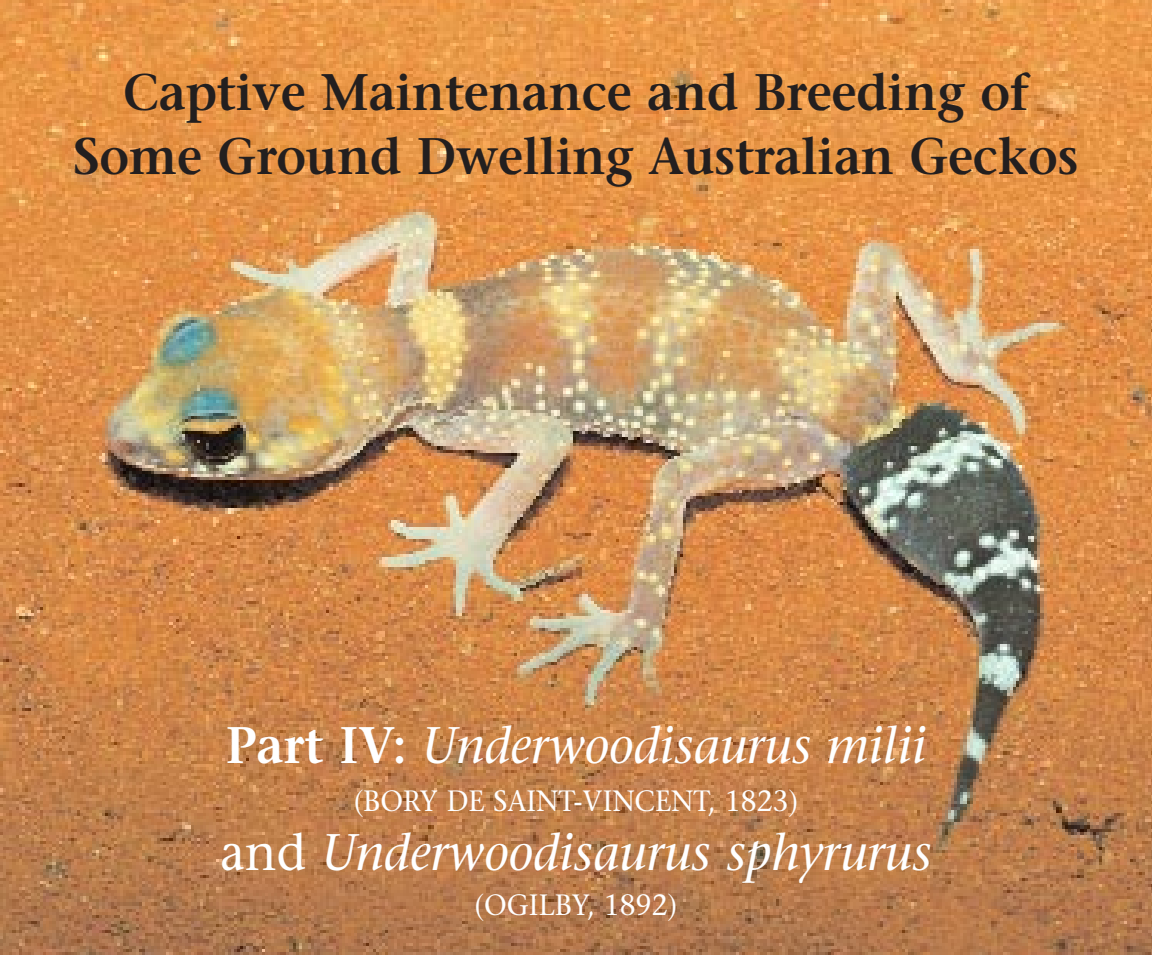
Captive Maintenance and Breeding of Some Ground Dwelling Australian Geckos



Part IV: *Underwoodisaurus milii* (BORY DE SAINT-VINCENT, 1823) and *Underwoodisaurus sphyrurus* (OGILBY, 1892)

