The origins, distribution and captive breeding program of Australian Green Tree Pythons, *Morelia viridis*.

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The arrival of Green pythons from New Guinea.

To shed some light onto the historical events surrounding the arrival of Green pythons and indeed many other species of PNG fauna and flora, we have so step back few million years back.
About 45-38 million years ago, when Australia departed from Gondwana, the entire continent was covered in lush rainforest but as it started drifting northward towards the Asian plate, the continent became arid. Most of the rainforest was lost but because the continent was moving north, closer to the Equatorial zone, the climate stabilised the process and the rainforests in northeast survived. The presence of Gondwanan flora in the Daintree and other patches of extant rainforest provide supporting evidence of this. When Australia reached its present position, it was separated from New Guinea only by a shallow and narrow channel of water, as it is today. However, during glaciation periods the sea level dropped and a land bridge joined the two landmasses. This didn't happen once, but 19 times during the ice ages of the last two million years. The last passage (100 000 years ago) was cut 8000 years ago when the sea level has rose again.
The movement of fauna and flora over those land bridges wasn't just one-way traffic. Australia received Green pythons, Spiny bandicoots, Cuscus, *Melomys* and *Uromys* rats, many species of reptiles and a myriad of invertebrates, whilst many Gondwanan species, e.g. Tree kangaroos and Death adders as well as many plants spread into New Guinea. Green pythons probably mingled with their northern cousins during those many low sea level periods but this connection was lost again the last glacial cycle.

Determinants of current distribution.

Being obligate rainforest species, Green pythons found their way as far as the southern parts of McIlwraith Ranges through a continuous rainforest corridor that stretched all the way from New Guinea. This happened during the later part of Tertiary (Pliocene) and Quaternary when the rainforest ended at McIlwraith Ranges (Rawlings & Donnellan 2003). The areas near Princes Charlotte Bay and the Laura Basin were already dry and the rainforest dwelling species (not only GTPs) couldn't traverse this dry habitat. This explains why there are no Green pythons in the relatively large tracks of rainforests of the Wet Tropics.
There are several rainforest habitats apart from Iron and McIlwarith Ranges on the Cape York Peninsula that could provide suitable habitat for Green pythons but all of them are far too small to support a viable population. There is one exception – the Lockerbie

Scrub. This 10,000 hectares block of rainforest is big enough to sustain population of half a million Green pythons, based on population density at Iron Range.

So, why aren't Green pythons there? Simply because the Lockerbie Scrub as we know it today, wasn't there. It's a relatively new forest that emerged in recent times, after the vast majority of Cape York dried up. Of course the Green pythons must have passed through that area but as the rainforest dried up with the rest of Cape York, Green pythons went extinct except for the Iron and McIlwraith Ranges.
Lockerbie Scrub was thoroughly surveyed for Green pythons during the 2007-8 Wet Season and no specimens were found (D. Natusch pers. com 2010).

Habitat partitioning
Interestingly, Cape York and PNG rainforests that are home to Green pythons, *Morelia viridis,* are devoid of Carpet pythons *Morelia* sp. Anywhere north of the Wet Tropics, Carpet pythons are considered an open forest species. Yet, Carpet pythons are very common in the Wet Tropic and in most rainforest habitats south of the Wet Tropics. Some taxonomists split the Morelia group into many sub-species or even full species but the most recent studies based on genetics indicate that there are only three species: *Morelia spilota*, *M. bredli* and *M. imbricata* (yet unpublished data). The New Guinea carpet python *Morelia harrissoni*, that also occurs on Cape York has a dubious taxonomic status and is probably a habitat-specific morph of *M. imbricata*.

Although suggestions have been made that the habitat partitioning between the two species is a result of competition for food resource, the more plausible theory is that the two species have different habitat preferences. This hypothesis also supported by the absence of both species at Lockerbie Scrub.

