION

Southern or blotched blue-tongued lizards, *Tiliqua nigrolutea*, are large, viviparous skinks distributed throughout southeastern Australia (Cogger, 2000). Adult females can range from 25–32 cm snout-vent length (SVL) and weigh between 300 and 500 g (and up to 800 g in late gestation) (Edwards and Jones, unpubl. data). In Tasmania, where this study was conducted, blue-tongued lizards occur in low altitude heaths and woodlands, and cool temperate forests (Wilson & Swan, 2003). Females have a relatively long gestation (4 – 4.5 months), clutch size varies from 1 to 17, and is only loosely related to body size (Edwards *et al.*, 2002). We have been studying the reproductive biology of blue-tongued lizards since 1995, and here we describe our observations of behaviours during gestation and parturition in adult female and neonatal blue-tongued lizards in captivity.

METHODS

We caught lizards by hand throughout southeastern Tasmania: males were distinguished from females by their relatively broader heads and an examination of the cloacal opening for the musculature of the hemipenes. Animals were housed in roofed outdoor enclosures 1.9 x 3.4 x 2.1 m; these were wire-fronted, allowing access to UV light and a natural photoperiod, and we provided bark and leaf litter for the animals to hide in. Direct sunlight and a 120 W floodlight globe at the front of each cage as an additional heat source provided a temperature gradient across which the lizards could thermoregulate during their active season of spring (September) to mid-autumn (April).

The lizards were maintained on a varied diet of fresh fruits (banana, apple, pear, grapes), snails and tinned, meat variety catfood, provided two to three times weekly. Water was available at all times. Mixed-sex groups of approximately five animals were maintained in each cage from early autumn (March) to early spring (September); during this period animals were not breeding and few interactions were observed between individuals. However, during the mating period (mid to late spring: October – November), we separated males from each other in similar, but smaller, cages because males can injure each other during fights. After birth, babies were held in large cardboard enclosures (1 m x 1m x 30 cm) and fed on a diet identical to that of the adults for several days. They were then released at the site at which their mother had been captured.

OBSERVATIONS AND DISCUSSION

Gestation

All behavioural observations were made on a qualitative basis. During the mating period (approximately mid-October to the end of November) all individuals were observed at regular intervals each day, allowing us to identify potentially pregnant females. During gestation all animals were observed every day, for 10 min at approximately one hour intervals from the time they became active (approx. 0930-1030 hrs) until they retreated at the end of the day (1500-1700 hrs). During the parturition period, cages holding gestating females were checked every morning for the presence of neonates, and all pregnant animals were checked every 30 to 60 min from 1030 hrs to 1600 hrs each day and daily on weekends for the onset of parturition.

The mating period occupied approximately four to six weeks in spring (mid October – late November) (Edwards & Jones, 2003). Thereafter, females received no attention from males, but basked on all sunny days and fed whenever food was offered. The proportion of time spent basking was not recorded, but did increase noticeably throughout gestation. During late gestation (late January - March), feeding by gravid females was greatly reduced although the quantity of food offered did not change. In some cases females fed little or not at all for several weeks prior to parturition (Edwards *et al.*, 2002). Respiratory depth and rate were also altered, from regular, relatively shallow breaths during early gestation, to sporadic and very deep inhalations that caused the whole upper torso to be raised off the substrate. Late gravid females moved around very little, emerging as sun entered the cages in the morning, basking throughout the day, and returning to cover in the mid - late afternoon. Shuttling between sun and shade involved moving only 30 - 50 cm, several times each day, while non-reproductive females and males foraged actively for much of the day. Gestation length was calculated from the day each female was observed mating to the day of parturition. For those individuals for which copulation was not observed, the date of mating was estimated as the mid-point between the date an individual was observed being chased by male lizards and the date that rejection behaviour towards males (Edwards & Jones, 2003) was first noticed. These data, including mean gestation length, clutch size and relative clutch mass, are published elsewhere (Edwards *et al.*, 2002).

Parturition

Parturition was observed on many (N = 16) occasions and typically occurred from late summer (late February) to early autumn (March). The earliest clutch we observed was born on 2 February 1998, and the latest was on 27 May 1996. The reason for this extremely late clutch is not known – the female had mated in the wild and was caught some time during her gestation period, but the situation is not without precedent, albeit in a milder climate on the Australian mainland, in the related *Tiliqua scincoides* (Turner, 1996).

