

# Furcifer pardalis (Panther Chameleon) – A Brief Species Description and Details on Captive Husbandry

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## ABSTRACT

Chameleons of all species, have proven extremely delicate animals to work with in captivity. Many health concerns arise when they are maintained in improper conditions, from infections to inadequate nutrition, all of which will lead to the deterioration of the animals wellbeing and ultimately, a shortened lifespan. Therefore, understanding the most important problems which commonly occur in captive chameleons and the factors responsible for said problems, is paramount to the successful breeding and maintenance of chameleons in captivity.

*Furcifer pardalis* or Panther Chameleons are one of the most common chameleons found in the pet trade, due in part to their impressive size, stunning variation in colouration, specialised morphological traits, unique personalities and most importantly, their relative hardiness when maintained in captivity. All of the aforementioned traits make Panther chameleons an exciting species to work with and an enjoyable challenge to successfully maintain, for the interested herpetologist.

The aim of this paper, is to comprehensively review the history, anatomy and health issues associated with Panther chameleons and the current husbandry techniques used in maintaining said animals in captivity. The methods described in this paper are up to date guidelines for the successful husbandry of captive Panther chameleons and are as a result of many years of experience in keeping and breeding both Panther chameleons and various other chameleon species, whilst also drawing from expert literature in the field of captive chameleon husbandry. Hopefully, this review aids in improving our knowledge on the captive needs of *F. pardalis* and ultimately leads to greater future success in the field.

**Key words:** Chameleons, captive husbandry, health, exotic species, nutrition, environmental enrichment, conservation.

## INTRODUCTION

The Panther chameleon, *F. pardalis*, is a species naturally endemic to Madagascar and was first described by the famous French naturalist and zoologist Georges Cuvier, in 1829.<sup>1</sup> The generic name of *Furcifer* is derived from the Latin root word of *furci*, translating to forked. This is in reference to the “forked” morphology of the animal’s feet, which have five digits, arranged into two groups, one containing three digits and the other containing two. This type of morphology is commonly referred to as zygodactyl or didactyl, however both are incorrect in relation to chameleons which fit into neither group and to date, there is no specific term for the unique arrangement of digits on a chameleon’s feet.<sup>2, 3</sup> The species name of *pardalis* is Latin for “Panther”, hence the English common name of “Panther chameleon”.

Following is the classification summary of the Panther chameleon.

**Kingdom:** Anamalia

**Phylum:** Chordata

**Class:** Reptilia

**Order:** Squamata

**Family:** Chamaeleonidae

**Genus:** *Furcifer*

**Species:** *Pardalis*

**Common name:** English - Panther Chameleon

**Species Authority:** Georges Cuiver 1829

**Synonym(s):** *Chamaeleo Pardalis* (Cuiver 1829)

## Anatomy

### Habitat: Range and origin

*F. pardalis* are found throughout a large part of Madagascar in somewhat varying habitat types, although most populations are located in relatively close proximity to coastal areas of the North, North-West, North-East and East coasts. Their distribution ranges from towns such as Diego Suarez on the very north tip of the island, to Mahajunga in the north-west, to Tamatave in the east of the island. Populations are also present on some of Madagascar’s surrounding islets, such as Nosy Be, Nosy Faly, Nosy Boraha (Île Ste. Marie) and Reunion Island (Île Reunion). Species populations appear somewhat fragmented from locality to locality.<sup>4</sup> As such animals show an obvious intraspecific diversity in colouration, from

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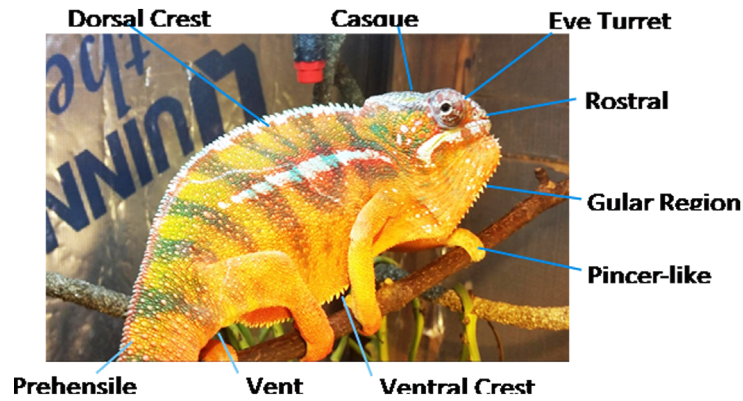
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**Figure 1:** Image highlighting some of the unique morphological traits within the Panther chameleon anatomy. These include the prehensile tail, gular region, eye turret, casque, rostral process and pincer-like feet

**Table 1:** Table listing some of the common *F. pardalis* ‘locales’ or forms based on geographic variation of colour. Some listed are rarer than others but most are commonly kept and bred in captivity by enthusiasts.

