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MONITOR LIZARDS

Crocodile Monitor

Varanus salvadorii

Varanus salvadorii is an arboreal monitor of up to about 250 cm in length from the rainforests of New Guinea, with a tail at least twice as long as the head and body, and a space requirement the size of a room.

Family: Varanidae

KEY FACTS

THE ANIMAL

Adult size	**150-250 cm** total length incl. tail
Weight	**2,500-6,000 g**
Lifespan	**15-25 years**
Active	**By day**
Lifestyle	**Arboreal**
Habitat	**Rainforest**
Difficulty	**Expert**

CARE

Min. enclosure	**300 × 150 × 200 cm** L × W × H for 1 adult
Temperature, day	**28-32 °C**
Basking spot	**35-40 °C**
Temperature, night	**24-26 °C**
Humidity	**70-90%**
Water	**Water section** depth 30-50 cm
UVB	**Essential** Ferguson zone 3
Diet	**Insects and vertebrates**
Kept	**Singly or in pairs**

BREEDING

Reproduction	**Egg-laying**
Sexually mature	**24-60 months**
Clutch size	**4-12 eggs**
Clutches per year	**1-2**
Incubation	**155-251 days** at 28-30.5 °C

PROTECTION AND PAPERWORK

CITES	**Appendix II**
EU annex	**Annex B**
IUCN	**Least Concern (LC)**

About the species

V. salvadorii is the only species in the subgenus *Papusaurus* and one of the longest monitors in existence. Animals in captivity seldom exceed 250 cm (snout-vent length 75-85 cm), and the longest museum specimen measures 255 cm; claims of over 4 m have never been confirmed. Males are clearly longer and heavier than females. A healthy adult male of about 75 cm snout-vent length weighs 5-6 kg and a female 2.5-3 kg; far heavier animals are usually too fat. The tail makes up most of the length: it is at least twice as long as the head and body, thin as a whip, relatively low and only slightly compressed from the sides. The body is slender and light compared with, for example, *V. komodoensis*. The snout is blunt and distinctly domed, and the teeth are long, serrated and slightly curved. The animal is black to dark olive green on the back with yellow spots in transverse rows, and the juveniles are more clearly patterned than the adults. There are skin folds on the sides of the throat, and the claws are strong and curved.

The species was described in 1878 from an animal collected at Dorei in north-western New Guinea. It is one of the least known monitors, especially in the wild. The long tail is held coiled, and its shape suggests that it is used as a prehensile tail in the trees rather than as a rudder in water.

The species is among the most demanding reptiles of all. An adult animal needs a facility that is in practice a room or a greenhouse with great height, many kilos of vertebrates as food every year, temperature, light and humidity control on a large scale and a keeper who can handle a nervous animal with powerful bites and claws. The species can live for a good 25 years, but many die far younger, especially from egg-laying difficulties, gout and bites from conspecifics.

Read more: Humidity, misting and ventilation

Distribution and habitat

Varanus salvadorii is found only on New Guinea and the small island of Salawati off the island's western tip: in the Indonesian part (Papua) and in Papua New Guinea. The type locality is Dorei, today Manokwari, in the north-west. The species is known from lowland and hill forest along most of the coast, but there are no certain records from the north coast east of the mouth of the Sepik River. Most records have been made below 200 m, but camera traps have photographed active animals at 1,500 m in the Torricelli Mountains.

The range has hardly been studied in the field, and the animals are rarely seen, so the records on the map are scattered. Records outside New Guinea on the map come from captive animals or misidentifications.

> **Native range:** Indonesia and Papua New Guinea.

HABITAT

Varanus salvadorii lives in undisturbed tropical rainforest in the lowlands and hills, in forest along rivers and in the open forest of the southern lowlands. It avoids cleared areas and secondary forest and disappears where it is hunted close to settlements. The species is first and foremost arboreal and moves quickly and surely in the canopy, where it uses the long tail as a counterweight and to hold on. It is diurnal and swims well. Adult animals seem to have fixed trees with hollows high up, and the most frequently observed food in the wild is birds.