The species' morphology – how do Australian GTPs differ from the rest?
Although the Green Tree Python *Morelia viridis*, is known as a single species, the populations north of the PNG Highlands are genetically distinct from those south of the highlands and Australia (Rawlings & Donnellan 2003). Using mtDNA, females from Australian populations can be distinguished from those in PNG populations but since the mtDNA is maternally inherited, such tests reveal nothing about the paternal side. Morphologically, the Australian GTPs are the smallest of all the races and relatively uniform in colour and pattern, which consists of lime green dorsal side and flanks dotted with white, yellow or creamy scales along the spine, sometimes with short crossbars. Specimens showing patches of blue colour are rare and yellow is absent in adults except for the ventral scales or a few scales on the flanks in some individuals. The neonates are always yellow, never red or orange like some of the PNG juveniles. The Australian GTPs are invariably docile, both in captivity and in the wild.

The Australian population and its ecology.
The first scientific study of *M. viridis* conducted by Dr. David Wilson at Iron Range revealed previously unknown details on population size and structure, habitat utilization, home ranges, ontogenic colour change and other aspects of the species' biology and ecology.

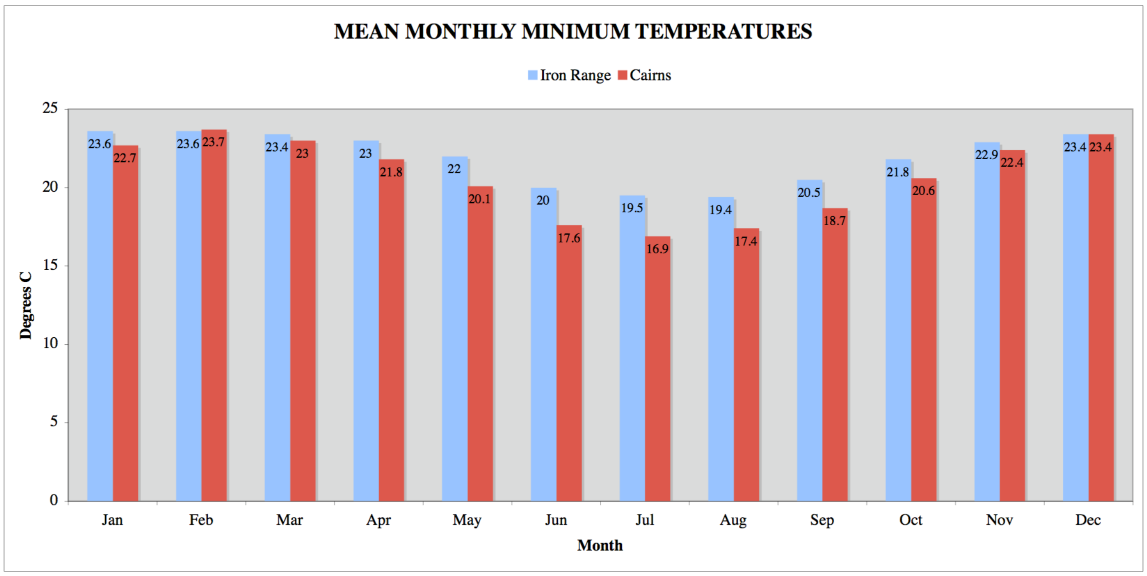
According to Wilson (2007) the population density at Iron Range is about 4-5 individuals per hectare. Considering the area of rainforest at that location, the GTP population should be about 1 million individuals. However, the sampling method used was limited to a single transect (the road sides), hence it would be difficult to extrapolate the entire population size with any accuracy.
207 individuals (55 recaptures) comprising 60 males and 104 females (where sex could be determined), half of the population being adults were the results of the mark-recapture study carried out over a period of 3 years.
Whilst adult and semi-adult females had established home ranges of 6.21 (+- 1.85) hectares with considerable overlap, males and yellow juveniles did not have set home ranges but were freely moving through female's home ranges. Movements of individuals varied between wet and dry seasons, peaking in the wettest period (Jan – Mar) with maximum distances covered in a single night of 182 m for a male and 180 m for a female (Wilson, D., Heinsohn, R, and S. Legge 2006).
Whilst nesting was never observed in the wild, what appeared as a clutch of neonates were observed on vegetation just above ground at the edge of an impenetrable thicket. This sighting suggests that the eggs were laid and incubated somewhere within the patch of thick vegetation, most probably on the ground (D. Natusch pers. com. 2010).