Locale	Location	Colours
Ambanja	North Madagascar	Blue/Turquoise with red
Ambilobe	North Madagascar	Green with Red/Blue/yellow
Ankify	North Madagascar	Blue/Turquoise
Ankaramy	North Madagascar	Pink/Red
Diego Saurez	North Madagascar	Green to Orange
Maroantsetra	North-East Madagascar	Green to Orange/Red
Nosy Be	Islet - Off the North coast of Madagascar	Blue/Turquoise
Nosy Boraha	Islet - Off the East coast of Madagascar	Grey/Brown/Red
Nosy Faly	Islet - Off the North coast of Madagascar	Blue/White/Red
Nosy Mitsio	Islet - Off the North coast of Madagascar	Lime green to yellow
Sambava	North-East Madagascar	Green to Red/Yellow/Orange
Tamatave	East Madagascar	Green to Red

**Table 2:** Table of distinct morphological traits noted in various Panther chameleon localities.

Locale	Morphological variation
Ambanja	Extended rostral process and enlarged temporal scales in males
Nosy Be	Elevated parietal crest and incomplete dorsal crests in males
Nosy Boraha	More pronounced tubercles on head and body in males

population to population, commonly referred to as “locales” (locale to locale). Each locale is named after the geographic region in which they are found. However, many other colour patterns occur both between and within geographic regions and to date population/locale continuity and fragmentation, as well as the extent of the inland distribution of the species remains to be fully verified.

**Identifying features**

Panther chameleons have a number of identifying features, especially to the experienced chameleon keeper, however the most obvious is their stunning colouration. This at least is true for males, as this species is sexually dimorphic and as such, females are quite drab in appearance when compared with their vibrant male counterparts. *F. pardalis* males from locales such as Nosy Be, Nosy Faly, Ankify and Ambanja typically

show stunning blue colouration. Males from locales such as Sambava and Diego Suarez tend to show greens and oranges. Locales such as Tamatave and Maroantsetra generally show bright reds/oranges/whites, while locales such as Nosy Mitsio show lime green to yellow colouration. Males from the locality of Ankaramy show a stunning Pink colouration throughout, with a number of these locales commonly kept in captivity (Table 1).

However, for a more detailed identification *F. pardalis* have other morphological traits present, which can be used, not only to accurately identify the species but also, to a limited extent, the locality of a given animal. This can be especially useful when trying to identify the locality of a female, as females of all populations share relatively similar colouration of tan/ brown or pink/orange/peach. Although there are slight varia-



**Figure 2:** Images of two panther chameleons from differing locales. Note the obvious morphological differences in casque shape and size between the two individuals. Ambilobe locale from the Malagasy mainland (left image) and Nosy Be locale from Nosy Be islet, located just off the mainland (right image).

tions in colours/patterns between locales, there is also variation within these populations and as such, female locality can be almost impossible to distinguish when using knowledge of colouration and patterns alone. Unfortunately, even with the use of morphological traits other than colour and pattern for identification purposes, our current ability to accurately identify female locales based on said traits is, at best, an educated guess.

A number of morphological variations have been observed among populations, some of which are generic in nature and can be attributed to a number of locales. These traits include mesomorphic versus endomorphic body form variations in males from differing geographic regions or more rounded versus more pointed caudal edge of the parietal crest in males from varying populations.<sup>5,6</sup> Other traits which are more population specific and can aid in identification of locales (mainly of males), where animals may be sub-adult and/or not yet displaying true colours, are listed (See Table 2 and Figure 2).

### Size

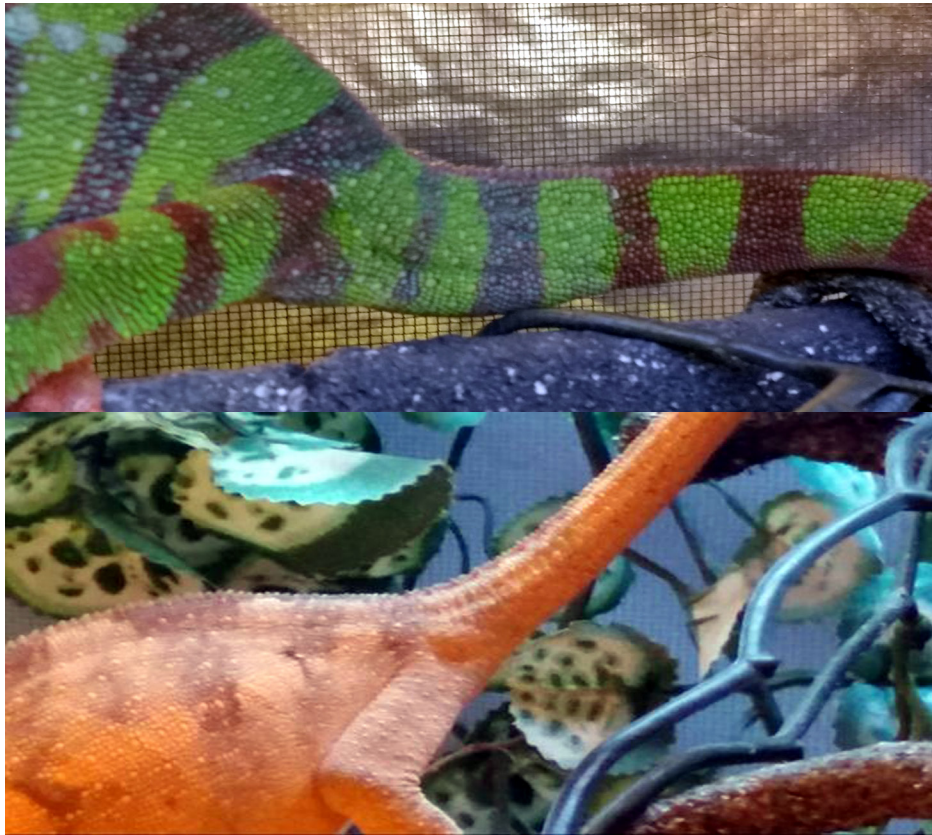
*F. pardalis* neonates are approximately 2cm in size (from snout to vent), while adults can reach 6-11 inches (snout to vent) or an overall size of to approximately 12-22 inches, with an average of around 18 inches (inclusive of tail). However, full grown adult males are considerably larger than females at approximately twice the size, in virtually every incidence. As such, females range through the lower end and males the upper end of the aforementioned size scale.