There was no noticeable change in a female's behaviour in the days before birth, or on the day of parturition itself, until birthing actually began. Following several hours of basking the gravid female became restless and began moving around, both in the leaf litter at the back, and in the open area at the front of the cage. Sporadic lower abdominal contractions were observed, with the female also repeatedly undulating her whole body sinusoidally in a lateral plane. Stronger contractions of the posterior abdomen followed, with the female raising her back legs, straightening them out behind her (Figure 1), and lifting her posterior abdomen off the substrate. Several such efforts were required for the embryo to be positioned ready for birth. Even stronger contractions followed (approximately five) with the female also arching her tail to expel the embryo (Figure 2).

Young were born surrounded by embryonic membranes and attached to a yolk sac containing a small amount of residual yolk (Figure 3). Often born curled in a circle, ventral surface upwards, with head and tail overlapping, they wriggled vigorously to free themselves. Sometimes, however, the embryonic membranes burst during expulsion and the neonate emerged headfirst. Often, the female began walking away as the neonate was emerging, dragging it behind her for a metre or more until it was completely expelled. Time between births varied from only a few seconds, when two embryos were expelled by the same set of contractions, to approximately 30 min. Between births, the female wandered around the entire cage, so neonates were distributed over a wide area. Females usually paid no direct attention to neonates after they were born, as the neonates tore off and consumed their birth membranes and the residual yolk contained within the yolk sac (Figure 4), with one observed exception. On 11 March 2004, a

Figure 1. The female posture during contractions – the legs are extended posteriorly and the tail is arched.

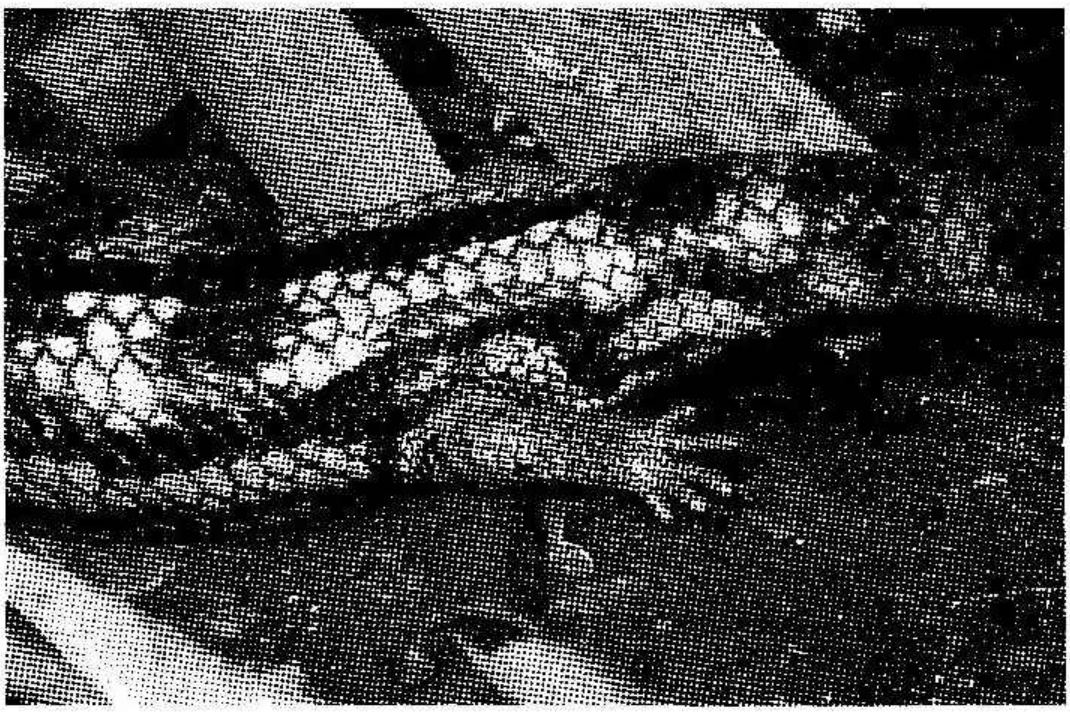


Figure 2. The tail remains arched and the legs are used to raise the cloaca above the ground to expel the neonate.