Fig. 1 Adult *Underwoodisaurus milii* (light phase). Photo Andreas Laube

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Introduction

This fourth part of the series concerns the two species of ground dwelling geckos that comprise the genus *Underwoodisaurus*. Bauer (1990) described these two species as belonging to the genus *Nephrurus*. Nevertheless, we follow the opinion of most authors and regard these two species of thick-tailed geckos as still belonging to the genus *Underwoodisaurus*. Besides other criteria, the most visible differences between the two genera are the knob at the end of the tail that all *Nephrurus* species possess is missing in *Underwoodisaurus* and the enlarged subdigital lamellae found in *Underwoodisaurus* are not found in the genus *Nephrurus*.

The general information written in this article is based on the experience that both authors have gained during their years of extensive gecko studies. The observations on husbandry and breeding of *U. sphyrurus* have been made by Robert Porter, whereas the information on the husbandry and breeding of *U. milii* is given by Andreas Laube. Due to the rarity of *U. sphyrurus* in captivity no records of

Fig. 2 Adult *Underwoodisaurus milii* (reddish phase). Photo Andreas Laube

successful captive maintenance of this species have been published before. We hope that these first observations published here will help to further enhance the knowledge concerning this interesting species. As some other small groups of *U. sphyrurus* may be being kept in captivity it is hoped that the information given here will help these keepers to successfully breed this species, giving more gecko keepers the chance to maintain this gecko.

Systematics and Appearance

Geckos of the genus *Underwoodisaurus* belong to the polygeneric subfamily Diplodactylinae. The subfamily is divided into the two tribes Carphodactylini and Diplodactylini (Kluge, 1967). *Underwoodisaurus* belongs to the Carphodactylini.

The genus *Underwoodisaurus* is endemic to Australia and is closely related to the knob-tailed geckos of the genus *Nephrurus*. It also shows some similarities to the genus *Phyllurus* to which it is more distantly related. Besides their external similarities, the genera *Underwoodisaurus* and *Nephrurus* share an intolerance of high temperatures and some osteological and morphological characters (Ehmann, 1992).

U. milii, also called the Thick-tailed or Barking Gecko, is a fairly large gecko with a broad tail that becomes constricted towards the end. The plump looking body is weakly depressed and the limbs are long and slender. The bird-like feet are strongly clawed. The heterogeneous dorsal scales are mainly small and granular in shape. Some enlarged conical tubercles are present. These tubercles usually show yellowish or white blotches, either forming a transverse band or are scattered all over the back and flanks. Even in specimens that show scattered spots on the back, the pale blotches form three discontinuous curved lines on the back of the head and on the neck. Some species bear black spots in between the pale blotches.

The ground color of *U. milii* ranges from yellowish or pinkish to light, dark or reddish brown. The head is often more colorful than the body. The original tail is dark brown or black with five to six cream or white transverse bands. Most of the specimens found in the wild possess regenerated tails. These tails are dark brown or black and usually lack the transverse bands. The ventral surface is white or cream-colored.

U. milii can reach a snout-vent length of 96.5 mm (How, Dell & Wellington, 1990) and a total length of about 165 mm (Storr, Smith & Johnstone, 1990). The average snout-vent length is 80–85 mm. Over the huge area that *U. milii* occupies populations differ in size and appearance. Geckos in the Shark Bay region seem to be bigger than in other parts of its range. According to How, Dell & Wellington (1990) the males of mainland *U. milii* in Western Australia are significantly smaller than the males of island populations in Western Australia. This observation has not been made in females. It is the capability to vocalise that has led to the English common name of Barking Gecko.