### Sexing

As mentioned, *F. pardalis* are highly sexually dimorphic with males showing brighter, more vibrant colours than their female counterparts, especially during mating season. As such, sexing animals is usually quite simple, by just looking at their colouration. However, juveniles can be difficult to sex, as they have yet to develop a number of morphological traits such as true colouration and a hemipenal bulge (or lack thereof) used in the identification of sexes. For definitive sexing, animals must be sub adult, approximately 6-8 months of age. It is at this stage they will begin to show true colours and males will develop a hemipenal bulge on the underside at the base of the tail, which is also quite distinct (Figure 3). Females are much less vibrant in appearance, usually a pink colouration with darker lateral markings. They tend to maintain a similar colouration (pink/orange/peach) to that of neonatal panther chameleons. Female tails are much thinner at the base than those of males, due to the absence of a hemipenal bulge.<sup>5</sup> This gives the tail a thin appearance overall and as such, is readily identifiable to an educated observer.

### Life span

The life span of *F. pardalis* generally ranges from 2-7 years although older specimens have been observed in captivity. Males of the species generally have a greater life span than that of females.<sup>7</sup> In the wild, very few panther chameleons will reach full maturity. This is due either to sickness/disease, or by being predated upon by other wildlife. As such, only approximately 5% of each clutch of hatchlings will ever make it to full adulthood. However, these figures rise rapidly in captivity when given proper care and maintenance, with approximately 90-100% of hatchlings surviving and reaching full adulthood.



**Figure 3:** *F. pardalis* hemipenial bulge present on male tail, just below the vent opening (top) versus that of a female tail lacking the aforementioned bulge (bottom).



**Figure 4:** Image of two male panther chameleons “fired up” after introduction to one another (Tamatave locale on left, Ambilobe locale on right). Note the gular extensions and lateral flattening of the bodies, in order to appear bigger and more dominant than in actual reality

The shorter lifespan of females is due both to the physical stress of mating and the stress of egg production/egg laying and calcium requirements necessary for aforementioned, usually taking a physiological toll over a number of mating's and gestation periods (clutches of eggs produced). Whether the correlation between size and lifespan of *pardalis* is relative, or whether the shorter female lifespan is due mainly to production of multiple clutches and the resulting physiological strain, remains to be fully determined.

### Social structure

As with most chameleon species, *F. pardalis* are almost exclusively solitary animals, regardless of sex or age. Males are more territorial and aggressive towards intruders than their female counterparts, however in reality neither like to be in social surroundings, with exception to the courtship/mating process, at which point chameleons may co-habitat in pairs for short periods of time. Males have larger home ranges than females and thus, are more active than their counterparts, who are more sedentary by nature.<sup>8</sup> In captivity it is sometimes possible to house a single male

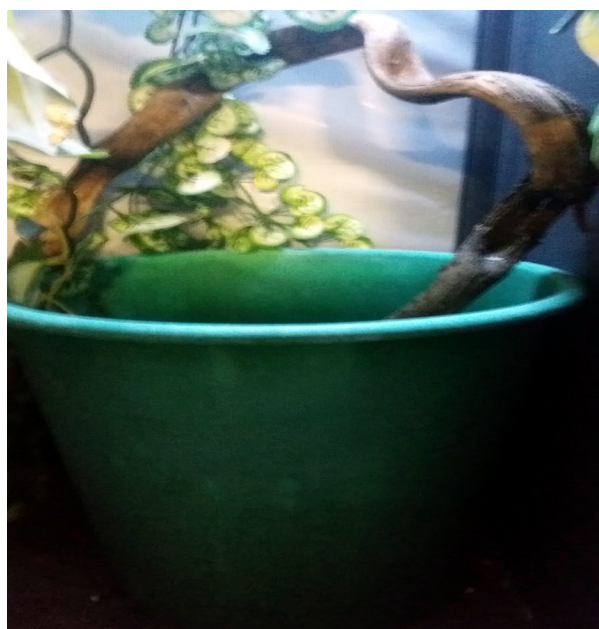
and one or two females together, in peaceful co-existence, providing the enclosure is large enough (quite large) and has many visual barriers present. However, housing *F. pardalis* together is not recommended and can result in the risk of serious injuries sustained through fighting. At a juvenile stage, males and females can cohabitate an enclosure, usually without any problems. However, as mentioned previously from the sub-adult stage onwards, chameleons cannot be housed together. This is especially true of males, who will show immediate aggression when introduced to another male (Figure 4)

## Mating

When breeding panther chameleons in captivity, various setups appear to be successful. Having environmental control in captivity allows con-



**Figure 5:** Image of male and female panther chameleons (*Ambilobe locales*) during the mating process. Note the females receptive (light pink) colouration and showing no signs of aggressive/non-receptive behaviour at this time.



**Figure 6:** Image of egg laying bucket. Bucket filled with moist soil to allow gravid females to burrow and create an egg laying chamber. Note the branch placed in container to allow for easy entry and exit for the chameleon.

trol of seasonal variations, meaning chameleons can be bred off season (when compared with wild animals). Captive panther chameleons can also be stimulated into breeding, via the reproduction of seasonal changes in climatic conditions, such as the rainy season, when temperatures drop and rainfall dramatically increases.

