MONITOR - JOURNAL OF THE VICTORIAN HERPETOLOGICAL SOCIETY
10 (1) 1998:22-30, 32, 35-36 Copyright Victorian Herpetological Society

LACE MONITORS (*VARANUS VARIUS*) IN THE WILD AND IN CAPTIVITY IN AUSTRALIA, WITH REFERENCE TO A COLLECTION OF SEVEN ADULTS HELD IN CAPTIVITY FOR EIGHT YEARS.

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INTRODUCTION

This paper is not about how to keep Lace Monitors. Rather it is a summary of facts known about the species and notes taken by myself when keeping and observing the species in captivity and the wild.

References to my own captive Lace Monitors pertain to seven specimens held by myself from 1975-83. Some of the things that I did such as placing snakes and monitors in the same cages ARE NOT recommended. Other facts are given here for completeness only and not as recommendations.

GENERAL

The Lace Monitor is one of Australia's largest monitor species, probably being second in size to the Perentie *Varanus giganteus* of arid Australia. Specimens over 2 metres are known. Although Brattstrom (1973) reports a maximum total length for a sample of this species at 765cm, larger specimens almost certainly occur. Queensland specimens don't appear to grow as large as those from New South Wales and Victoria. Lace Monitor's are found in most wooded parts of east and south-east Australia including along the Murray/Darling river basins and nearby areas.

Large males attain up to about 2 metres in length, while adult females are consistently smaller, rarely attaining 1.5 metres in length.

They are distinguished from all other Australian monitors by the following suite of characteristics, (as taken from *Reptiles and Amphibians of Australia* by H.G. Cogger, (1975).

The tail is laterally compressed, except at the base. There is a distinct median double keel dorsally along the posterior half of the tail. The caudal scales are not arranged in regular rings, as ventral caudal scales are larger than the dorsal caudals. The nostrils are directed laterally and the caudal keel is low to moderate. All supraoculars are small and irregularly distributed. A row of enlarged scales forms a ridge on the inner edge of the basal part of the fourth toe.

Having said the above, Lace Monitors are usually easily distinguished from other Australian and non-Australian monitors on the basis of their colour pattern/s and/or general appearance. Examples of fairly typical Lace Monitors, including some of the subjects of this article are pictured in my book *Australian Reptiles and Frogs,* on pages 121-122 and 201.

Essentially two colour morphs are known, both being pictured by Hoser (1989). The broad-banded form was thought to be restricted to males as a sex-linked recessive trait, although John Montgomery in 1988 claimed to have seen a female of that colour morph. Further investigation into the causes or origins of these broad-banded specimens is necessary. Broad-banded specimens seem to be most common in particular places, (usually inland areas), and are usually absent from coastal areas.

Juveniles tend to be much more brightly coloured and this fades with age. I have seen what appeared to be a very old broad-banded male from Lightning Ridge, NSW whose colour had evidently faded to be an almost uniform grey. It is not rare for 'normal' morph Lace Monitors to appear to be a near uniform grey colour.

In the wild this species only lives in timbered habitat and both colour forms are commonly sympatric. In arid areas it tends to be restricted to along rivers and other treed places. It is normally a shy species and will usually take to a tree when disturbed, keeping the tree trunk between itself and it's observer when possible.

Bush walkers often become aware of the presence of a Lace Monitor when a group of birds will gather and attack a roaming specimen, commonly as a result of its intrusion to nesting areas.

In the nine year period to 1978, I had dog that was adept at finding specimens of this species by following their scent trails and barking when he found them. Invariably I would have to climb the tree with a noose to catch the lizard. This was usually a lot easier said than done.

Although a forager of both ground and trees, the species often appears to remain within a given home range. Stebbins and Barwick (1968) found that a wild specimen of this species wandered 3/4 of a mile in a single day (over 1km). They noted that some wild Lace Monitors seem to have a large home range which they 'tour' spending a few days in each section and sheltering in a particular tree hollow each night. Frauca (1966) noted a Lace Monitor occupying the same tree hollow for three years indicating that home ranges or territories may be long standing. Monitors of the *Varanus gouldii* species group, commonly found in the same areas as Lace Monitors appear to be far more nomadic in habit and as a consequence more commonly seem to enter built up areas.

In areas of the North Coast of New South Wales, Lace Monitors commonly forage around rubbish bins in picnic areas for food scraps, such as bones. Some specimens become so bold as to lose a lot of their fear of humans, and can be approached quite closely. Gary Stephenson noted finding specimens in some areas actually hiding

in garbage bins containing rubbish. In early April 1998, this author found a large male foraging amongst rubbish in a picnic area at Akuna Bay, in Kurringai Chase National Park, about 20 km north of Sydney city. The lizard had relatively little fear of humans.

Around Sydney where both Lace Monitors and the Heath Monitor (herein called *Varanus rosenbergi*), (formerly known as a form of *Varanus gouldii*) occur, the Lace Monitor seems to be most common in the Valleys where the trees are largest whereas the Heath Monitor is more common on the scrubby high ridges. The two areas with the largest populations (and highest densities) of Lace Monitors near Sydney seem to be Bobbin Head and nearby areas and to a lesser extent Arcadia. The Lace Monitor is however fairly common throughout it's range and like all Australian monitors does not appear in any way to be endangered or threatened (as per IUCN or similar classifications).