U. sphyrurus, commonly known as the Border Thick-tail, is a small to medium sized gecko rarely exceeding 75mm snout-vent length and 12gm in weight. The coloration of the southern forms, though not bright is still subtly striking. The head and body is pale brown peppered with black and white spots, which are larger on the dorsal tubercles. This background color has a pinkish hue that is often quite strong, particularly around the head. This perfectly matches the pink rocks of this part of the species' range. Further north in the granite belt the gecko is predominately grey in color (see photographs in this article, Cogger, 2000 & Ehmann, 1992 for the former color form compared to that in Wilson & Knowles, 1988 for the latter). The original tail is much darker than the body, almost black in some individuals, banded with three or four white rings. It is narrow at the base then expands rapidly, eventually tapering to a narrow tip. Regenerated tails are a dull brown with slightly darker mottling and are more rounded in shape with less tip attenuation. The underside is pale, sometimes with darker flecks. The eye is also an eye-catching feature being steel blue in color. Juveniles are similar to the adults although the markings tend to exhibit more contrast.

Fig. 3 Adult male *Underwoodisaurus sphyrurus*, Woolomin, New South Wales. Note the pink hue of the background rock from the same locality, which is often reflected in the coloration of the specimens from this region. Photo Rob Porter

Sexing of adult geckos is very easy, as the males possess clearly visible hemipenal pockets. In addition, both species of the genus *Underwoodisaurus* show significant sexual dimorphism concerning body size. The females are generally larger than the males although the difference is not as great as in the genus *Nephrurus*, where the size difference between males and females is the biggest recorded for the family Gekkonidae (Fitch, 1981).

Distribution, Biotope and Ecology

U. milii inhabits the southern part of Australia and reaches the coastal area of Western Australia as well as the coast of New South Wales and Queensland. The species can be found from the area north of Shark Bay in Western Australia through the southern part of this state, the southern islands of the Australian west coast, the southern parts of South Australia, the north of Victoria, all over New South Wales, with the exception of south-east, to southern Queensland. A few records have also been made in the south of the Northern Territory.

U. milii occupies a wide range of habitat, in arid regions of the continent, in humid coastal heathlands or in wet sclerophyll forests. Generally it prefers cooler microhabitats. It is common in rocky areas (limestone, sandstone, granite) in open woodland or shrubland. By day the geckos use a wide range of places to hide. They can be found under litter, debris, in crevices, under shaded rocks or loose bark as well as in mammal burrows. Up to thirteen geckos have been reported under a granite slab (Wilson & Knowles, 1988). According to Ehmann (1992) they shelter in the burrows of wombats or rabbits where they occupy smaller side chambers. There seems to be a correlation

between the number of deep shelters and the abundance of this species in the northern part of its distribution area. Older animals seem to prefer deeper shelters than young individuals. Communal egg-laying and winter aggregations have been reported for eastern populations (Wilson & Knowles, 1988). How, Dell & Wellington (1990) examined 464 geckos of *U. milii* in Western Australia. In their study gravid females were recorded between October and February. Out of 153 females examined one unique instance of a gravid female was recorded for the month of June.

U. milii hunts insects, spiders, scorpions and small lizards in or near its hiding place. In addition to living prey, eggs have also been found in the stomachs of *U. milii*. Although hunting mainly happens at night they occasionally ambush and hunt during the day. This happens very often in the early morning or shortly before sunset.

Fig. 4 An example of the habitat of *Underwoodisaurus sphyrurus*, Woolomin, NSW. Photo Rob Porter

The Action Plan for Australian Reptiles (Cogger et al., 1993) lists only four Australian gekkonid species as being of conservation concern. Two of these are restricted to offshore islands. Of the two mainland species listed one, the Pernatty Knob-tailed Gecko (*Nephrurus deleani*) has a very restricted distribution while the other is the border thick-tailed gecko (*Underwoodisaurus sphyrurus*). Although this species has a distribution extending some 30,000–100,000 km^2 (Ehmann, 1992), its actual occurrence over this range is very localised. It inhabits the exposed rock outcrops of the granite belt of southeast Queensland south to the tablelands of northern New South Wales extending to just south of Tamworth.

