A Description of the Successful Hatching of the Fijian Banded Iguana (*Brachylophus bulabula*) and Observations on Vermiculite Moisture

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The Fijian banded iguana (*Brachylophus bulabula* KEOGH, EDWARDS, FISHER, AND HARLOW, 2008) is endemic to the north western islands of Fiji, including Ovalau, Gau, Kadavu, and Viti Levu; the species has also been introduced to the island of Vanuatu (Keogh *et al*., 2008). Along with the other extant members of the *Brachylophus* genus, *B. bulabula* populations are under threat. Now restricted to just a few islands, numbers have declined by 50% in the past few decades (Fisher *et al*., 2012). This has contributed to its classification as 'endangered' by the IUCN and its listing under appendix 1 of the Convention on International Trade in Endangered Species (Fisher *et al*., 2012). The latter being the CITES category a species is assigned to facilitate providing it with the highest possible level of protection. Wild populations are at particular risk from a combination of habitat destruction and fragmentation leading to a loss in genetic diversity (Tershy *et al*., 2016).

Invasive species, most notably black rats (*Rattus rattus*) and domestic cats (*Felis catus*) predate on the iguanas and their eggs (Tershy *et al*., 2016). Furthermore feral goats (*Capra aegagrus*) both destroy habitat and as folivores/frugivores directly compete with *B. bulabula* for food (Tershy *et al*., 2016). Despite the significant decline of *B. bulabula* in the wild and the aforementioned causes being clear and understood there are no conservation measures in place to protect this species (Fisher *et al*., 2012). Whilst *in-situ* conservation is typically the most effective way to protect an organism, it is evident that not all species can be successfully preserved in their natural habitats (Witzenberger & Hochkirch, 2011). Therefore increasingly *ex-situ* conservation in the form of captive breeding is required to act as an insurance policy preserving a species until a reintroduction effort becomes feasible. Although it may not be ideal, *ex-situ* conservation may be the only realistic option to ensure that much of Fiji's endemic herpetofauna persist for the foreseeable future (Narayan *et al*., 2009).

Some lizard species, such as the green iguana (*Iguana iguana*) have been bred in captivity with great success for decades (Jacobson, 2003). This has culminated in a huge body of species specific literature in both books and peer-reviewed articles. From vitamin and mineral supplementation of diet to mating introduction methods, such information on *B. bulabula* is sparsely recorded. Required egg incubation temperatures and humidity levels being no exception. Anecdotal reports published online by both private herpetoculturists and zoo employees attempting to breed this species have stated problems with this fundamental aspect of captive reproduction. We describe our findings with regards to this topic here.

In June of 2013 an unrelated, two year old pair of captive bred *B. bulabula* were imported into

the UK from Austria. On arrival they were housed individually for a one month period of acclimatisation. The male was then introduced to the female's enclosure under close supervision in case either iguana became aggressive. The enclosure in question was a glass and wood, vertically oriented vivarium (122cm long, 61cm deep and 183cm tall). Panels of cork bark where attached to the back and sides of the enclosures interior increasing surface area for activity. Cork bark tubes of varying lengths and diameters were positioned within the vivarium providing the iguanas with basking and refuge sites. Plastic artificial foliage in the vivarium further increased surface area for activity and provided both animals with areas of cover to reduce stress. A 10cm deep layer of coarse orchid bark was used as the enclosure substrate to help maintain ambient humidity. Two 160W mercury vapour lights bulbs in reflectors provided heat and UVB. This combined light and heat source was controlled by a timer switch set to give the iguanas twelve hours of daylight all year round. This ensured one aspect of abiotic environmental consistency. The lights were positioned on top of mesh covered sections cut into the vivarium roof preventing the occupants coming into direct contact with them and getting burnt. Two digital thermometers were used to monitor ambient temperature both at the hottest and coolest areas within the enclosure. To do this the temperature sensor of one thermometer was placed at the basking site directly below the lights and the other near the enclosure floor. During daylight hours the basking site temperature would fluctuate between 38˚C and 41˚C whilst the coolest area of the enclosure remained at 24˚C. This temperature gradient allowed the *B. bulabula* to easily thermoregulate. At night the entire enclosure temperature would drop to 21˚C. The *B. bulabula* pairs' diet was diverse including fruit (blueberries, apple, grapes and raspberries), vegetables (carrots and fresh peas) as well as dark leafy greens (rocket and dandelion). Every feed was lightly dusted with a specific herbivorous lizard vitamin and mineral supplement. Once every two weeks six 5th instar, live locusts were offered to the *B. bulabula* pair as a source of protein and to promote natural predatory behaviours. Before being fed to the iguanas these prey items were 'gut loaded' with fresh fruit and dusted with calcium powder.