Adults are generally maintained in isolation, with one individual periodically introduced to the other. In the authors experience, it is better to introduce a male to a female's enclosure, as males can be quite territorial and aggressive when in their own enclosure (range), even during the mating season. However, males generally seem more passive when introduced to the females range (enclosure)

During the mating season females will become receptive to males, allowing them move closer without showing any signs of aggression.<sup>9</sup> This is the only time female panther chameleons will become somewhat acceptant of males encroaching within their range (Figure 5).

## Nesting

When nearing readiness to nest, gravid females will become noticeably active and descend to the ground. This is for the purpose of finding a suitable nesting site. Once a suitable site has been located, the female will begin excavation of a burrow, in order to lay her clutch of eggs. The females use their snout and forefeet to break the soil, with the hind feet used to remove said soil. Depending on site location and the substrate hardness, the nest construction can take from a couple of hours, to several days.<sup>10</sup> If construction is taking multiple days due to difficulty, females may abandon the burrow in favour of a new site.

Once the burrow is at least 6 inches deep and the female is happy with the burrow, she will then position herself in a round chamber at the end of the burrow and proceed to lay her eggs. In captivity, egg laying substrate is usually softer and easier for females to dig and construct a nest. As such, captive females tend to burrow to the bottom of the container and construct the nesting chamber against a hard surface such as the bottom or sides of the container (Figure 6). Females generally deposit their eggs within 1-2 hours.<sup>11</sup> After leaving the burrow, she will then carefully backfill the entrance to the hole, making visual location of the site quite challenging.

## Captive husbandry

### Selecting a chameleon

It is crucial before selecting a chameleon, that the natural climate/habitat to which they are found in the wild, be reproduced as accurately as possible in captivity. It is important to recognise the costs which can be associated with keeping a species from a cooler, more humid environment in extremely hot environments such as a desert region, or vice versa.

Most chameleon species are somewhat adaptable to their environment, with species such as *F. pardalis* excelling in this area. As such, panther chameleons have managed to adapt very successfully to the ever changing habitat found in their natural range. Due to constant deforestation for the purposes of lumber and charcoal production, many *F. pardalis* populations have managed to adjust to a point where they are living quite comfortably in close proximity to villages, in less than ideal conditions.

Due to the aforementioned adaptive qualities shown by panther chameleons, they have the ability to tolerate conditions in captivity which may not be an exact match to those found in their natural range. However, the aim when keeping any chameleon species in captivity, should always be to provide an enclosure which is as accurate as possible in mimicking conditions found in the natural range of a given species.

When choosing a panther chameleon, it is always advisable to choose a captive-bred animal where possible, as wild caught chameleons can harbour large numbers of endo-parasites, which can wreak havoc on the



**Figure 7:** Example of enclosure used to house smaller female chameleons. Enclosure dimensions are approximately 18" x 18" x 36" which is a standard size used to house both sub-adult males and female chameleons

animal in captivity. In the wild, most chameleons live with large numbers of endo-parasites in a very fine balance, however when introduced to captivity, the stress of the ordeal in conjunction with parasite loads, can lead to the animals quickly becoming debilitated and as such, the greatest cause of mortality in captive chameleons which are given adequate care is parasitic infestation or diseases which are introduced from the wild.

One should always look for any signs of dehydration or stress, with both being the major killers of chameleons in captivity. Animals who appear lethargic, have sunken eye turrets or closed eyes should be avoided. Any chameleons with visible deformities or swellings, especially in the legs, should be avoided. This also holds true for animals with well-defined vertebrae noticeable along the back or where the ribs can be seen quite clearly. In cases where the area surrounding the vent is soiled, this may be indicative of a serious gastrointestinal (GI) disorder.<sup>12</sup> Wherever possible, a chameleon should be observed while feeding to establish any tongue launching abnormalities which may be present and could indicate other underlying medical conditions such as calcium or vitamin deficiencies.

Females which are gravid should also be avoided, especially if wild caught in origin, as they will often die due to the stress caused by shipping, handling and lack of necessary calcium levels in the diet during the shipping process. When obtaining recent wild caught imports, the time of year can also be of significance in the animal's overall state of wellbeing. In Madagascar, the mating season runs during the months October through March (Spring and Summer). It is at this time that mature *pardalis* are actively breeding and as a consequence of this, animals are undergoing serious territorial conflicts and in doing so, are accumulating high levels of parasites. After December the condition of adult

specimens deteriorates and as such, only large juveniles or sub adult/small adult specimens should be obtained after the month of March. Of course, many of the aforementioned problems can be avoided by obtaining captive bred animals from a reputable breeder and in general this is the advisable method in obtaining *F. pardalis*.