Previous authors (e.g. Cogger, 2000; Wilson & Knowles, 1988) have suggested that the species is restricted to granite rock areas, however, surveys by New South Wales National Parks and Wildlife Service between 1995-7 (Spark, 1997) turned up the species associated with other geological types including sedimentary and basalt rocks. The survey found the species utilised both fallen logs and loose rocks as shelter sites provided they were situated in areas shaded by vegetation. One of the main attributes of all microhabitats containing *U. sphyrurus* was the presence of thin, white filaments of mycorrhizal fungus, which are prevalent beneath shaded rocks and logs where the substrate is permanently moist (Spark, pers. com). There is even some suggestion that the white markings on the gecko provide additional camouflage amongst the strands of fungi. Deep leaf litter and at least a 50% tree canopy cover are also prerequisites for this species and lizards can often be heard rustling through the dry leaves whilst foraging at night (Annable, pers. com.).

The species' range is characterised by a relatively harsh climate with temperatures down to -15°C in winter and exceeding 40°C in summer. The associated rock outcrops may therefore provide an essential thermal buffer during these

periods. The deep crevices and fissures will remain at a much more amenable temperature and humidity during these times of extreme. That the species is almost impossible to find at these times (Aland, pers. com.; pers. obs.) indicates that they may indeed seasonally migrate to more suitable thermal microenvironments.

The apparent rarity of the species is difficult to understand. Human influences such as land clearance, stock grazing, logging and the effects of fire have affected much of its range and would certainly have caused a decline in numbers (Cogger et al., 1993; Spark, 1997). However, this does not explain its low density in huge areas of pristine national park such as Girraween National Park (Queensland) and Bald Rock National Park (New South Wales) where other gekkonid species such as *Oedura tryoni*, *O. lesueuri* and *Saltuarius wyberba* are abundant. Perhaps these granite areas are suboptimal habitat for the species but the small population density has continued to survive, as habitat disturbance has been minimal. Further south, extensive tree clearance and livestock grazing have destroyed large areas of preferred habitat and the species has suffered as a consequence. Certainly in areas where the species still exists in small patches of suitable undisturbed land the gecko remains relatively common (Annable, pers. com.; pers. obs.).

As with *U. milii*, *U. sphyrurus* is a fairly vocal gecko when disturbed. It will push itself up onto rigidly extended legs, raise and wave its tail sinuously from side to side, open its mouth and, if further provoked, will lunge forward whilst emitting a rasping squeak. It is an efficient predator of small insects and observations in captivity indicate that it has an extremely rapid strike, both forward and to the side of the head.

Husbandry

U. milii can successfully be kept in groups of one male and two or three females. A terrarium for a group of this size should measure at least 60x40x40 cm (length x width x height). In order to guarantee a sufficient airflow the entire roof of the glass tank is covered with wire mesh. It is recommended that the enclosure is furnished with walls made of artificial rock or cork in order to give the geckos an opportunity to climb. The substrate consists of sand or a mixture of sand, smaller stones or coarse gravel and earth. Some hollow artificial stones or pieces of cork and wood serve as hiding places. A drinking vessel and a small plastic box complete the furnishing. This box is filled with a mixture of moist sand and potting compost. It should be big enough to host all specimens at one time. A small hole in the lid is provided to give access to the interior.

The box will be used as a day retreat by the geckos although they do not occupy the box as often as other species of diplodactyline geckos. In contrast, *U. milii* more often uses the box as a place to defecate. The box becomes most important during the breeding period because the females will use the moist substrate for egg deposition. Due to having only a small hole in the lid, the substrate remains moist longer than other areas of the cage. This helps to minimise the possible loss of fertilised eggs if the keeper does not discover them immediately after they have been laid.