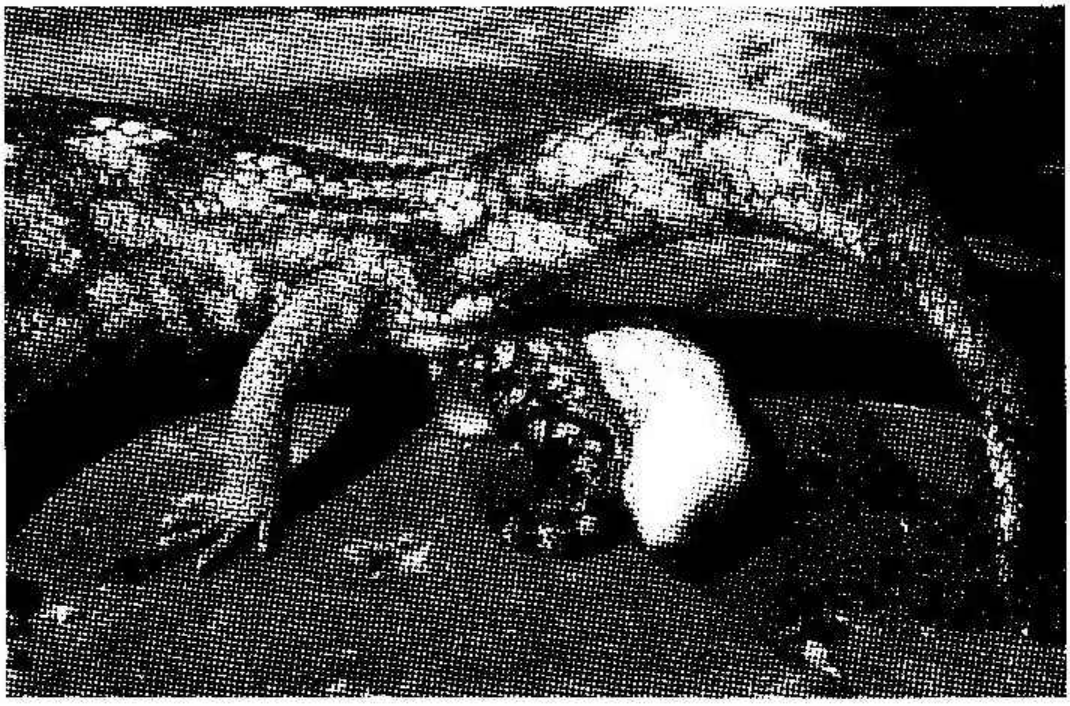


Figure 3. Young are often born ventral surface up, surrounded by intact embryonic and extra-embryonic membranes, including the yolk sac and a small amount of residual yolk.

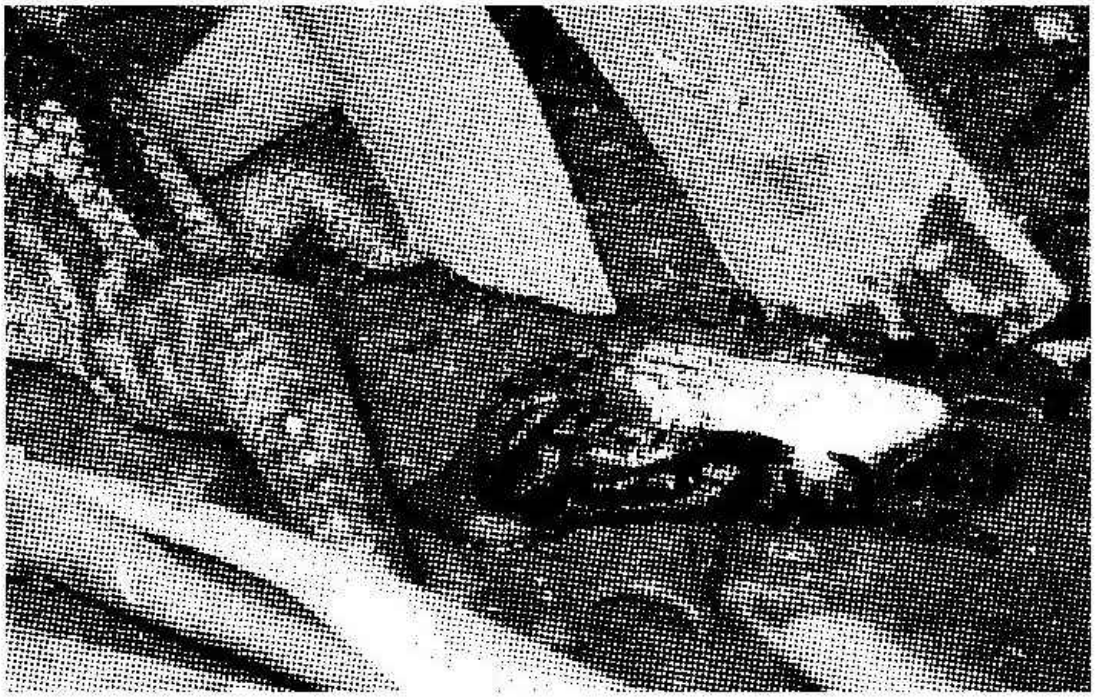


Figure 4. Neonates immediately consume birthing membranes including the residual yolk in the yolk sac.