## Housing

When housing a panther chameleon, one must recognise the slightly differing needs of females and males. As mentioned previously, panther chameleons have the ability to adapt to a wide range of habitats/ enclosure designs. Captive bred panther chameleons will adapt to smaller enclosures than their wild caught counterparts, with such animals doing just fine in enclosures ranging in size from 12" x 12" x 18" to 2' x 2' x 4'. However smaller enclosures are only recommended when keeping large numbers of chameleons in a relatively small area or where working with juveniles and sub adults (Figure 7). Where possible, larger enclosures are always preferable to panther chameleons, especially males, whom tend to patrol their territory regularly.<sup>10</sup> It should be noted that certain locales, particularly the blue colour morphs, are not only more active in nature but also more highly strung/stressed than other colour morphs and as such, can sometimes be found sitting on the floor of their enclosure or scraping at the enclosures sides. When adequate materials are used for the enclosure, this is usually not a problem. However, wire enclosures can cause serious damage to the animal, usually from rostral abrasions or damage to the feet, caused by the chameleon rubbing against the wire of the enclosure for extended periods of time. As such, any wire used for chameleon enclosures, especially on the floor, should where possible, be plastic coated to minimise the risk of such problems occurring.<sup>13</sup>



**Figure 8:** Images showing examples of lighting used above chameleon enclosure. Note the UV tube at the rear and a UV basking spotlight at the front. This is in order to provide good even light across the top of the enclosure, while also providing a temperature gradient for the chameleon.

Unlike many other chameleon species, *F. pardalis* do not appear to require dense vegetation for security.<sup>14</sup> In most cases, panther chameleons don't seem to hide or show camouflage behaviours associated with other species when approached, with most specimens adapting quite readily to gentle handling on a semi-regular basis. No chameleon species should be over handled, as this will only result in stress to the animal, possibly leading to other health problems.

### Lighting

*F. pardalis* are relatively tolerant of less than perfect light conditions when compared with many other reptiles, however they do need adequate levels of UVB to allow for proper conversion of available vitamins, especially pro-vitamin D3. They also need an area to shade when they feel it necessary and as such, having a UV gradient throughout the enclosure is advisable. This can be achieved relatively easily through addition of plants/ shrubs/ small trees to the enclosure, giving the animal a number of areas to shade.

One particular study showed females who were reared and mated under varying UVB levels and exposure times produced clutches of eggs with varying hatching success rates. The evidence indicated that females exposed to mid-level long/low exposures of 5-15 $\mu$ W/cm<sup>2</sup> UVB irradiation, produced viable eggs which had a significantly higher percentage hatching success rate when compared to those females who were exposed to UV extremes (highest/lowest long/low exposures).<sup>15</sup>

As well as the benefits gained in the species ability of processing and converting pro-vitamin D3, improved lighting also improves the visual aspect of the animal, through showing off their bright and vivid colours. In the authors opinion better lighting also leads to both a physiological and behavioural enhancement of the animal in captivity.

Various reptile specific UV tubes are now available from a number of manufacturers, all of which have clearly defined levels of UVA and UVB, with some more intense than others. Tubes which are advised for successful husbandry of panther chameleons in captivity are medium intensity, such as UVB 2.0. However, UVB 5.0 tubes can also be used if chameleon is housed in a larger enclosure and has adequate areas to shade when necessary (Figure 8).

### Heating

*F. pardalis* have the ability to tolerate a considerable temperature range, with values ranging from 9°C - 38°C however, these temperatures are extremes and the species should never be kept at either extreme. Generally, panther chameleons are happy at temperatures which range from

18°C - 32°C, dropping to the lower end at night. As a rule of thumb, panther chameleon enclosures ranging from 22°C - 30°C will sufficiently meet the requirements of *F. pardalis*.

Panther chameleons need to thermo-regulate their body temperatures and as such, in the wild they warm themselves by basking in the morning sunshine. They will also darken their colouration, in order to retain as much heat as possible until their desired internal temperature has been reached.

However, in captivity chameleons do not have the ability to bask in this fashion. If temperatures in the animal's enclosure are below desired levels, they must be given an artificial heat source allowing them bask and thus, thermo-regulate (Figure 9). If ambient daytime temperatures in the enclosure are below 25°C, a basking spot lamp should be included for this purpose.

As with UV tubes, there are also many types of spot lamps on the market specifically tailored towards reptiles. Some of the better bulbs are UVB-emitting non fluorescent in nature, allowing for a more natural exposure to heat and UV, with both emitted from the same source. However, these bulbs must be placed so that the chameleon is unable to get close enough to overheat or burn. UV spot bulbs are more expensive than the standard incandescent bulbs and while it is advisable to use them where possible, it is not crucial for the animals wellbeing.

### Humidity

Humidity levels are of crucial importance in keeping many chameleon species, especially those from montane regions. However, *F. pardalis* do not seem to mind lower levels of relative humidity. Although humidity in the natural habitats of panther chameleons can sometimes reach 70% during the day, the species seems to be sufficiently happy in lower relative humidity (RH) levels in captivity.

Although some chameleon keepers believe lower RH of 40% or less can be the cause of shedding problems, this has never been a problem for the author. However, excess humidity can be the cause of problems if not properly monitored, with a wet enclosure, especially the enclosure floor or on the chameleons perching branches, leading to possible infections.<sup>16</sup>

Although seasonal variations occur in the natural habitat of *F. pardalis*, ranging from warmer, wetter summers to cooler drier winters, panther chameleons in captivity do very well with moderate levels of humidity and minimal fluctuations in said RH throughout the year. In the authors experience, providing sufficient drinking water is available, relative humidity (RH) levels of 45%- 60%, have proven more than adequate in keeping happy, healthy, productive *F. pardalis*.



**Figure 9:** Image of infrared heat lamp. IR bulbs can be used to increase the heat in the enclosure if temperatures are below necessary levels. IR spot bulbs are especially useful for maintaining adequate temperatures during the colder winter months or if the enclosure is located in a cooler part of the home.