Within Australia there appears to be little if any commercial exploitation of this or any other monitor species and few monitors are kept in captivity here. Most Zoos and sizeable fauna parks in eastern Australia tend to have a pit containing Lace Monitors. These specimens are invariably very large and obese males.

Preferred body temperatures for active Lace Monitors were found to be between 34 and 36 degrees celsius by Bartholomew and Tucker (1964), Stebbins and Barwick (1968) and Spellerberg (1972). Heatwole (1976) determined the near lethal temperature for this species to be 43.7 degrees celsius.

Monitors do not pant when overheated, but will pump the gular area, (Greer, 1989). I cannot recall ever seeing an obviously overheated Lace Monitor, except on a day when the air temperature got to nearly 50 degrees celcius just outside of Warren, NSW. Three specimens were caught on the ground near a watercourse in the heat of the day and were unable to flee when approached. All recovered later that night as the air temperature dropped.

Even when basking in relatively cool weather of under 20 degrees celsius (in captivity), large adult Lace Monitors seem to have little difficulty in elevating their body temperature to such an extent that they feel very warm to touch.

Pianka (1982) and Brooker and Wombey (1986) have both noted the 'intelligence' of large monitors, including Lace Monitors, with Pianka describing it as 'Mammalian-level intelligence'.

In the period 1970-85, I encountered over a hundred wild-caught Lace Monitors and noted a strong bias in favour of male specimens. The apparent surplus in males of this species has also been noted by others, including John Baker and Gary Stephenson, both who have also come into contact with substantial numbers of adult Lace Monitors.

The reason for this apparent surplus of males isn't known, although it may be due to more nomadic 'human eye-catching' habits, or there actually being more males

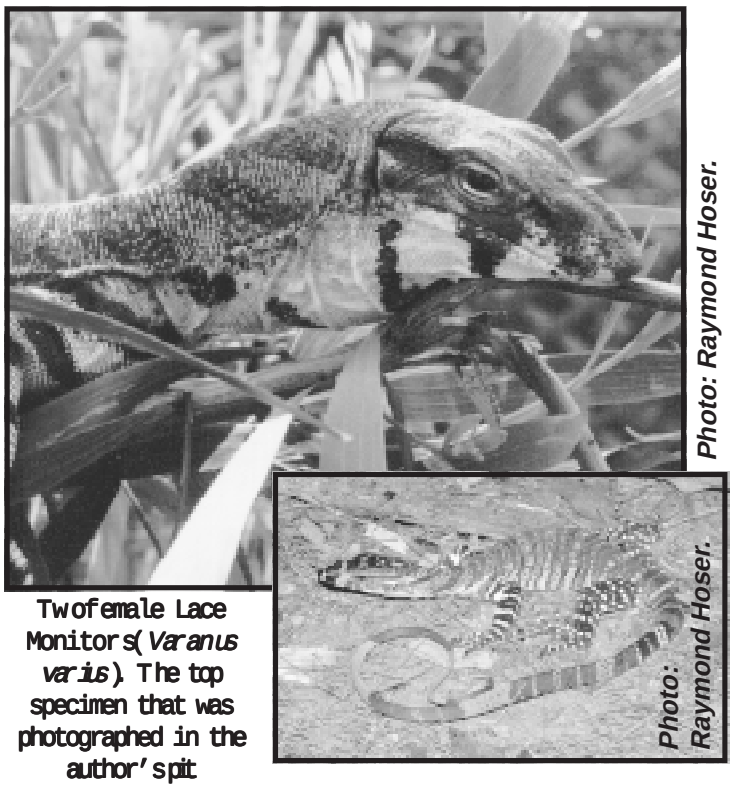

Photo: Raymond Hoser.

Photo: Raymond Hoser.

Two female Lace Monitors (*Varanus varius*). The top specimen that was photographed in the author's pit originated from Cannowindra, NSW. It's colour was intermediate between the "Bell's" and normal forms. The specimen to the right, (normal phase) was from St. Ives, NSW.

in the wild.

LONGEVITY

Captive specimens usually appear to live indefinitely without showing signs of ageing (to the untrained observer) and obviously live for many years. Anecdotal evidence on wild specimens indicates a similar situation.

I would assume (but not backed up by fact at this stage) that some specimens of this species may live up to 40 years of age.

I have received a number of anecdotal, (but not documented), reports of specimens in captivity living for 20 or more years.

Kim Kennerson of Wentworthville in Sydney and prior to him some others held an adult male in captivity for 15 years and seven months before it apparently escaped from it's outdoor cage and was attacked and killed by dogs. That specimen was adult when caught at Coonamble, NSW and was apparently in good health when killed.

Kennerson (1979) cited a case published in 1937 of a specimen of the same species living for 15 years, Flower (1937).