The adults descend to the ground or near ground level to hunt for rodents and marsupials where they take up ambush position on low branches, or higher above fallen logs traversed by rodents. There is evidence of Green pythons preying on birds and telemetry data indicate that the pythons spent considerable time in the canopy of flowering trees, presumably ambushing nectar-eating birds.
The yellow juveniles prefer open areas created by tree-falls or rainforest edges where they rest and hunt very close to the ground. They primarily feed on small lizards and frogs and sometimes during the ontogenic colour change they move into the rainforest interior and presumably switch their diet to rodents and birds.
In captive populations, males don't feed during the winter months and the same probably occurs in the wild.

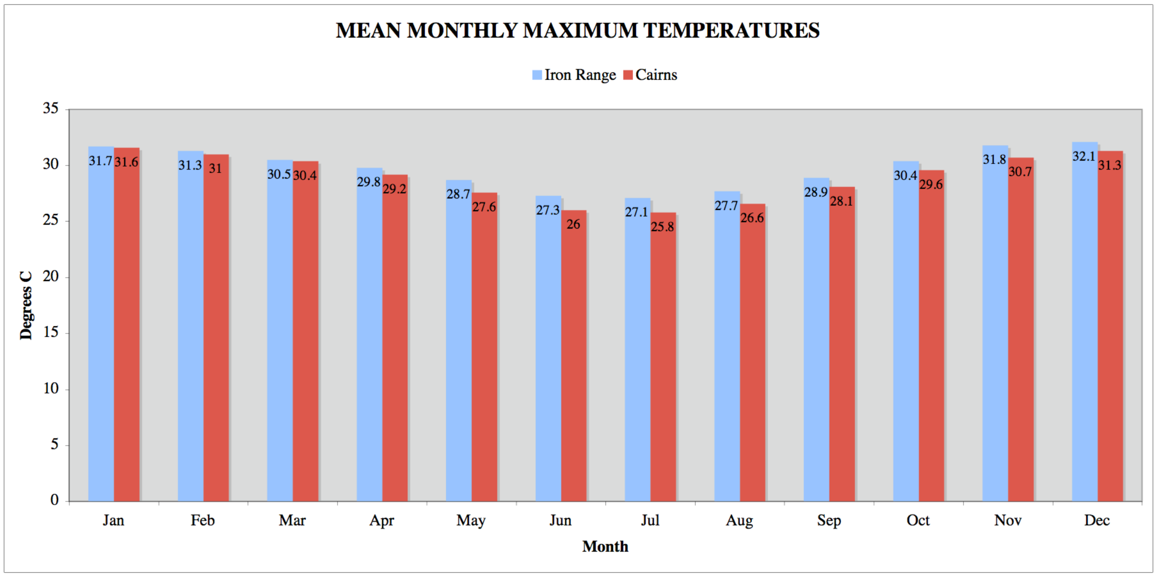
Conservation.
Previously, *Morelia viridis* was classified as a *Rare* species. However, recent re-classification by QPWS elevated the species' conservation status to *Near Threatened*, based on the assumption that the population comprises of less that 3000 adult individuals This assumption is certainly an error considering Wilson's data and also, the population size at McIlwraith Range is unknown at this stage. Combined, the total number of adults will most certainly exceed 3000.
The population is well protected. The entire distribution range is within the Iron and McIlwraith Range National Parks, where the rainforest is further protected by a buffer zone of sclerophyll forest, also within the National Parks. It is therefore unlikely for any natural or man-made event such as wild fire, land clearing, etc., will affect the core habitat. Poaching is not a volatile and controversial issue and there is no real evidence of poaching. Considering the handful of successful prosecution cases, poaching is negligible and insignificant in terms of conservation of the species. The activity pattern of Green

Tree Pythons is very seasonal, peaking in the summer months coinciding with monsoon activity, during which the access road to Cape York is closed to all traffic.
Whether the global warming phenomenon is going to have an adverse effect on GTPs is unknown, however, some concerns regarding the species' mating and recruitment may be real. At present time, the mating takes place at the onset of dry season, when the day and night temperatures fluctuate most. The hatching starts just before the storm season, (followed by the monsoonal rains), which provides a significant boost in food resource. It's reasonable to speculate that if this pattern shifts either way, complications may arise.