The climate is warm and humid all year, with over 3,000 mm of rain, high humidity and only small fluctuations between the seasons. The forest is under pressure from logging and plantations, and the animals are caught for trade, for their skin and as food. The species is listed as Least Concern on the Red List, but the size and trend of the population are unknown. Food choice, nest choice and daily rhythm in the wild are poorly known.

Care

THE ENCLOSURE

Size is the first requirement that decides whether the species can be kept responsibly. One adult animal needs at least 300 × 150 × 200 cm (length × width × height), and a group of one male and three females at least 550 × 250 × 300 cm. Far larger and taller facilities are better: animals in rooms that are too small become fat and develop skin abrasions and worn claws, and where the climate allows, outdoor facilities or greenhouses with access to trees are preferable. Newly hatched juveniles can begin in a closed enclosure with about 2 m² of floor area and a height of 2 m, but after half a year they need far more space.

Build for adult size from the start, with solid walls and closed, secure doors. The species is an escape artist: smooth surfaces of glass or steel over 120 cm high it cannot climb, but wood, concrete and mesh are searched for the slightest unevenness, and it can escape through a gap of 5 cm. Mesh must have openings large enough to climb on, but small enough that the head and legs cannot pass through. Heat sources and lamps must be shielded so that the animal cannot hit or burn itself on them.

Furnish with plenty of strong branches and trunks with soft bark at all heights and resting places high up, for example stones or shelves 150-200 cm above the floor. Concrete and other rough surfaces wear on skin and claws. The floor should be deep and soft, so that the animal takes a fall from height without injury: 50-100 cm of coconut fibre or a mixture of soil and leaves that holds moisture and lets the animal dig and lay eggs. In an ordinary enclosure the animals destroy live plants at once, so use artificial plants; only in very large facilities do robust plants survive. A large water pool of about 90 × 120 cm and 30-50 cm deep is part of the setup; some animals swim daily in large pools, and the water is changed often. Hides, for example hollow tree trunks and a cool, damp cave, and screening so that the animal can get out of sight of people and conspecifics reduce stress.

TEMPERATURE

Varanus salvadorii is tropical and diurnal and needs a large temperature gradient from about 26 °C at the cool end to basking spots of 35-40 °C. The background temperature is kept at 28-32 °C and lowered slightly in winter. The basking spot is heated with powerful lamps from above, so that it resembles a ray of sun, and it must be large enough for the whole animal to warm up; the species prefers to bask high up. The animal must have access to the basking spot for at least 4 hours a day. It is the surface temperature of the basking spot, measured with an infrared thermometer, that is decisive, not the air.

The animal must always be able to move away from the heat to shade, water and a cool, humid burrow. At night it must be 24-26 °C, as in tropical rainforest. Keep the temperature stable, and use thermostats with independent safety cut-outs, because large lamps and heating cables can otherwise cause a fire hazard or overheating. Cold, damp periods cause respiratory problems.

Read more: Heat and temperature

HUMIDITY AND WATER

The species requires high humidity, 70-90 % at all times, and at the same time good ventilation so that bacteria and fungus do not take hold. Dry skin and difficulty shedding are signs of too low humidity, while discoloured, soft patches in the skin suggest too much moisture and infection. A healthy animal has glossy skin and has finished shedding within a week. The humidity can be varied with the season, for example four to six short misting sessions a day over a long period in the middle of the year and two to three the rest of the year.

In the wild the species drinks rainwater up in the trees, and many animals in captivity will not drink from bowls, waterfalls or pools. Artificial rain with misting or sprinklers is therefore necessary to keep the animal hydrated. A large water pool increases the humidity and is used for bathing and swimming. The deep, damp floor gives the species the opportunity to dig and lay eggs.

LIGHTING AND UVB

The species is diurnal and basks in the upper layers of the forest. Unfiltered sunlight is best; indoors the roof should let UV through, and it must always be supplemented with powerful lamps that provide both UVB and heat. UVB is necessary. The basking spot must give a UV index of 4-6 for up to 4 hours a day (Ferguson zone 3), and the rest of the terrarium must have shade with lower UV, so that the animal can choose for itself. The animals avoid a UV index above 9. Measure the UV index with a UV meter, especially under artificial light.