**Figure 10:** Image of misting nozzle used for increasing humidity and to provide drinking water. Note the misting nozzle placed top and center of the enclosure in order to provide adequate coverage during misting.

The normal method of increasing humidity is via misting of the enclosure interior on a regular basis, however this method is not only quite labour intensive when working with larger numbers of chameleons and enclosures but also lacks sufficient accuracy when trying to maintain a specific relative humidity (RH).

For more accurate control of humidity levels, misting systems and humidifiers can be used in conjunction with a humidistat. Once the relative humidity drops below a certain level, the stat will switch on the misting system or humidifier in order to increase the humidity and thus attain the required RH levels (Figure 10).

### Water and Hydration

Many species of chameleon will only drink moving water or pendent droplets hanging from leaves and foliage and meeting these needs constantly, can be most challenging. Fortunately, panther chameleons are quite happy to drink water from most surfaces when compared with other chameleon species. The most important factor is the stimulation of the animal to begin the drinking process. This may take some minutes of misting the enclosure for the animal to see moving water droplets running down leaves and the sides of the enclosure, before beginning to drink.

Whenever possible, water should be filtered via reverse osmosis or similar filtration system in order to remove any possible contaminants or water additives such as fluoride. Supplementation such as vitamins or calcium can be added to filtered water as required, allowing for total control over drinking water constituents. Water should be provided on

a regular basis, with a minimum of two good misting's of the enclosure per day for at least 5 minutes on each occasion.<sup>17</sup> A constant supply of water via a drip system is very beneficial and also allows for less misting of enclosures where time constraints may be present.

There are a number of methods which can be used to provide drinking water. These include the simplest of methods, such as a plastic cup or bottle filled with water, all the way to professional misting systems that allow the control of water droplet size. With basic systems such as a plastic cup or bottle, a very small hole is pierced in the bottom using a pin. The cup/bottle is then filled with water and placed on top of the enclosure in a position which allows water to drip from the vessel on a regular basis and collect on leaves within the enclosure.

Other common ways of watering chameleon enclosures include misting using a standard spray bottle. This is a good method for giving the whole enclosure, both plants and chameleons, a descent watering. However, this watering procedure must be undertaken multiple times per day for approximately 5 minutes per misting session. This method can be very time consuming when working with larger numbers of chameleons and as such, is best used as a supplementary method of watering in conjunction with a professional misting system. Various misting systems are available in different sizes with "x" number of misting nozzles, depending on how many enclosures need watering. These systems are also user friendly, allowing for additions or subtractions of misting nozzles, depending on the needs of the keeper.



## Diet

Over the years, the availability of insect species has increased dramatically. There are literally hundreds of species which can be used as feeders for chameleons. The insects being used can depend on a number of variables, such as the species or size of chameleon being kept. It may also depend on how certain feeder insects are viewed by national authorities such as the relevant department of agriculture, due to many insect species being viewed as pests or potential invasive species. Feeder insects, which are readily available in most countries and are commonly used in captive panther husbandry include crickets, locusts, mealworms, giant mealworms, waxworms, fruit flies and maggots. However other insects are sometimes used if and when available. These include silkworms, tomato hornworms, snails, moths and spiders.

Gut loading of feeder insects in addition to dusting with vitamin/calcium supplementation, is critical to maintaining a healthy chameleon.<sup>18</sup> Common feeder insects such as crickets and locusts need regular feeding (gut loading) in order to pass on nutritional benefits to the chameleon, as non-gut loaded insects are basically a shell with next to no nutrition available to pass onto the chameleon. Common foodstuffs used for gut loading insects include most greens such as garden grass, dandelions (leaves and flowers), broccoli, cabbage and kale. Other beneficial foodstuffs which crickets enjoy include fish flakes, which are high in protein and also have sufficient levels of fat and fibre present. Feeding crickets using both fish flakes and greens for moisture, is ideal as their staple diet.

Although there is considerable knowledge in various elements of nutrition in chameleon species, this area still remains one of the greater weaknesses in our overall understanding of chameleon needs. A high number of failures in captive management of chameleons is due to nutritional imbalances in the animals.<sup>19</sup> Dusting the feeder insects with a specialized reptile vitamin and calcium powder every feeding for juvenile to sub-adults and every other feeding for adults prior to feeding to the chameleon has proven very successful for the author.

It is very important to vary the food items offered to help maintain a correct nutritional balance but it also aids in stimulating the chameleons natural interest. Offering various insects can be especially useful when trying to elicit a feeding response in a depressed individual or one going through a period of convalescence. However, the only way to guarantee the avoidance of nutritional problems is to keep the animals outdoors where natural and adequate levels of UVB radiation is present and to feed the animal a very wide variety of wild insect species.

## Common problems encountered in captivity

### Housing

Common problems encountered in captivity include improper housing, insufficient lighting or insufficient water/humidity levels. As mentioned in 'housing' section, panther chameleons need a reasonably sized enclosure with good airflow (see above for details). However, placing of enclosure near cold draughts or anywhere where extreme temperature fluctuations occur should be avoided.

### Water

Having the correct humidity aids in keeping a healthy chameleon. However, having improper humidity is not as critical as inadequate or insufficient availability of drinking water. Dehydration is a major problem for chameleons and can quickly lead to kidney failure followed by death. Making sure captive chameleons have adequate access to drinking water will result in a well hydrated, more active animal. See above section on watering needs for further details.