Three of the adults held by myself in the period 1975-83 were obtained from a Mr. John Baker of Greenacre, a Sydney suburb. He had kept them in an outdoor pit, 2.4 metres (8 feet) by 3.6 metres (12 feet), since he caught them in 1969 near Bingarra, NSW. The pit had minimal furnishings and the monitors appeared to be in excellent health at all times. The climates of Sydney

and Bingarra seemed sufficiently similar to present no problems in keeping this species in outdoor enclosures.

All specimens were mature adults when caught. In 1983 I passed ALL my adult Lace Monitors (7 in all) to a Mr. Ken Sheppherd of the Sydney suburb of St. Clair, where until 1991 all continued to be in good health, whereupon they were released in a wildlife reserve.

The three specimens from Bingarra would have to have been at least nearly 30 years of age if not more. None appeared to have shown visible (to me) signs of ageing, although all three keepers (Baker, myself and Sheppherd) avoided overfeeding the lizards.

HOUSING

The Lace Monitors held by myself were held in the Sydney suburb of St. Ives, where the climate is essentially similar to that of where the species occurs. The outdoor pit/s where the Lace Monitors were kept was actually two similar adjoining pits connected by a door which was under normal circumstances left open so that the monitors could walk from cage to cage freely.

The pits were walled to a height of about 150 cm (five feet) and totally enclosed with wire above that to an average height of 210 cm (seven feet). The pits were also underlain with wire to prevent escape by digging. That wire was on average 20 cm (8 inches) under the soil surface. The wire used had 1 cm square holes. Thus the pits were totally sealed.

The combined measurements of the pits were 17 metres long by 7 metres wide. (A third pit adjoining, measuring 10 metres by 7 metres held other lizards). The pits had vantage points to receive sun from all directions at all times of day and were also designed to be sheltered from wind and rain if necessary. All pits had a single large pond and good drainage of ground, to prevent any chance of flooding (not into the ponds). Water was cycled through the ponds periodically through a specially plumbed system to keep them clear.

The pits were furnished with native vegetation (from the Sydney bush) and sandstone rocks and logs. I found that if logs were placed at ground level, the undersides would tend to rot, so within a short time I learnt to place logs on rocks to elevate them a few inches above the ground, greatly increasing the 'life' of the hollow logs. Vertical logs were not utilised for resting in.

The pits had sandy soil to prevent excessive moisture build up and potential health problems. Vegetation covered the ground as well. Photos of inside the pits is shown on page 182 of *Australian Reptiles and Frogs*.

CAPTIVE OBSERVATIONS - HEALTH

No Lace Monitors held by myself ever had any 'serious' health problems. In recent years I have seen some Lace Monitors kept in what I would have thought to be appalling conditions and yet they have thrived. A Melbourne reptile keeper kept an adult pair in two tiny wooden boxes in a basement in his house, never exposing the animals to daylight, for several years and yet they appeared to thrive. He has since legally transferred the animals to a keeper in North Queensland where they still to thrive (as of 1998).

As a result of my neglect to remove ticks from Lace Monitors upon introduction into the pits initially, I did over ensuing years develop a tick problem. It appeared that these ticks bred in the pits and would as part of their life cycles lodge themselves on the monitors. By the time I realised the severity of the problem it was probably too late for me to do anything about removing ticks from the pits, and all I could feasibly do was remove the ticks from the lizards.

The ticks were on the monitors in their dozens and in some cases hundreds. They were of no fewer than three types. Despite the obvious burden of these ticks, no monitors ever displayed any signs of ill-health as a result of carrying these ticks. The nostrils and ears were the favoured resting place for ticks, which tended to clog up both openings. Other resting places included the eyelids and in skin crevices such as around the limbs. The skin immediately below the vent was also a common lodging spot. After a monitor was 'cleaned' of ticks it would take about twelve months for it to regain a similar number of ticks which would again be removed. Removal of ticks was simply done on an individual basis with tweezers with the removed ticks being placed in a sealed bottle of desiccant to kill them.

The most serious health problems that usually appear to occur are from agonistic behaviour between specimens (mainly males).

Two men who kept numbers of Lace Monitors, John Baker and Richard Wigglesworth, (both of Sydney suburbs) reported males injuring one another when fighting and needing to be 'stitched up'. Wigglesworth had an adult male's belly ripped open by another male. The injured male's internal organs had literally spilled out of it's body. Wigglesworth pushed the intestines and other organs back into the body of the lizard and stitched it up. The lizard healed without complications.

John Baker reported a case of tapeworms in the female from Bingarra about two years after capture that was treated with a dog-worming tablet.

Interestingly *Varanus gouldii* and closely related species appear to be prone to innumerable health problems and seem to be nowhere near as hardy as *Varanus varius* in captivity.

CAPTIVE OBSERVATIONS - MISCELLANEOUS

Although males held by myself fought frequently in the breeding season the fact that my cages were not as confined (small) as other people's may have gone a long way towards mitigating potential injuries inflicted by one male on another. However the presence of battle scars on wild males indicates quite severe fights also occur in wild specimens with 'limitless' space.