Keep a fixed day length of about 12 hours of light and 12 hours of dark all year round, controlled by a timer. The species can, however, also breed with a seasonal variation from 15 hours of light in summer to 9 hours in winter. Be aware that powerful UV lamps with a filament can give off a lot of heat close to the animal.

Read more: Lighting and UVB

FEEDING

Varanus salvadorii is a predator, and in the wild birds appear to be the staple food, supplemented with small mammals, eggs, insects and lizards. In captivity whole prey is given: quail, chicks, rats, mice and occasionally fish, crayfish, rabbit, duck or turkey. Smaller prey given more often is better than large meals such as whole rabbits and hens, which cause long periods of inactivity. Whole animals cover the need for calcium and vitamins better than meat. Eggs can be buried as enrichment, but many eggs and chicks with yolk make for a diet rich in fat and cholesterol. Adults are fed twice a week and young two to three times, and the amount is increased in the mating season. Food that has to be fetched from up a trunk or coaxed out provides exercise.

Overfeeding is the species' biggest problem in captivity. Obesity and weak muscles are linked to egg-laying difficulties, and a protein-rich diet combined with too little water causes gout. Keep the animal lean, assess its condition regularly, and adjust the amount. Calcium and vitamin supplements are used with caution and especially for gravid females and young. Long tweezers reduce the risk of bites during feeding.

Read more: Calcium, vitamins and supplements

BEHAVIOUR AND HANDLING

Varanus salvadorii is typically nervous and shy and avoids contact with people, and some animals react aggressively. Each animal has its own character. With a calm daily routine and enrichment, many animals gradually become comfortable with the keeper and seldom show defensive behaviour, while a few remain very nervous and irritable. Wild-caught animals are particularly sensitive and need places where they cannot be seen.

Safety: Before a bite the animal flattens its body, coils its tail, inflates its throat and hisses loudly. If it is cornered, it gives a warning bite, and even that can cause serious wounds that require medical treatment. The bite is also venomous: it can sting, bleed for a long time and swell, because the venom inhibits blood clotting. The claws are strong, and the long tail can lash like a whip. Use bite-proof gloves reaching up over the forearm and long tweezers, and do not share a room with an aggressive animal. Restraint is a last resort and requires two to three people: one for the head and neck, one for the body and legs and one for the tail. Target training and food that lures the animal from one room to another make it possible to avoid handling; in this way the animals can also be accustomed to veterinary examinations, for example blood samples.

Like all reptiles, the species can carry salmonella. Wash your hands thoroughly after any contact with animals, food, enclosure and water, and do not let children or pregnant women handle animals and equipment.

Socially the species is kept singly or in pairs. Females can be aggressive towards both males and other females, especially around egg-laying, and aggression has been seen in all combinations of sexes. Even so, pairs and small groups can live together for years, for example one male and three females in a very large enclosure. Screening between males and females is necessary, because both sexes can become stressed from seeing each other. For mating the animals are put together for two to four weeks and separated again, and the female can seriously injure the male.

Read more: Quarantine and hygiene Read more: Buying animals: captive-bred, wild-caught and transport

Breeding

SEXUAL MATURITY AND SEXING

Females become sexually mature after two to three years, males one to two years later. Adult males are clearly larger and heavier than females with a broader, more angular snout. The bulges from the hemipenes are not distinct enough for reliable sexing, and the female's hemiclitoris is easily confused with the male's genitals. In adult males the bones of the hemipenes can be seen on X-ray, but the most reliable method is a DNA test of a drop of blood, which can be used on animals of all ages. Breeding should only take place under the auspices of zoos or collections with room to keep the animals apart.

MATING

The species breeds all year in captivity, but at northern latitudes the animals seem to prefer spring and autumn. Mating can fall in April-June, July-August and September-October, among other times, depending on temperature, humidity and day length. Males and females are most often kept apart and brought together only for two to four weeks, with the animals lured into each other's enclosure with food to avoid handling.

The animals only recognise the partner's sex once they have examined the scent with the tongue. The male approaches with jerky head movements and constant tongue-flicking, and a willing female lies down flat, often with closed eyes. Females can attack the male violently, especially after egg-laying, so that the male gets bite wounds at the base of the tail and on the hind legs. It is therefore necessary to be able to separate the animals at once. The species may be able to reproduce by parthenogenesis, so a female kept alone can lay viable eggs.