## Lighting

Providing the right type of lighting for a chameleon is crucially important. There are many lights on the market specifically designed for reptiles however, many of these lights barely provide the necessary intensity for maintaining a healthy chameleon. Many of the better lights currently on the market, only provide usable light to a distance of approximately 12 inches from the source. As such the intensity of the lighting can be quite deceptive to the human eye. To compound lighting problems, all specialized UV lights usually have a lifetime of 6-8 months before they lose intensity to a point whereby they are of no benefit to use. As such, UV tubes/bulbs must be replaced regularly in order to maintain reasonable light intensity which the chameleon can make use of.

## Health

### Stress

Stress is a major problem for chameleons and too much stress can ultimately lead to death. Panther chameleons tend to be less highly strung than other species of chameleons. However, some individuals may stress much easier than others and must be treated/handled accordingly.

### Calcium and Vitamin D deficiency

Juveniles and reproducing females require higher levels of calcium and vitamin D3 than adult males. Metabolic bone disease (MBD) is due to insufficient vitamin D3, which is usually as a result of the animal not receiving enough UV rays of the correct intensity, in turn preventing the chameleon from producing the requisite concentrations of D3. It leads to deformities of the bones as well as skin defects. It can be treated semi successfully if diagnosed early, however MBD is best treated through prevention.<sup>9,20</sup>

Egg-binding in females can happen as a result of many variables, such as lack of proper nesting site, dehydration, stress, hormonal conditions, disease conditions and malformed eggs to name a few. However, in captivity egg binding is generally a result of insufficient levels of calcium in the diet (Hypocalcemia), especially during the egg producing phase.

However, too much calcium and vitamin D can lead to soft tissue mineralization, which can ultimately prove fatal. It should also be noted that synthetic vitamin D3 is highly toxic to chameleons when overdosed. Therefore, great care should be taken when using vitamin D3 supplementation. As mentioned, panther chameleons also produce endogenous vitamin D in response to UVB exposure, hence the importance of adequate light exposure for the animal to bask in when it feels necessary. As such, careful monitoring of supplemented calcium/vitamin D3 concentrations in conjunction with regular exposure to UVB is recommended for healthy panther chameleons.

### Hypovitaminosis A and Hypervitaminosis A

Growing juveniles appear to require approximately 50-100 IU of vitamin A per gram of cricket food in order to avoid symptoms of hypovitaminosis A, such as spinal and tail kinking, loss of muscular coordination, eye closure, skin lesions and abnormal flexing.<sup>9</sup> Standard dusting of insects prior to every feeding, is usually adequate to meet the needs of growing chameleons.

Hypervitaminosis or Vitamin A overdoses include symptoms such as kidney failure, gular fluid retention, sterility, failure to ovulate in adult females. However, hypervitaminosis is lethal to chameleons when compared with hypovitaminosis and an overdose of vitamin A can kill a chameleon in very short time. As such great care should be taken when treating a chameleon for vitamin A deficiency.



**Figure 11:** Image of Fungal skin infection on the flank of a female panther chameleon. Note the white spot top center of the image. The spot is retained skin from previous sheds, caused by the infection

### Parasites and Protozoa

Endo-parasites or worms are a common problem in wild caught chameleons but are becoming less of a problem in species such as *F. pardalis*, which are now being bred in larger numbers in captivity. Many of these parasites are very difficult to treat and some species are resistant to many of the common treatments available and either require special treatment, surgical intervention or in some cases cannot be treated at all.<sup>21</sup>

Historically, the standard drug of choice for deworming chameleons has been Fenbendazole, which is commonly used to treat horses and other cattle. It will eradicate most roundworms, such as nematodes and ascarids, however it is not effective in treating flatworms/tapeworms or blood born filarial species. For treatment of flatworms/tapeworms the recommended vermifuge is Praziquantel.

Blood born micro-filarial species are resistant to most treatments, with the only known vermifuge to be of use in their eradication being Ivermectin. However, Ivermectin is extremely dangerous and even the smallest of overdoses can result in the death of the animal. As such treatment should only be carried out by persons experienced in its usage.

Protozoans are another important group of flagellates which are again common in wild caught chameleons. In the wild, chameleons will usually live quite happily, yet in a fine balance, with a large number of protozoans. However, the stress induced by captivity in conjunction with large protozoal loads, can wreak havoc on a chameleon.<sup>22</sup> As such, prophylactic treatment of newly acquired wild caught animals is advised.

The common treatment used is the potent antibiotic, Metronidazole. Due to its strength, care must be taken when dosing, as an overdose can cause the animal serious gastric distress, whilst also wiping out all of the beneficial bacteria, including bacteria the chameleon needs for food digestion.

### Respiratory infections

Upper respiratory infection (URI) is one of the most serious problems which is encountered in captive chameleons, with panther chameleons being no different. Upper respiratory infection can occur in chameleons as a result of many factors such as bacteria, cold drafts, mould or fungus in enclosure but is usually due to improper conditions in the enclosure, such as incorrect temperature and/or humidity. What is clear is that untreated respiratory infections are certain killers to chameleons, if not treated in time.<sup>23</sup>

Symptoms of respiratory infection can come in many forms. Some of these include wheezing or popping from the lungs as the animal breathes. Other obvious symptoms include stringy mucus at the gum line, or bub-

bles in the mouth when breathing. The more advanced symptoms associated with respiratory infections in chameleons include drooling long stringy, clear drool from mouth and/or breathing with mouth gaping open. However, the drooling symptom is similar to that sometimes seen in a dehydrated chameleon. As such, care should be taken when using this method for making a diagnosis of respiratory infection. It should only be used to diagnose in conjunction with other known RI symptoms. It is also of importance that the chameleons history of hydration is taken into account when using this in RI diagnoses.