That my males may have been less vicious than other keeper's Lace Monitors in combat may also be considered as a factor why my specimens didn't severely injure themselves.

Photos: Raymond Hoser.

Photos: Raymond Hoser.

Pits being constructed in 1976 at the author's parent's house. The location was the Sydney suburb of St. Ives. The pits were built on a sloping block and had underground wiring to prevent the lizards from digging out of the cage. When finished the pits were sealed with wire about 2 metres overhead (see photos at bottom of page and on page 32). The photo on the bottom right and on page 32 was taken about 3 years after completion.

However on three occasions in the period in question (1975-83) I was forced to 'stitch up' wounds inflicted from aggression. Once however it was the smaller female who had to be stitched up. The wounds appeared to be mainly inflicted from biting rather than scratching. The stitches were in all cases needed mainly on or around the base of the tail, and to a lesser extent around the front legs, neck and head. The stitches were left in the Lace Monitors until the wounds healed completely, before they were removed without complication, leaving minimal scarring.

Captive Lace Monitors appear to have a social hierarchy based solely on size and strength. This hierarchy appears to be most important when feeding and fighting (males). Although it would be conceivable that a dominant specimen/s may monopolize prime basking site/s at the expense of smaller/weaker individuals, I couldn't say that such behavior was noticed in my specimens. Perhaps that was partially due to the abundance of basking spots available at most times of day.

Notwithstanding the above, each Lace Monitor did have fairly distinctive habits as to which parts of the cage they preferred to shelter in and bask, although movement of a given monitor through the cage did not seem to be dictated by others.

Captive Lace Monitors when fed, usually concentrate on eating the food available rather than fighting one another over it. Feeding the monitors, when they were very hungry, would invariably initiate a feeding frenzy whereby the monitors simply concentrated on eating as much as possible before another monitor could get at any.

Photo: Raymond Hoser.

Photo: Raymond Hoser.

The monitors kept by myself were not overfed as is common for this species and therefore always seemed to be ravenously hungry. For lizards of such large size, they could be kept on remarkably small amounts of food and if necessary starved for long periods of time (many months) without appreciable change in condition.

On a few occasions I have seen a given Lace Monitor attack (by biting) a cage companion feeding, when it approached. In a 'feeding frenzy' I saw a large male accidentally bite and swallow the head of the smaller female. The female's head was quickly spat out and neither lizard showed any ill effects or signs of injury.

I was able to regulate food eaten by a given monitor by dictating where I threw food (usually chunks of meat or dead mice and rats), thereby ensuring all lizards were adequately and equitably fed.

One of the favourite sights of my father was when I fed the Lace Monitors large numbers of live frogs caught and thrown into the pits. The Lace Monitors literally jumped around the pits following the jumping frogs until they caught them, often in mid air.

It appears that besides becoming less shy towards myself and other humans, the behavior of captive Lace Monitors changes in other ways.

Captive specimens appear to stay out of cover longer than their wild counterparts, often basking until the sun sets. This could be connected to the fact that captive specimens who are confined always know where they will be sleeping on a given night.

However it should be noted that wild studies of Lace Monitors indicate that a given monitor will usually sleep in one of a number of regular resting sites in it's 'home range'. Certainly pursued monitors have shown no hesitation in sleeping in tree tops when pursued and forced to remain in a tree overnight.

In fact a Lace Monitor at Nevertire, NSW, was 'treed' one afternoon, kept in the tree until the night and removed from the tree the following morning.

Another wild adult male was held in a tree at Bobbin Head, (Sydney) for three successive nights, before the tree was chopped down and it escaped up another tree.

The Nevertire Lace Monitor (referred to above) had what I thought was a unique habit of jumping into a pond and submerging itself when it felt threatened, (when I approached). The lizard would often rest in such a position with only it's snout protruding and did on some occasions sleep overnight in the pond. The lizard did not suffer any ill effects as a result of this behaviour. Other males in the pit also clearly had 'dominance' over this lizard and it's behaviour was in some respects modified as a result of this.

I have since found out that a captive Lace Monitor held at Sydney's Taronga Zoo also displayed similar behavior to the Nevertire lizard (above) in taking to water when alarmed.

My experience shows captive specimens appear far more likely to emerge from shelter on days too cold for their wild counterparts.

As with wild counterparts the daily activity cycle of Lace Monitors held in my pits would usually consist of emerging from shelter after sunrise and basking until a preferred temperature is reached. After that time the monitors would appear to wander about the pits, presumably while keeping their body temperature at a relatively favourable level.

Captive specimens frequently showed no hesitation in sleeping in the open, particularly in warmer weather. On some occasions, captive Lace Monitors were observed sleeping overnight in the open in the rain, sometimes over two or more days, without any signs of ill effects.

Over time in captivity, Lace Monitors will, like other large monitors, lose their fear of humans. Although this makes them generally easier to handle and in the main less unpredictable and potentially aggressive (to humans), feeding can become a greater problem. Long-term captives will run straight at you if they think you have food.