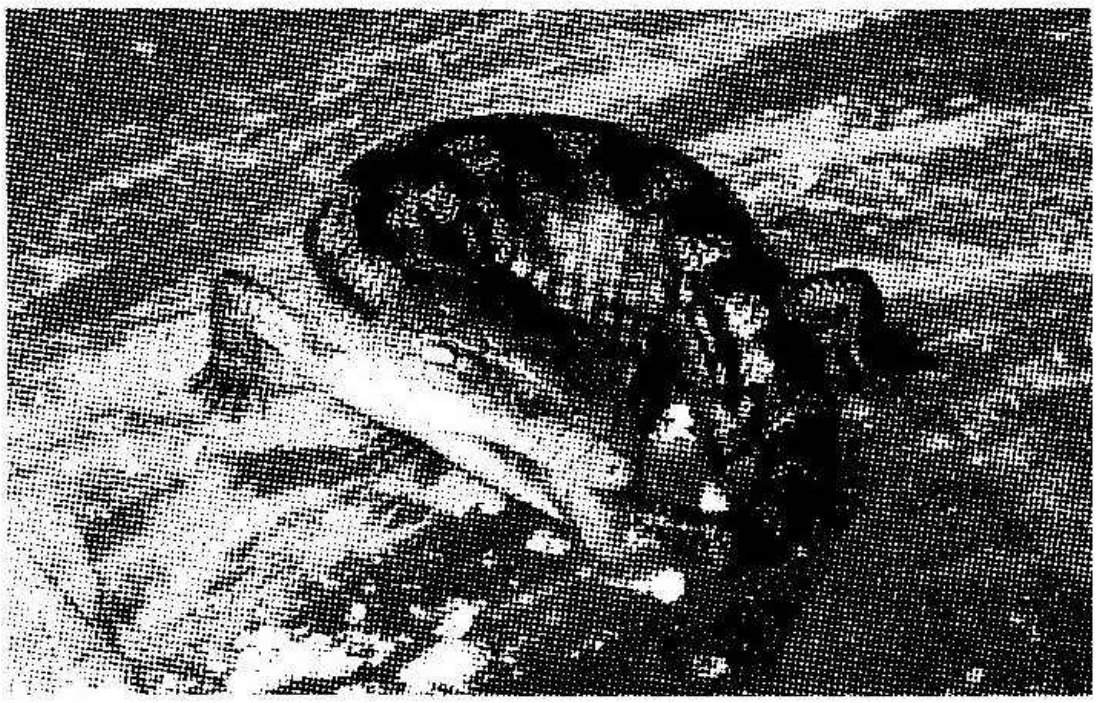
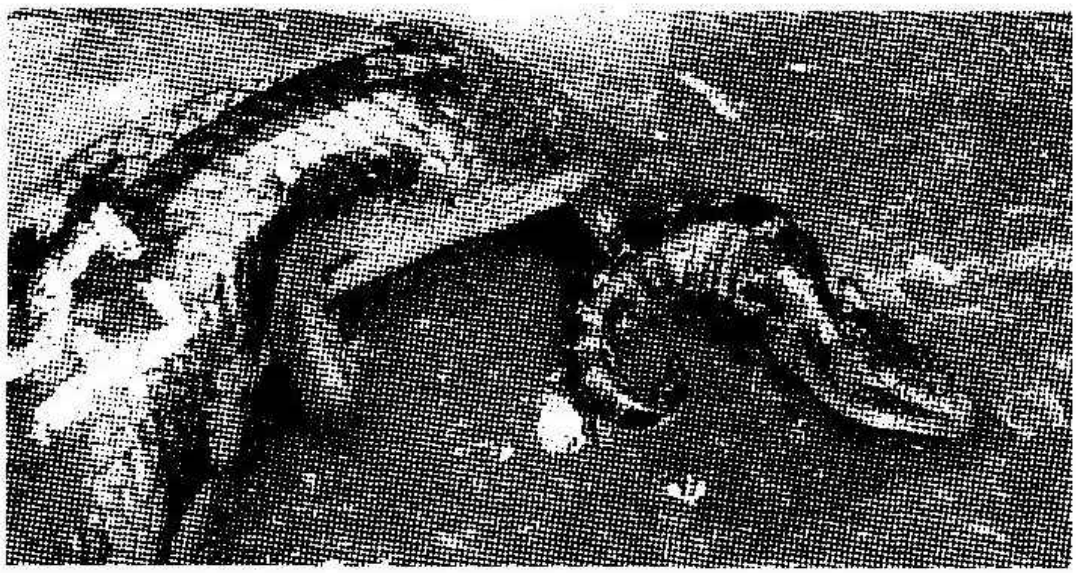
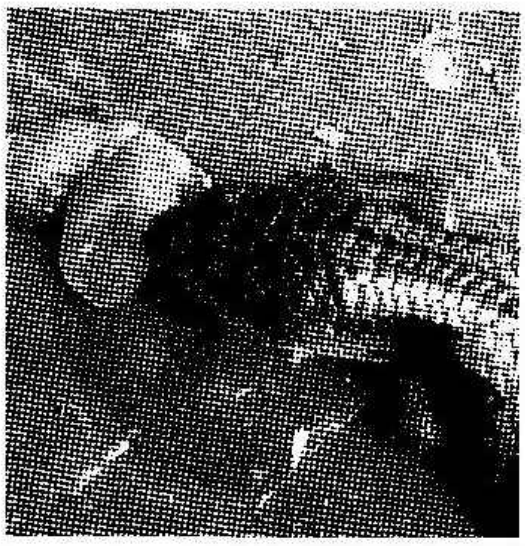