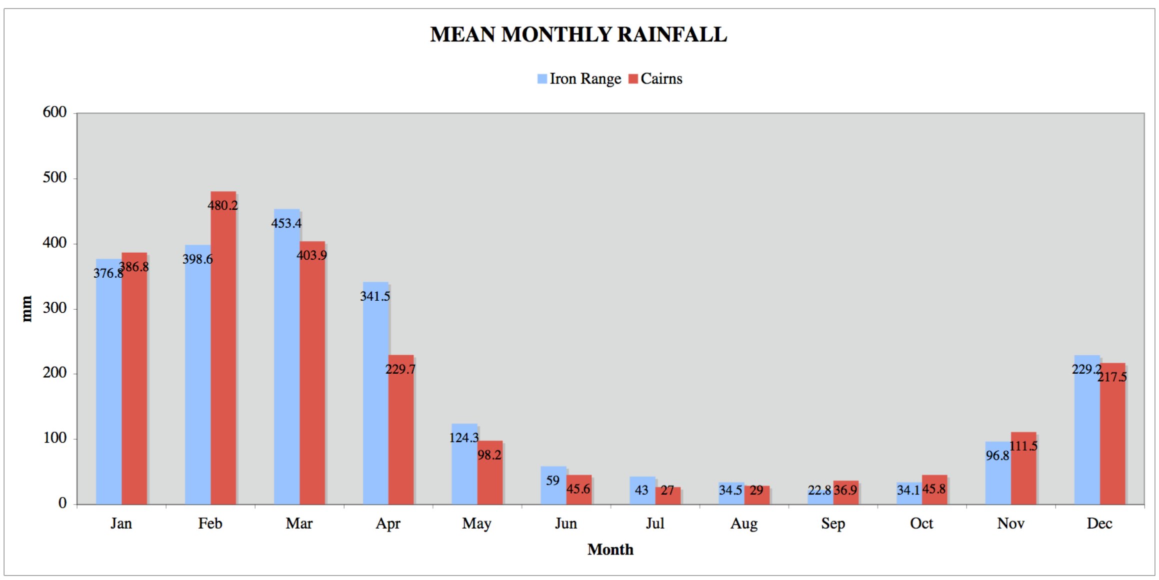
My husbandry techniques and the breeding program.
The climatic conditions in Cairns are almost identical to those prevailing at Iron Range, in terms of seasonality, temperatures and rainfall.



Graph 1. The similarities in mean monthly minimum temperatures in Cairns and Iron Range over the last 35 years (Australian Bureau of Meteorology).



Graph 2. The similarities in mean monthly maximum temperatures in Cairns and Iron Range over the last 35 years (Australian Bureau of Meteorology).



Graph 3. The similarities in long-term mean monthly rainfall in Cairns and Iron Range (Australian Bureau of Meteorology).

Therefore, Cairns is an ideal place for keeping and breeding *M. viridis* under very similar conditions to their natural environment. This opens the opportunity for making behavioural observations, which may not be done in the wild. The pythons in my care are kept in large, outdoor wire-mesh enclosures that are landscaped and surrounded by lush vegetation; hence the snakes are exposed to natural conditions all year round. This eliminates any need for controlling the temperatures, humidity, photoperiod, airflow, exposure to UV and the atmospheric pressure. Only during the driest parts of the winter months is the over-head sprinkler used to boost humidity and keep the vegetation healthy.

Reproduction
The mating season takes place between late April and the early July, depending mainly on the night temperatures but also on atmospheric pressure. Females lay eggs between late August and mid September (19.8. > 24.9.) and hatching occurs between late October and mid November (10.10. > 15.11.).

The following data pertain to eight clutches laid in 2008-9.

year	range	mean	variation
2008	18.5 - 25.5	12.3	7
2009	15.5 - 23.5	20.5	8

Table 1. The weights of freshly laid eggs (in grams, accuracy 0.5 grams).

year	range	mean	mode	variation
2008	10-16	13.1	13	6
2009	12-15	13.5	13	3

Table 2. The body weights of neonates in grams (in grams, accuracy 0.5 grams).