On the 5/07/2016 three eggs were deposited in a designated egg laying site (41cm long, 35cm deep and 25cm tall deep plastic container filled with damp vermiculite) within the enclosure. Two were white in coloration with a slight pink hue. The third was a fraction of their size, miss shaped, dehydrated and yellow. The two eggs that appeared fertile were quickly removed and prepared for incubation. To do this a Tupperware container (25cm long, 20cm wide and 15cm deep) with six ventilation holes punctured in its lid was filled with vermiculite to a depth of 10cm. The vermiculite had been soaked in lukewarm water before excess moisture was removed by compressing it between two hands. The eggs were then half buried in this incubation medium and the Tupperware containers lid secured. This was then placed in a 'Zoo Med Reptibator' (www.zoomed.com) reptile egg incubator with the built in thermostat set to 27˚C. A digital thermometer probe was inserted into the egg incubation container to monitor the ambient temperature. Its digital readout positioned outside of the incubator was checked at least once a day until the eggs hatched. The incubation temperature remained at 27˚C whilst the vermiculite slowly dried.

Within two months this incubation medium was dry to the touch. However, contrary to expectations the eggs showed no signs of dehydration, the usual evidence of which being concavities of the shell. The decision was made not to rehydrate the vermiculite. From this point on the eggs were monitored several times a day for expected signs of dehydration. However despite this considerable drop in vermiculite moisture content lasting until the very end of the incubation period the eggs remained healthy. What is not clear is whether *B. bulabula* eggs are resilient to the dehydration of incubation medium or require it for successful development.

Five days before hatching a considerable concavity was observed in one of the eggs. Initially thought to be a sign of dehydration this concavity disappeared in minutes without any increase in incubation medium moisture content or ambient humidity. It is hypothesised that this was the nearly fully developed iguana moving inside its egg. In retrospect such an observation could be used as an indication that hatching is imminent. Beginning at approximately 8am on the 12/01/2017 both iguanas (one male and one female) hatched within an hour of each other. Minutes after emerging from their eggs, both hatchlings exhibited considerable aggressive behaviour (chasing and biting each other). Consequently the means to separate hatchling *B. bulabula* in the same incubation container immediately after hatching must be prepared for in advance. The two iguanas were then set up in individual enclosures and now ten months on (December, 2017) are fully established and growing quickly.

As previously stated the extent to which the drying out of the vermiculite incubation medium is required or simply tolerated for successful *B. bulabula* egg development is uncertain. It is hypothesised that as the vermiculite dried ambient humidity surrounding the incubating eggs dropped. However humidity measurements were not taken to prove this hypothesis. When the authors are next presented with eggs from this pair of *B. bulabula* the egg incubation protocol outlined here will be repeated. However along with monitoring temperature routine measurements of ambient humidity within the egg incubation container will be taken with a digital hygrometer.

It is hoped that the previously stated observations will be applied by all those individuals and institutions attempting to breed this endangered species and so increase the captive population. There could also be broader *ex-situ* conservation applications as the observations outlined here may be applicable to breeding other members of the *Brachylophus* genus. This can only be proved if information collected by those involved in the husbandry and captive propagation of the taxonomic relatives of *B. bulabula* (*B. fasciatus* and *B. vitiensis*) are recorded and then shared.

Reference List:

Fisher, R., Grant, T. and Harlow, P. (2012) *Brachylophus bulabula*. IUCN Red List of Threatened Species. Version 2013.2.

Jacobson, E.R. (2003) *Biology, husbandry, and medicine of the Green iguana*. Krieger Publishing Company.

Keogh, J.S., Edwards, D.L., Fisher, R.N. and Harlow, P.S. (2008) Molecular and morphological analysis of the critically endangered Fijian iguanas reveals cryptic

diversity and a complex biogeographic history. *Philosophical Transactions of the Royal Society of London B: Biological Sciences*, **363** (1508), 3413-3426.

Narayan, E., Christi, K. and Morley, C., (2009) Captive propagation of the endangered native Fijian frog Platymantis vitiana: Implications for ex-situ conservation and management. *Pacific Conservation Biology*, **15** (1), 47-55.

Tershy, B., Newton, K.M., Spatz, D.R., Swinnerton, K., Iverson, J.B., Fisher, R.N., Harlow, P., Holmes, N.D. and Croll, D.A. (2016) The biogeography of threatened insular iguanas and opportunities for invasive vertebrate management. *Herpetological Conservation and Biology*, **11**, 222-236.

Witzenberger, K.A. and Hochkirch, A. (2011) Ex situ conservation genetics: a review of molecular studies on the genetic consequences of captive breeding programmes for endangered animal species. *Biodiversity and Conservation*, **20** (9), 1843-1861.