Lace Monitors kept individually appear to become used to humans and captivity more rapidly than specimens kept in a group.

The individuality of Lace Monitors in terms of temperament and 'personality' appears to be more distinctive than for most other reptiles. Certainly all seven adults held by myself had distinctive personality traits.

The smaller female (from Cannowindra, NSW) had a 'curly tail' trait. To a degree that was clearly noticeable the lizard would carry it's tail in a curled up state to the side of her body. This was both when stationary and walking and particularly when approached by humans. When agitated the lizard would literally 'whip' the aggressor (myself) with her tail. Oddly enough this same lizard rarely attempted to bite and was normally easy to handle. Also when approached this particular lizard had a much stronger tendency to hiss when approached. Typically when approached, this lizard would hiss and simultaneously curl her tail, (in moe than one complete circle), and although she may have risen her head as if to get ready to bite, rarely did.

The Cannowindra female would rarely flee or move her body if approached, and rarely needed to, as I would usually only walk past her. The lizard usually basked and slept on a wooden beam directly over the entrance door to the pit, so her behavior pattern was no doubt partially a result of 'captivity'.

A large male, pictured in plate 563 in Hoser (1989), from Bingarra NSW, was so docile it would not flee when approached and wouldn't put up a struggle when handled. Likewise (to a lesser extent) for the other two Bingarra monitors. The docility of all three lizards was probably a result of their long period in captivity, including in highly confined surroundings for many years. All three Bingarra lizards could at times be handled and 'trusted' not to bite (I was never proved

wrong in my judgement). The other male Lace Monitors never became 'tame', would flee when approached, were difficult to handle and would always bite if allowed to.

Changes in personality/behaviour were not always easily explained. Sometimes a given specimen would become more shy or aggressive without easy explanation, although such behaviour changes were usually only short term.

As a 'pet', Lace Monitors are durable and docile. For four weeks in June 1981 (the Australian winter) four of the seven were allowed to walk around the house (which was kept locked) without causing problems. The lizards literally sat around and did very little.

Captive Lace Monitors held by myself would usually voluntarily stop feeding around May (the commencement of winter in Sydney) and would usually (voluntarily) re-commence feeding in the first warm weather of late August or September, although I used to feed the lizards only sparingly until the weather was more reliably warm, such as by October/November.

The restriction on feeding monitors in cold weather is also necessary to prevent digestion problems that may arise from the Monitors being unable to digest food due to cold, which could severely affect the lizard's well-being.

Although it may be assumed that non-feeding of Lace Monitors in winter is a result of lower temperatures, such may not be entirely true. Lost interest in food may also be related to a circannual rhythm. Certainly the four monitors brought into the relatively warm house in June 1981 didn't suddenly develop a renewed interest in food. Peters (1970) kept a Lace Monitor in warm conditions throughout a winter and it too lost interest in food. Similar behaviour in terms of loss of interest in food was noted in some snakes held by myself and kept warm over winter.

During summer (on hot days), monitors were fed frozen rodents without complication.

Although Lace Monitors (both wild and captive) will sleep in elevated positions, such as in trees, they will invariably sleep in a horizontal or near horizontal position and on a surface large enough to support the bulk of their body weight, such as a reasonably thick branch or limb.

Some monitors would sleep on horizontal beams of wood used to hold the wire above the cages, and the smaller female sometimes slept in an acacia tree that had branches thick enough to support her weight.

Both wild and captive Lace Monitors seem to prefer basking on wood rather than rock/s if all things are equal in terms of exposure to sunlight and heat.