As *U. milii* inhabits the southern part of Australia it is very important to imitate a winter period of about two or three months. As room temperature is often related to the outside climate it is recommended that your natural seasons be followed. For keepers in the northern hemisphere this means that *U. milii* can easily be kept according to their own seasonal cycle. During winter time the sexes should be separated in order to give the highly productive females a recovery phase and to increase the possibility of breeding success during the coming summer period. The temperature during the winter period should drop to 12–14°C at night and about 22–24°C during the day. In addition, the duration of cage illu-

mination is minimised to eight hours per day. The summer period is characterised by up to 14 hours of illumination and temperatures of 28–30°C during the day with night temperatures of 22–25°C. Higher temperatures than these in summer are not suitable because *U. milii* is intolerant of very high temperatures. Although none of my animals have died due to excessive heat, their discomfort is clearly evident in their behavior.

All cages are illuminated with fluorescent lamps. In some cases the cages where my *U. milii* are being kept are placed at the bottom of a rack system where UV lamps for other reptile species are installed. The specimens of *U. milii* will take advantage of this UV illumination. However, it has never been observed that this has influenced the success in keeping or breeding this species. An additional spot lamp ensures a local "hot spot" for the geckos. The lamps of the cages below locally heat the floors of the cages above in the rack system.

Misting takes place very seldom, usually not more than one or two times per week. The geckos either drink from the vessel or lick the drops of condensed water from the inner surface of the plastic box. The water in the drinking vessel is occasionally fortified with a liquid vitamin supplement. The adult geckos are fed with two different species of commercially bred crickets, locusts and the caterpillars of wax moths. All food items are dusted with a vitamin-mineral powder (KORVIMIN ZVT).

The gecko's period of activity starts immediately after the light has been switched off. The geckos leave the daytime retreat that has often been occupied by all the specimens that live in the cage. Usually they place themselves very prominently in the cage, observing the activities of the keeper outside.

As there was nothing in the literature regarding the captive requirements of *U. sphyrurus*, initial husbandry techniques were based on the author's experiences with *U. milii* and on personal observations of the animal's natural habitat. These initial conditions proved to be a good starting point as the species has since proved itself to be hardy under captive conditions and, with the appropriate environmental conditions, easy to breed. Their small size means space can be limited and up to five adults (including three adult males) have been maintained for several years in an enclosure measuring 60x30x30 cm (length x width x height). The structure is predominantly constructed of glass with a removable timber back. Access is through a hinged door at he front of the enclosure and the entire top is open for good ventilation. Two 5 cm diameter holes have been cut into the timber back around 5 cm up from the base to enhance this ventilation.

A fluorescent Reptisun 5.0 UV tube is positioned directly above the open top and is controlled by a photoelectric switch positioned outside to provide natural annual day length fluctuations. A low wattage blue incandescent light bulb is also installed above the enclosure at one end and is used to provide a small amount of heat and a night viewing light that provides minimal disturbance to the geckos. The main heat source is a length of Flexiwatt heat tape beneath one end of the enclosure. This is controlled through a rheostat and produces a gentle hot spot of around 28–34°C through the warmer months dependant on the ambient temperature at the time. Winter temperatures are a little trickier as they are probably tied closely to successful reproduction in the species and are explained in full detail under captive breeding below.

The enclosure is sparsely furnished with 20 mm of fine washed sand substrate upon which is placed three inverted 10 cm flowerpot saucers, which have been notched to provide an entry for the lizards. In addition, a small flat rock is installed half buried into the substrate directly over the heat tape. The conductivity of the rock provides an excellent thermoregulatory site for the lizards and sever-

al inhabitants often position themselves on this rock during the early part of their active period. The only other furnishing is a small glass water bowl at the cool end of the enclosure. The substrate beneath the saucers is maintained at slightly different moisture levels; one permanently moist, another moistened but allowed to dry and a third left permanently dry. This permits the inhabitants to choose their required moisture/humidity microhabitats as necessary. The first of these also served as an oviposition site for females. The entire enclosure is given a light spray several times per week during spring and summer.