The treatment of RI's requires a course of antibiotics, with the most common of these used in chameleons being Enrofloxacin. Enrofloxacin is a broad spectrum antibacterial agent which is effective in treating a wide range of gram positive and gram negative bacteria. As treatment of RI's requires a course of aggressive antibiotics, early detection is of importance. The course of treatment may run for up to one month with chameleons depending on the speed of diagnosis and the severity of the condition.

### Eye infections

Eye infections can sometimes occur in chameleons in captivity and due to their anatomical make-up and methods of hunting prey, any infection of the eye can have serious implications in the animals health. Symptoms of an eye infection will often begin with the fusing shut of the affected eye, sometimes with visible matter<sup>(24)</sup>.

The first step in the treatment of an eye infection is washing the eye with tepid water, allowing for the removal of any encrusted matter in and around the eye. As a rain shower is the natural way chameleons clean their eyes in the wild, washing with water will aid in the animals ability to open the affected eye and also help wash away any debris which may be trapped in or around the eye.

The second step in the treatment of any eye infection in the chameleon is the topical treatment of the eye with an ointment. Eye treatments such as Teramycin are commonly used and can be applied to the eye after first washing out using a cotton swab dipped in sterile solution. Gentcin non-steroidal ointment has also proven successful in treating certain eye conditions.

### Fungal infections

Fungal infections in chameleons usually occur on the skin along the flanks of the chameleon and are as a result of improper conditions such as humidity levels which are too high, in combination with poor ventilation. If left untreated fungal skin infections can seriously impact the chameleons health through physiological stress<sup>(24)</sup>.

Symptoms of fungal infections include raised white or powdery spots on the animal (Figure 11). However, infection may also be characterized by a loss of appetite for extended periods by the chameleon, while it remains drinking water.

Povidone Iodine or Chlorhexidine Diacetate can be used to wash the infected area before the topical application of an anti-fungal ointment, such as one from the Azoles class of drugs. Treatment may be required for a period of 5-10 days in order to affect a cure.

### Mouth rot

Mouthrot or infectious stomatitis, is a condition which can occur in chameleons as a result of trauma to the lips or gums causing them to become directly infected by bacteria or may be as a result of a systemic bacterial infection.

Symptoms of this condition include swelling and discolouration of the infected area. This may sometimes manifest itself in the animal showing sensitivity when the sore areas are touched. A chameleon may even stop feeding due to the pain caused during the food mastication process.<sup>25</sup>

It is crucial to treat any signs of mouthrot before it can spread, as some of the more potent bacterial strains can travel into the jaw bone and eventually erode it. Treatment of less serious mouthrot involves cleaning off any caseous matter from the infected area, followed by irrigation of the site using a syringe filled with either Povidone Iodine or Chlorhexidine Diacetate. In many cases the aforementioned will be adequate in clearing up any infection however, for more serious cases of mouthrot, a more potent injectable therapy such as Baytril will be necessary.

### Rostral abrasions

Rostral abrasions in chameleons are injuries to the rostral process of the animal and mainly occur due to a chameleon rubbing off a hard/rough surface, such as the mesh or glass of an enclosure. This is usually as a result of the animal being stressed in its environment, due to improper conditions such as temperature, humidity, too small of an enclosure or non-availability of food/water. Males will sometimes cause rostral abrasions to themselves if they can see a female nearby and are excited to get out to the female. This is usually an easily remedied situation when the aforementioned factors are considered and corrected as necessary.

### Damage to Feet and Nails

When damage occurs to feet or nails, this is usually due to impact injuries resulting from a single or multiple falls, although may also be caused by the animal getting a foot trapped in something within its enclosure. More serious feet and nail problems are usually related to vitamin or calcium deficiencies and if not too severe, can usually be rectified by making the relevant changes to the chameleon's dietary intake, by altering the levels of vitamin or calcium supplementation received.

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none

### CONFLICT OF INTEREST

No Conflict of Interest to declare

### CONCLUSION

The panther chameleons are a beautiful species of chameleon, whose diverse morphological traits and colouration make them one of the most spectacular chameleons currently available in the captive trade.

However, it is not only their fantastic colours and availability that make them a good chameleon to keep in captivity. Other traits which make them ideal for captive management include their size (not too big and

not too small), their general hardiness (when compared with many other chameleon species), their adaptability to hand feeding and watering and of course, their great individual personalities.

As the requirements of *F. pardalis* are quite broad, they are a relatively forgiving species when conditions are less than optimal. However, it should be mentioned that their hardiness does not guarantee success, even when following all husbandry guidelines carefully. Even with the very best of care, some individuals will not thrive or breed successfully in captivity.

Maintaining a larger number of chameleons will increase the likelihood of successful breeding. Unfortunately, the more chameleons that must be cared for, the more likely it is that a potential illness or malady could be missed, due to the increased difficulty in providing the necessary vigilance to each individual. It should also be noted that even hardy chameleon species such as *F. pardalis* require greater focus, effort and general experience with regards their maintenance, when compared to snakes, geckos and other hardy reptile species.

However, even with the multiple challenges encountered in the maintenance and general husbandry of chameleons, the aforementioned traits make *F. pardalis* an endearing and captivating species to work with, for everyone from the first time chameleon keeper, to the serious chameleon enthusiast.

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