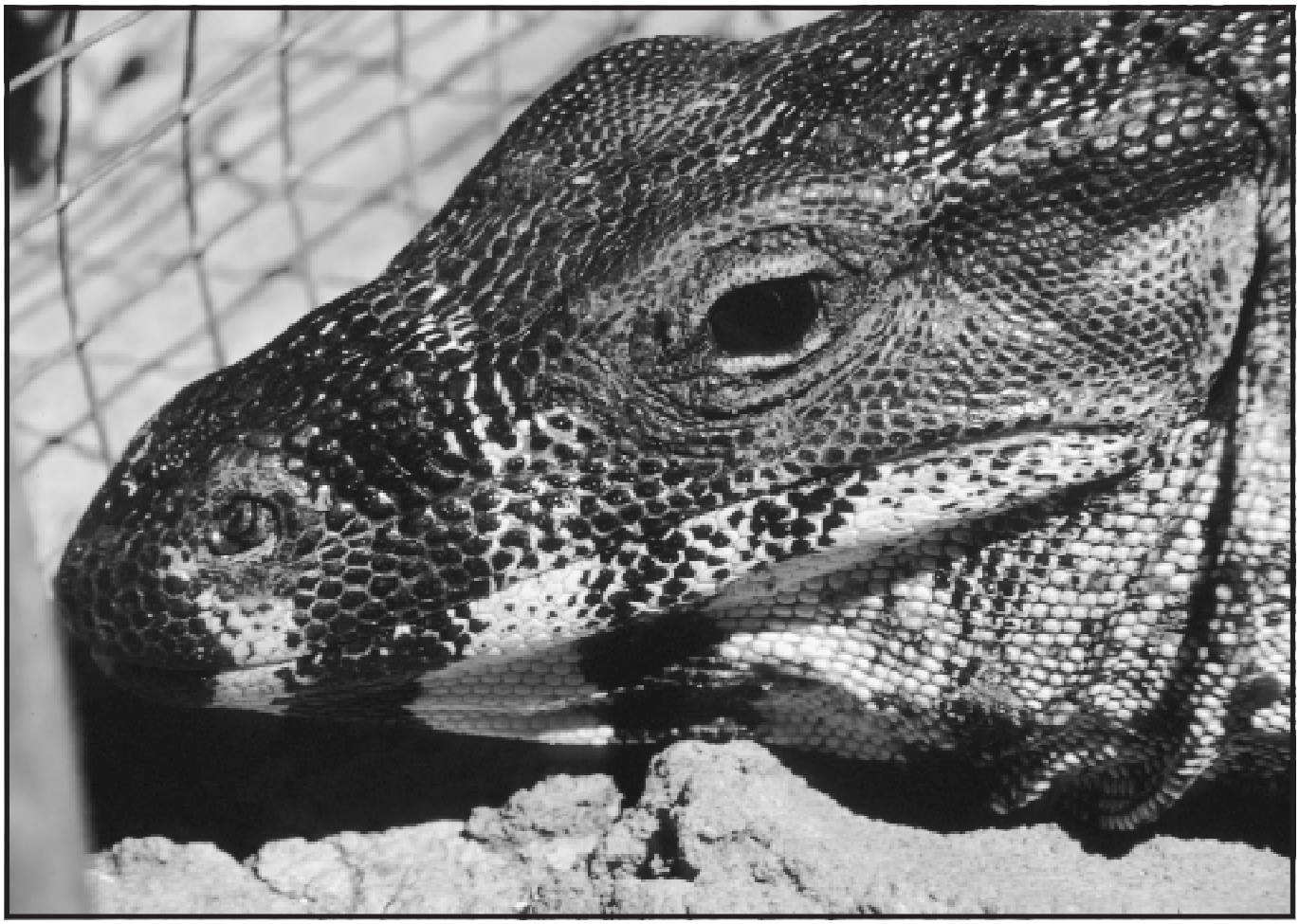

Photo: Raymond Hoser.

Adult male Lace Monitor (*Varanus varius*) in the author's pit. It originated from Bingarra, NSW. Note the ticks lodged in the nostril. This is common in the species and can be easily over looked. However this author was unable to identify any substantive harm caused by these parasites.

Photo: Raymond Hoser.

Adult male Lace Monitor (*Varanus varius*) (Bell's form), in the author's pit. It originated from just north of Lightning Ridge, NSW.

However people who have kept Lace Monitors in a 'concrete and rock' set up have not appeared to have difficulty maintaining the species.

MATING ACTIVITY

Mating was commonly attempted by all Lace Monitors held by myself throughout the warmer months. Usually the male will move toward the female and then proceed to mount her, whilst also caressing her by 'licking' and trying to stroke her head, either with his paw or head. The male uses his tail in caressing either by rubbing it over the female's tail or more frequently by wrapping it around the female's own tail. In effect the male actually tries to pin down the female by force and the female rarely co-operates. The male will also bite the female when attempting to mount her.

When the female completely refuses to co-operate she usually walks away or tries to do so, although sometimes she will actually run if she gets free. Usually a male will attempt to mate the same female for a whole day or longer, until he has success. Sometimes a male may be pre-occupied with the same female for weeks.

Fighting between males only seems to occur when two males both want to mate with a given female. That fighting rarely occurred in my pits was probably due to the long term contact of the group of seven monitors and the well established social hierarchy that no monitor wished to challenge.

Male Lace Monitors are known to attempt to mate members of the same sex, obviously with little success. This may also occur when females are present.

When actual copulation occurs, it is not unlike that for most other lizards (stereotyped sexual behavior). The male's tail is usually at least partially wrapped around the female's. The anal regions are pressed together and the lizard's bodies are either wrapped around one another or simply close together in a belly to belly manner. The male continues to caress the female throughout copulation and with the exception of actual copulation, the female is usually unco-operative to some extent.

Copulation between Lace Monitors can range from minutes to hours, including 'foreplay' such as mounting. I have witnessed two males copulate with a single female on the same day. (Both males had fought prior to this and the 'loser' of the fight was actually the first to mate the female).

On another occasion two other males fought and the victor was the only one to mate a female.

When copulation was actually taking place, monitors would rarely stop copulating and flee when I walked up to them in the pit. This was even true when I approached at a distance close enough to make them usually want to flee. If the two monitors did break when I disturbed them mating, the male invariably follows the female. Autumn and spring seemed to be the main mating seasons, in particular September to November and to a lesser extent March-April.