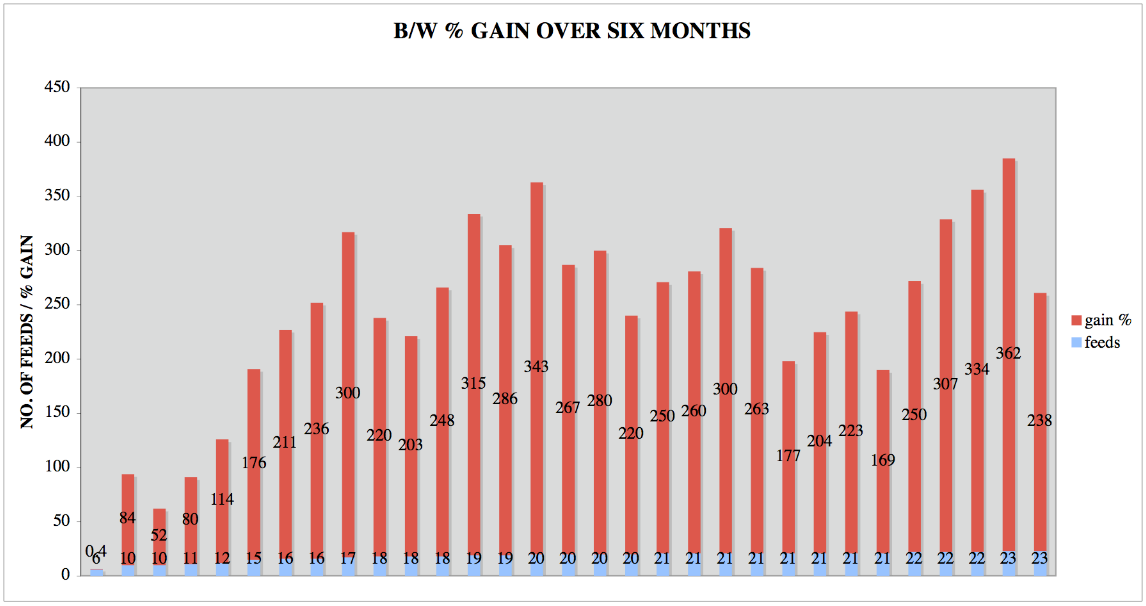
year	range	mean	mode	variation
2009	30-63	48.5	49	33

Table 3. The body weight of six month-old juveniles (in grams, accuracy 1.0 grams).

Feeding regime
All neonates were fed one meal per week, ranging from pink mice to weaners within the first 6 months of their lives.

feeds	gain (grams)	gain (%)
20	33.5	250

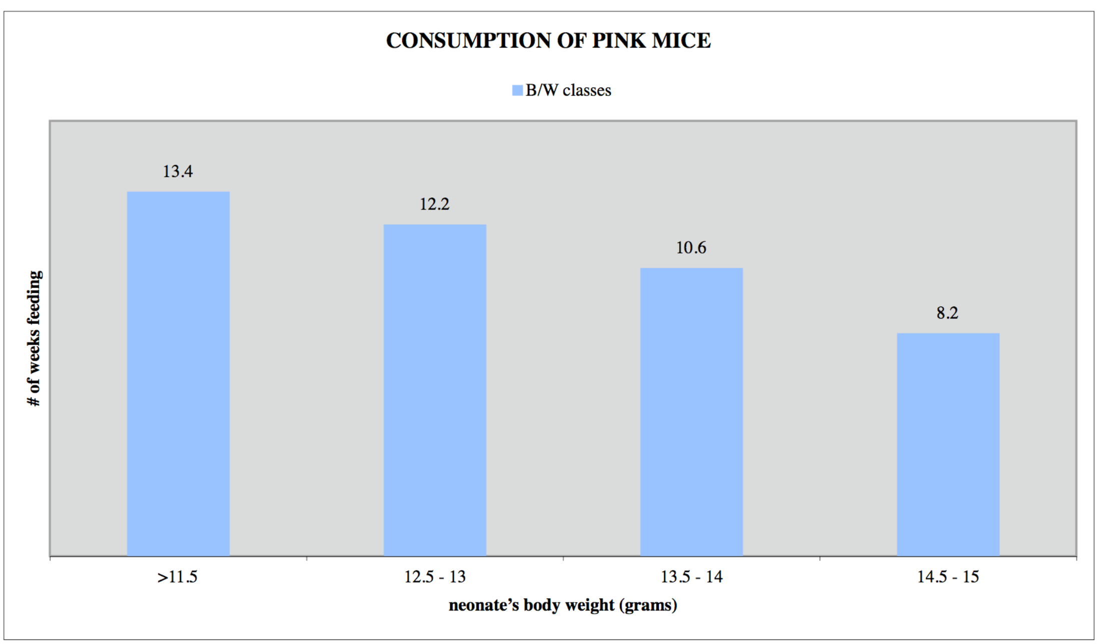
Table 4. *feeds* is the mean number of food items, *gain* in body weight in 6 months, *gain (%)* increased body weight over 6 months expressed in percentages.