EGG-LAYING AND CLUTCHES

Clutches are 4-12 eggs, and the eggs weigh 40-80 g. A female can lay two clutches in a year. In the last two weeks before egg-laying the female becomes less active, basks a great deal and digs many trial holes, in which she pushes her snout down. The digging and egg-laying themselves take about three hours. The eggs typically lie 20 to 50 cm below the surface, and afterwards the female fills the hole and hides the nest so that it is hard to find; she often stays nearby and guards it. Some females do not dig at all, but scatter the eggs over the floor, and some females eat their own eggs.

The species is fussy about the nest site, so provide several options in secure, screened areas. A container 120 cm high with a mixture of coconut fibre, sphagnum, peat and sand, which the female can reach along a branch, works well. The nesting substrate should be kept at 80-90 % humidity and be deep enough for her to dig down at least 60 cm. Egg-laying difficulties are the most frequent cause of death in adult females, and retained eggs are common; cysts on the ovary can also be fatal. Watch the female, therefore, and see a vet quickly if she is lethargic or does not lay.

INCUBATION

The eggs are removed and placed in vermiculite mixed with water in a ratio of about 1:1 by weight, preferably sterilised and with filtered water. Incubate at 29-30 °C; about 28.5 °C may be too low. It is an advantage to give each egg its own container, so that bad eggs do not infect the good ones, and to weigh the container every other week and replace the water that has evaporated. Eggs that turn dark within the first two weeks are usually infertile and are discarded.

The eggs hatch after 155-251 days, and the higher the temperature, the shorter the time. Do not touch the eggs along the way: eggs that are regularly taken up to be measured may die, even though the young are fully developed. Dead young in fully developed eggs also occur without a known cause.

REARING THE YOUNG

The juveniles are independent from hatching and should begin eating within 72 hours. The first meals are often newborn mice, and after that insects such as grasshoppers can be the staple food for the first months with a newborn mouse a week. Two feedings a day alternated with fasting days and plenty of room to climb give active juveniles, and the weight can double in ten weeks. Force-feeding is not recommended; if a juvenile does not eat, check the climate, stress and parasites. Even newly hatched juveniles can have intestinal parasites, so have the first faeces examined.

Juveniles of the same size can be kept together, but some become aggressive, and even compatible juveniles are separated for feeding, because the sharp teeth can cause serious wounds. They bite early and may go for gloves, so use long tweezers from the start. The juveniles can be told apart by their spot pattern until they are large enough for a microchip.

Health and common mistakes

Varanus salvadorii is not easy to keep healthy, and many animals in captivity are short-lived. The typical problems are:

- Egg-laying difficulties, the most frequent cause of death in females, often in connection with obesity and weak muscles. Retained eggs and cysts on the ovaries usually require surgery.
- Gout, the most frequent cause of death in males, from too protein-rich a diet, overfeeding and too little water.
- Obesity from too much and too fatty food and too little movement in a facility that is too small.
- Aggression between animals, in all combinations of sexes, with bite wounds that require a vet.
- Parasites: imported animals often have ticks and many kinds of intestinal worms and single-celled parasites.
- Skin fungus and other infectious diseases that can spread from other reptiles in the collection; use separate tools and good hygiene.
- Burns from unshielded lamps and heat sources, also because stressed animals seek out the lamp to hide.
- Respiratory infections from cold and incorrect humidity, and skin problems from a climate that is too dry or too wet.

Only a very small proportion of the animals traded are captive bred. Indonesia has an annual capture quota for trade, so adult animals offered in Europe can have an unknown or illegal origin. Wild-caught animals often have parasites, are stressed and often stop eating. Have a faecal sample and a health check done by a vet with experience of reptiles when buying. See a vet at once if the animal stops eating, seems lethargic, has an open mouth and wheezing breathing or has a bite wound.

Always ask someone who knows

This guide is a good place to start, but it cannot replace experience. Animals differ, and much of what matters most is learned from people who have kept the species for years. Talk to a breeder, an experienced keeper or a vet who knows reptiles and amphibians before you get the animal - and again if anything looks wrong.