A detailed description of a fight between wild male Lace Monitors at Myall Lakes, NSW is provided by Twigg (1988) in *Herpetofauna.* His account of fighting between males in the presence of a female (which was as usual smaller than the males) parallels the conflicts observed in my pits in form. Twigg gives an account of a conflict lasting nearly 30 minutes including 10 minutes of 'wrestling' which was probably longer than most fights observed in my pits.

An 'upright position' with both monitors face to face and holding each other up with front limbs is assumed when the fight commences after both males have decided to fight, after 'scenting' one another. Although one male will attempt to get on top of the other in a 'dominant' position, the other will resist and try likewise. During the conflict, the males will periodically crash into the ground only to usually reassume the 'upright position' as they continue to fight.

When fighting, Lace Monitors (in my pits) would also sometimes lock together and 'roll' across the ground in the pit.

The more 'evenly matched' the monitors, the longer the conflict is likely to last. The 'beaten' monitor after being pushed sideways on it's back will collapse into a supine position on the ground. The weaker monitor will 'submit defeat' by laying flat on it's belly on the ground with it's limbs sprawled. This position is maintained for some time before the winning male moves away from the loser.

In some cases observed in my pit, the beaten monitor concedes defeat by fleeing, although frequently the winning male will pursue the other and attempt to continue the fight to 'submission'. A ploy sometimes

used by a male to ward off another aggressive male (in my pits) would be to flee into a tight hollow log where the other monitor couldn't possibly pursue and continue to fight.

Twigg (1988) actually provides a series of five photos of a conflict between two males of this species. A description of male combat in *Varanus bengalensis* by Auffenberg (1979), reveals essentially similar combat behavior between males of that species. A photo of fighting *Varanus mertensi* on page 202 of Greer (1989) seems to indicate similar fighting behavior in that species.

Worrell (1970), plate 30, shows a 'normal phase' male Lace Monitor fighting with a 'banded phase' Lace Monitor, which it appears to be pushing into a submission posture.

Photo: Raymond Hoser.

At home (in the house) a 'dog-tame' Lace Monitor (*Varanus varius*) from Cannowindra, NSW.

Michael Anthony (formerly of Sydney, NSW) reported a case of two male Lace Monitors fighting on the ground at western Victoria. A smaller female was apparently sitting almost directly overhead on a tree branch for the duration of the fight.

During 'fights' the concern of Lace Monitors towards human presence decreases to become almost oblivious, making observation of combat behavior in this species fairly easy.

EGG LAYING

Eggs were laid by both females held by myself at least four times in total. None hatched as all were eaten by other monitors in the same cage. Only twice out of four occasions were eggs actually buried and these were uncovered by other monitors and eaten before I could do anything about it. The reason why on the other two occasions eggs were apparently laid in the open was because my pits probably lacked suitable egg-laying sites.

Joe Bredl of South Australia had a similar problem with his Lace Monitors eating eggs laid in his pits before he could remove them, two years in succession, (Bredl, 1983). In 1982 he removed a gravid female from his pit and she produced eggs, some of which were incubated to produce young.

The statistics given by Bredl were as follows:

Mating: 26 (day)/10(month)/82(year) and 6/11/81

Female noticed gravid and removed from pit: 8/12/82

Eggs laid: 11/12/82

Number of eggs laid: 7, (five were OK, two were deformed)

Measurements of eggs: 4cm x 7cm, 65g (average for five good eggs)

I**ncubation Medium:** Peat moss.

Incubation Temperature: 30-32 deg. Celsius (Av.)

Humidity: 85 per cent (estimation) eggs sprayed once a week.

Eggs hatched: one on 13/5/83, three on 14/5/83.

Incubation time: 143 and 144 days.

Hatch rate: 4/5 or 80 per cent. (one egg developed to full term but failed to hatch)

Average measurements of four live young: Snout-vent: 119 mm, Tail length: 186 mm, Total length 305 mm. Weight: 34 grams.

Bredl, (1983) provided photos of the eggs and hatchlings described above.

Kevin Markwell of Cardiff, NSW, gave an account of incubation of another clutch of eggs laid by a Lace Monitor, at the Maitland Nature Wonderland Fauna Park, (Markwell, 1983).

On 17th December 1980 four eggs were removed from the ground in the Lace Monitor cage. The eggs were incubated in a vermiculite-based medium.

Two eggs were apparently infertile and discarded. The temperature the eggs were incubated at wasn't known or strictly controlled. The container with eggs in vermiculite was placed on a domestic hot-water system allowing for a relatively warm incubation temperature subject to fluctuation.

Two eggs hatched although one hatchling died almost immediately after hatching.

The statistics given by Markwell were as follows:

Dead Hatchling: Snout-vent: 11.3 cm, tail length: 15.7 cm, total length: 26.0 cm, Egg: 6.98 cm long x 3.95 cm wide.

Live Hatchling: Snout-vent: 11 cm, tail length: 17 cm, total length: 28 cm. Egg: 7.0 cm long x 4.1 cm wide.

Incubation Time: 317 days (as compared with 143

and 144 above).