Graph 4. The variation in body weight gain of six months-old juveniles in relation to their body weight at hatching.

Does size matter?

Pink mice are generally considered as "incomplete food" because they lack developed bones, roughage and solids in gut content. The sooner juvenile Green Pythons switch from pinkies to fuzzy mice and hoppers, the faster the growth rates in the first year of their life and also, less risk of rectal prolapse. It takes less time for bigger neonates to reach the stage of prey switching than smaller individuals. The difference between neonates weighing >11.5 grams (at hatching) and those over 14.5 grams, in terms of switching onto fuzzies is approximately 5 weeks, i.e. 5 feeds.



Graph 5. The number of feeds / time varies between the four body weight classes of juveniles before they are big enough to feed on fuzzy / hopper mice.

Ontogenic colour change

Data derived from 12 clutches between 2006 and 2009 indicate that timing and duration of the ontogenic colour change in Australian native GTPs is reasonably uniform, synchronized and fast completed. The onset of colour change is never before the age of 8.8 months and is always completed at the age of 11.3 months.

	beginning - weeks	**duration - days**
mean	38	8
range	35-45	3-31
mode	37	4

Table 5. The beginning of the OOC is defined by change from yellow to light green colour all over the body, not just the nose. The completion of the OOC is when the colour is solid, darked shade of green. Although the range for the OCC duration is 10 fold, the mean and mode values indicate skewness in the sample.

Wilson (2006) published that juvenile (Australian) Green Tree Pythons change colour when they reach body size between 53 and 59 cm and that the OCC is size mediated and corresponds to 1 year of age. He also suggested that the yellow juveniles live along rainforest edges and gaps, where they feed on skinks and invertebrates (an obvious error) during daytime. Upon OCC, they move into the rainforest interior where they commence feeding on birds and small mammals. This indicates two important events associated with OCC; prey switch and change of habitat. Although more evidence is needed to support this notion, it sounds plausible. However, I propose that both events are the consequence of colour change rather than the cause. The OCC is a morphological expression of physiological activity that may be triggered by developmental (e.g. hormonal) changes or environmental pressures.

The results of my experiment with 26 captive bred green python juveniles (2009 cohort) suggest that the size or the body weight is not a good predictor of the time OCC should occur. The statistical analysis did not show negative slope, indicating that larger individuals do not change colour earlier than smaller ones. Whether the age of the juveniles is the trigger for OCC is yet to be tested but the prediction is that it may not be the case either. If age is the determinant of OCC, we would expect the juveniles within each clutch change colour approximately at the same time. My data do not support this theory.

References:

Rawlings, L.H. and S.C. Donnellan 2002 Phylogeographic analysis of the green python, *Morelia viridis*, reveals cryptic diversity. *Molecular Phylogenetics and Evolution* 27, 36-44.

Wilson D. and R. Heinsohn 2007 Geographic range, population structure and conservation status of the green python (*Morelia viridis*), a popular snake in the captive pet trade. *Aust. J. of Zoology*, 55, 147-154.

Wilson, D., Heinsohn, R. & Andler, J.A. 2006 The adaptive significance of ontogenic colour change in a tropical python. *Biol. Lett*. Doi:10.1098/rsbl.2006.0574. Published online.

Wilson, D., Heinsohn, R. & Wood, J. 2006 Life-history traits and ontogenic colour change in the arboreal tropical python *Morelia viridis*. *J. Zool. (lond.),* Print ISSN 0952-8369.