Fig. 5 Enclosure rack containing housing for *Underwoodisaurus sphyrurus*. Photo Rob Porter

Border Thick-tails are not fussy about their prey items. The majority of the diet is made up of gut-loaded crickets of appropriate size, 2–3 per lizard twice per week during the warmer months gradually decreasing to no feeding for 6–8 weeks over winter. Cockroaches are also offered occasionally and are devoured with equal relish. Prey items are dusted alternately with a Rep-Cal/Herptivite mix or Miner-All every second feed, or every feed for gravid females and growing juveniles.

Initially, the breeding colony was established on the Central Coast of New South Wales where the climate was similar, though slightly less extreme, than the species' natural climatic range. The severity of the winters these geckos experience suggested that a significant winter cooling period would be required to ensure regular breeding in captivity. To this end, the breeding group were routinely transferred to over-wintering quarters from the beginning of June to the end of July each year. This involved a large plastic container and lid measuring 50x30x18cm high filled with around 6 cm of fine sand. Several pot saucers were introduced and mostly buried into the substrate except for their entry hole. The sand beneath one saucer was moistened while the others were left dry. The lid contained four 5 cm diameter ventilation holes. This plastic container was then placed inside a larger polystyrene foam box and lid with about twenty 1cm ventilation holes punched around the sides. This entire set-up was then placed in a sheltered area outside where it received no direct sunlight and, apart from intermittent checks, was left for the wintering period without any further maintenance.

Normal enclosure temperatures were gradually reduced from late April until late May when all lights and heating for the enclosure were turned off. One to two weeks later the animals were transferred to the winter quarters. At the end of July the geckos were returned to their standard enclosure apparently none the worse for their frigid ordeal and heating was gradually increased. A thermometer recorded the temperature range within the winter box and showed that around 5° C was the lowest experienced by the lizards though the average was around 8–10° C at night,

warming up to mid-teens during the day. These temperatures should have closely approximated a natural thermal cycle for *U. sphyrurus*. This technique proved very successful in inducing captive reproduction in this species with eggs and hatchlings produced for three consecutive seasons.

In July 2001 the author moved to southeast Queensland some 1000 km north of the Central Coast. The following spring the colony again produced viable eggs as much of the over wintering took place before the move. The following season the same winter process was followed but neither female produced any eggs. It is believed that the warmer winter conditions in Queensland inhibited breeding by some means, possibly by hindering sperm production in males. Although night temperatures in this area would often drop below 10°C the day temperatures would usually rise above 20°C and occasionally would reach 24°C. In an attempt to counter this warming effect, the author is currently experimenting with placing some specimens in a similar plastic wintering box as described above but one that is placed in a domestic refrigerator during the day for around 10 hours. The refrigerator is set at its warmest level at around 6–8°C. The box is then brought out and left without any additional heat over night where the temperatures experienced by the lizards would rise to the low teens. By this method the geckos actually undergo a fairly natural winter temperature fluctuation but one that is reversed i.e. cold day and cool night temperatures. The animals appear to show no outward signs of stress through this technique and have been left in the refrigerator for up to 36 hours without problems. Time will tell if this drastic cooling process is successful and this will be reported in a future paper.

Captive Breeding

If the sexes have not been separated the breeding season of *U. milii* kept in the northern hemisphere starts around February, although at this time the geckos are still kept under winter conditions. The winter period "officially" ends around March due to an increase in temperatures as well as the prolonging of daily illumination times. Sexes that have been separated over the winter are brought together at this stage. Usually the females of groups where sexes have not been separated already bear eggs at this time. In contrast to other diplodactyline geckos where a separation positively affects breeding success this observation has not been made with *U. milii*. As mentioned above the separation of sexes in *U. milii* is mainly done to give the females a chance to recover.