Other documented incubation times for this species include: 6 months (Fleay, 1950), 6-7 months (Horn, 1980), 6 months (Peters, 1980).

Clearly incubation times for eggs of the Lace Monitor are highly variable. The variation is almost certainly temperature dependent. That it is possible to successfully incubate the eggs of a reptile at such different rates is quite remarkable. The Lace Monitor may not be unique among monitors in the variability of incubation times of eggs. Visser (1981), states "The data available in the literature regarding the incubation period for the eggs of monitor lizards is very unclear; reports of duration range from 110 days to ten months".

Barnett (1979 and 1981) incubated eggs of *Varanus gouldii* at between 24 and 25 degrees and 29.5 to 32 degrees with success, the eggs taking from 169 to 208 days to hatch. These figures correlate roughly with those available for Lace Monitors. Greer (1989) provides a summary of the literature and breeding records published on all other Australian monitors to about mid 1989.

Clutch sizes for Lace Monitors range from four to twelve eggs according to published accounts including Waite (1929) (12 eggs), Irvine, (1957) (9 eggs), Frauca (1965) (8 and 10 eggs), Fleay (1950, 1953) (6-9), Swanson (976) (6 eggs), Horn (1980) (5 eggs), Peters (1970) (4 eggs), Weavers (1983) (9.7 – Average of three clutches), Bredl (1983) (7 eggs), Markwell (1983) (4 eggs).

Clutch sizes documented for other monitors ranges from 2 in *Varanus brevicauda* (Pianka, 1970), to 35 in *Varanus spenceri* (Christian, 1979).

Egg-laying for Lace Monitors is thought to be around December in most cases. It has been speculated by a number of colleagues that southern populations may breed slightly later than more northern populations, although at this stage sufficient data is unavailable.

A number of authors have documented cases of wild Lace Monitors laying eggs inside termite mounds, including Bustard (1970), Cogger (1959, 1960, 1967), Fleay (1953), Greer (1989), Houston (1976), Jenkins and Bartell (1980), Knowles and Wilson (1988), Longley (1945), McPhee (1979), Mertens (1986), Swan (1990), Swanson (1976), Weavers (1983), Worrell (1970).

However most of these authors are actually citing cases from the literature or the comments of other authors rather than basing their statements on personal experience. However a number of herpetologists have given me first hand accounts of Lace Monitors either laying eggs in termite mounds or of eggs or hatchlings being found inside termite nests.

Certainly David Fleay of Queensland has observed Lace Monitors laying eggs in termite mounds on a number of occasions.

Robert Croft and Bill Saunderson (both formerly of St. Ives, NSW) gave an account of how they found young Lace Monitors emerging from an arboreal termite nest. After seeing a single hatchling run into a termite nest about four metres (13 feet) above the ground, they pulled the nest apart to find some four hatched eggs and a total of three hatchlings, including the original specimen. The find was in bushland at the Kurringai Wildflower garden, immediately adjacent to suburban Sydney.

Bruce Triemer, formerly of St. Ives (now deceased) observed a similar case in St. Ives bushland. He observed what he thought was a sub-adult Lace Monitor (in actual fact probably a mature female), digging into a termite mound on the ground. Triemer disturbed the monitor which ran up a nearby tree to where it was inaccessible. Triemer then opened up the termite mound to find a number of hatchling Lace Monitors, (he didn't say how many).

Parental care of lizards is rare and possible cases in Lace Monitors should be investigated when possible. Gerry Swan and Harry Ehmann gave details at a 1990 Sydney Herpetological conference of a case of a Heath Monitor *Varanus rosenbergi* that had laid eggs inside a termite mound on the ground in bushland in St. Ives. The two men had spent considerable time observing the site. They postulated that young monitors (including Lace Monitors) would not have strong enough claws to be able to dig out of termite mounds. As the mounds are sealed after eggs are laid, how the young monitors get out of the mounds without help from an adult outside isn't known.

Swan and Ehmann, along with Greer (1989), doubted that adult monitors would specifically 'rescue' hatchlings from the termite mounds as young monitors don't make sounds to alert outsiders of their presence, nor do adult monitors appear to tend to their 'nest' in any way after they have been laid.

Furthermore, non-laying Monitors have not been observed over a period of time 'loitering' around termite nests waiting for eggs to hatch.

Swan and Ehmann postulated that perhaps young monitors only get liberated from termite mounds if there is another animal that digs them out, such as another monitor nesting some twelve months later (see the above incubation time documented by Markwell). Swan and Ehmann postulated that some young monitors may actually hatch from eggs inside mounds and die before they are liberated from the mounds.

Certainly eggs of the freshwater tortoise *Chelodina expansa* are known to over winter, with young emerging from nests only in suitable conditions up to and exceeding 12 months later (Cann 1978). A similar situation may exist for some Lace Monitors.

When egg laying, captive female Lace Monitors in my pit tended to dig a narrow tunnel under a rock and deposit the eggs in a chamber at the end which was barely covered with dirt. This is apparently similar to the nesting for this species in the wild, as described by Greer (1989).

(text for this article continues on page 35).