Figure 5. On a rare occasion the mother assisted a neonate to free itself from the embryonic membranes by shaking it.



neonate was born encased in birthing membranes which did not burst. The neonate did not wriggle for several minutes, and the female returned to nudge it several times. When there was no response, she grasped the now externalised yolk sac in her mouth and vigorously shook the neonate until it started to wriggle and was able to push through the birthing membranes which constrained it (Figure 5). The female did not eat the birthing membranes, but left them for the neonate to consume as usual, although as this has only occurred once that we have observed, we cannot confidently describe it as a display of maternal care. On several other occasions, neonates did have great difficulty bursting their birthing membranes and struggled more and more feebly as they became cold and tired; this typically attracted no attention or assistance from the birthing female. In several parturition events that were not observed, young that were stillborn (as described by Bartlett, 1984) or that were too cold to escape their embryonic membranes were found dead. Thereafter, we assisted any others we saw in great difficulty by piercing membranes for them.

Figure 6. The post parturient female eats any unfertilized yolk masses which were delivered with the neonates.



We observed the occurrence of post partum maternal care in the form of yolk provisioning to neonates, which started to consume this yolk and all birthing membranes immediately (within 60 sec) after parturition. This type of maternal care has been documented as a substantial energy contribution to the neonate in other reptiles, and is known as postnatal

lecithotrophy (Hewavisenthi & Parmeter, 2002; Lance & Morafka, 2001). Following consumption of the residual yolk (within 15 min of birth), neonates moulted an extremely fine and paper-like skin, which was unlike any subsequent moults in texture. Once this was done, neonates began to actively move around the cage, and would probably have dispersed quite widely, had they been in the wild. They also took food offered to them, and undertook extremely agonistic displays of hissing, inflating their rib cages and biting, towards each other and observers, as previously described by Fleay (1931).

While most females completed parturition in a single day, several females gave birth to an extra neonate the following day, as previously described for *T. scincoides* (Turner, 1996). This was usually stillborn, or did not successfully emerge from embryonic membranes, and was often found dead at the back of the cage. Unfertilised eggs were also passed as large yolky masses, sometimes between live births, but more often at the completion of parturition. The female later consumed these (Figure 6). Some, but not all, females were extremely intolerant of observers entering the cage during the parturition period and up to 60 min following the birth of the last neonate. Attempts to approach or handle young or remove stillborn babies were met with aggressive lunging and biting attacks, which may be another form of maternal care. Adult male lizards did not display any outward agonistic behaviour towards neonates, even when they were unrelated, either on their day of parturition, or on subsequent days. Indeed, in subsequent days we frequently observed neonates basking atop adult males and females in patches of sun.

We have described here the observation of several types of maternal care, both physiological and behavioural, in a captive colony of blue-tongued lizards. These include yolk provisioning to neonates, and monitoring and assistance in escaping embryonic membranes at parturition. However, these occurrances are yet to be quantified. Such data will provide valuable information on the relationship between parental care and the costs of reproduction in viviparous reptiles.

ACKNOWLEDGMENTS

This research was funded by a School of Zoology, University of Tasmania postgraduate research allowance to A.E. This research was carried out under University of Tasmania Animal Ethics approval numbers 95046, 98105 and A0007572.

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