Fig. 6 *Underwoodisaurus milii* hatching and hatchling. Photo Andreas Laube

Mating has not been observed to date. Gravidity can be clearly seen through the abdominal skin, even if the geckos are not handled. Gravid females will constantly visit the plastic container that is filled with the moist substrate. After a short time of digging activities, usually not longer than two

Fig. 7 *Underwoodisaurus milii* at approximately two months of age. Photo Andreas Laube

days, the two oval, parchment shelled eggs will be laid. It is very rare that females lay just one egg. The number of clutches per year can be fairly high as *U. milii* is, at least in captivity, highly productive. One of my females laid seven clutches in eight months before it was separated from the male. Further egg laying could have been expected although the female was fairly weak at this time.

At least two cases have been recorded where one egg in a clutch of two was eaten. In both instances the two eggs were discovered in the morning, only sparsely covered with substrate. It was decided to leave the eggs in the plastic box until the evening. Surprisingly just one egg could be found during the excavation of the clutch later in the day. As no food items had been in the terrarium only a specimen of *U. milii* could have eaten these eggs. It is interesting that all the remaining eggs of these two clutches were unfertilised. This observation could be an indication that the female who produced the clutch had eaten one egg, although it cannot be proven. Future observations may help to find out more about this behavior.

Fertilised eggs measure 23.5–26.0 x 13.5–15.0 mm. At an average incubation temperature of 26.5°C the geckos hatch after 73–82 days. At this temperature the sex ratio is more or less evenly balanced. Incubation temperatures of 29.0°C lead to incubation times of 62–68 days and slightly more males than females are produced. A slightly moist mixture of hydrogranulate and active charcoal at a ratio of approximately 4:1 serves as the incubation substrate.

The young mainly hatch at night. The pattern of the offspring corresponds to the pattern of the adults. The size at hatching is 40–43 mm SVL and 25–29 mm tail length. Rearing is easy and sex can be distinguished at an age of six months. The first fertilized clutches from the offspring can be expected at the age of about 18 months.

As with *U. milii*, no mating behavior of *U. sphyrurus* has been observed in captivity to date. The first clutch of the season is laid in November or early December suggesting a mating during mid-Spring. This compares with the observation of Spark (1997) of a gravid female being located in the field in December. The female deposits the eggs beneath a pot saucer that covers permanently moist sand and mounds the substrate up over the clutch. The eggs measure 23x11.5 mm in size with a mass of 1.5–2 gm. These sizes are a little larger than those recorded by Swan (1990) at 21x10 mm, presumably from a wild female. Females of 10.9 and 10.2 gm in weight after oviposition produced clutches weighing 4.1 and 3.2 gm respectively; around 30–35% of the females body weight. To date two clutches is the most obtained from a single female during one season.

After laying, the eggs are removed to a separate container for incubation. This comprises a 100ml plastic container and lid containing moist sphagnum moss at a ratio of approximately 9:1 water to moss by weight. The sphagnum fills the container to within 5mm of the top but is not compressed, leaving ample air spaces amongst the medium. Eggs are incubated at 27–29°C. Hatching occurs 59–73 days after laying. Hatchlings range from 35–39 mm snout-vent length and 1.2–1.7 gm

in weight at emergence. The coloration is similar to the adults although the tail markings are a little stronger in contrast.

Clutch mates are raised together in small plastic containers around 18 cm in diameter and 10 cm high with a fine sand substrate and a single inverted pot saucer as a home site. Feeding commences approximately a week after hatching, consists of small crickets dusted as described for the adults above and offered 2–3 times per week. Growth is relatively slow with juveniles reaching around 58 mm snout-vent at twelve months of age and 70 mm the following year. It is estimated that sexual maturity will normally be achieved at about 30 months. Juvenile husbandry appears relatively straightforward as long as one area of the home site is kept moist to maintain high humidity within the refuge.

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Fig. 8 Adult male *Underwoodisaurus sphyrurus*, Woolomin, NSW illustrating the beautifully colored eye. Photo Rob Porter