

Provision of egg-laying sites for captive breeding of the endangered Fijian ground frog *Platymantis vitianus*, University of the South Pacific, Suva, Fiji

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SUMMARY

To try and stimulate breeding of the endangered Fijian ground frog *Platymantis vitianus* (n=10) in captivity, a purpose-built outdoor enclosure was built and an environment that mimicked their natural habitat created within it. We incorporated natural structures as potential *P.vitianus* egg laying sites, including rotting logs and hollow giant bamboo *Piper aduncum* stems. A range of other types of natural substrates e.g. coconut husks, rocks and decaying leaf litter, were also added thus the frogs could choose between various potential egg-laying sites and refugia. All material was sterilized in an autoclave prior to being installed in the enclosure. Pots containing native plants were also added. Nocturnal frog activity was recorded in the enclosure using digital video surveillance cameras: Several male and female frogs were observed in or near potential egg-laying sites throughout much of the assumed wet-season breeding period, and on the 21 December 2006 and 7 January 2007, single clutches of *P.vitianus* eggs were located. The December clutch was situated underneath a moist rotting log and the January clutch inside a bamboo stem lined with soil. The frogs probably created nest scrapes amongst the leaf litter and soil within these egg-laying sites while mating. It is not known if these egg-laying sites provided ideal egg-laying conditions, but they were used successfully by two pairs of frogs.

BACKGROUND

The Fijian ground frog (locally known as dreli or botoniviti) *Platymantis vitianus* is currently listed as endangered (IUCN 2004). It is found on the 60 ha island of Viwa (situated 30 km northeast of the Fijian capital, Suva) lying 0.95 km off mainland Viti Levu. Viwa is one of only four islands, all mongoose *Herpestes javanicus* free, currently inhabited by *P. vitianus*. A captive breeding programme using 10 frogs collected from Viwa was initiated by scientists at the University of the South Pacific (USP) in February 2006.

Nesting behaviour of *P. vitianus* has not been studied in the wild due to logistical and technical difficulties, and nobody has ever located their egg masses *in-situ*. Their natural woodland habitat usually has plentiful organic material

such as moist rotting logs, decaying leaf litter and coconut *Cocos nucifera* husks, which are used by the frogs as both refugia and egg-laying sites (Ryan 2000). The current study provided captive frogs with a selection of natural potential egg-laying sites to try and stimulate breeding.

Based on the reproductive categories of Jameson (1957) terrestrial-developing anurans fall within one of two categories, both of which often involve direct development (i.e. eggs hatch directly into froglets, forgoing the larval stage). These two categories are: i) direct development of very large ova deposited in 'nests' (simple scrapes) on moss, litter or soil often within hollows or burrows, and ii) eggs or tadpoles carried by a parent before hatching into tadpoles or froglets. Since *P. vitianus* is an entirely terrestrial frog and as a direct mode of embryonic development (i.e. egg to froglet) has

been observed previously (Narayan *et al.* 2007), we proposed that *P. vitianus* could possibly be excavating nest scrapes for egg-laying on the ground concealed within hollows in or under natural vegetation or rocks.

This paper discusses the egg-laying sites provided, the methods used for preparing them, and the subsequent successful laying of two clutches of eggs in an outdoor captive breeding facility.

ACTION

Collection of frogs and captive breeding enclosure: Ten adult Fijian ground frogs, 5 male (average snout-vent length = 25 mm) and 5 female (average snout-vent length = 70 mm), were collected from Viwa island on 15 May 2006. These individuals were collectively managed in a purpose-built outdoor enclosure at the USP in Suva, Fiji throughout 2006 and 2007.

This study was approved by the Animal Ethics Committee (AEC) of the USP. It was supported by the Australia and Pacific Science Foundation (APSF) grant no: APSF 07/6.

Enclosure preparation: Soil, coconut husks, rocks, decaying leaf litter, rotting logs and bamboo were added to the 5 m x 5 m x 4 m high enclosure to mimic natural conditions and to provide the frogs with a range of refugia and potential egg-laying sites. All material was sterilized in an autoclave set at a temperature of 100°C for 15 minutes prior to being installed in the enclosure.

Provision of egg-laying sites: The basic criteria for selection of egg-laying sites for the captive breeding programme was to use inexpensive, readily accessible items that mimicked that found in natural habitat from which the frogs had been collected on Viwa island. It was hoped that providing appropriate egg-laying sites would stimulate breeding. Two main types of potential egg-laying site were provided:

i) **Rotting logs** – these were chosen as they are commonly found in the natural habitat of *P. vitianus* (Zug *et al.* 2004). The frogs are reported as often using rotting logs as their retreat sites on Viwa, although the natural egg-laying sites of the frogs have never been discovered (Ryan 2000). Three rotting logs were added to the enclosure

each approximately 50 cm in length and 30 cm diameter (Fig. 1). Areas of the enclosure floor were spread with sterilized soil and leaf litter on 10 November 2006, and the logs placed upon this substrate.

ii) **Giant bamboo** – sections of giant bamboo *Piper aduncum* stem were chosen as the hollow structure would provide sufficient space to act as refugia for the frogs, as well as providing a potential egg laying site. Three dried sections (60 cm length; 12 cm diameter) were provided as ‘nest boxes’. Each section was modified so that the frogs could be easily monitored: the stems were cut lengthways to create a removable ‘roof’ to allow for easy inspection with minimal disturbance to the frogs (Fig. 2). The inner surface and the edges of the bamboos were trimmed and smoothed throughout in order to reduce the risk of trapping any part of the frog when replacing the roof, and to prevent the frogs causing any self-induced injury. The inside of the bamboo sections was lined with soil and leaf litter. As with the rotting logs, these substrates were installed in the enclosure on 10 November 2006.

The logs and the bamboo were collected from the botanical garden on the USP campus.



Figure 1. A rotting log in the outdoor enclosure provided as cover for a potential *P. vitianus* egg-laying site on the soil and leaf litter substrate.



Figure 2. A section of giant bamboo (cut lengthways to create a removable 'roof' to allow for inspection) acting a refugia - three adult female and one (paler) male Fijian ground frogs can be seen dwelling inside.

The bamboo and logs were positioned approximately equidistant from each other (c.50 cm apart) within the enclosure. High moisture and relative humidity levels were maintained via the sustained rainfall that was witnessed throughout the breeding season (November 2006 to January 2007).

Additional substrates: A range of other substrate choices for egg-laying and refugia were additionally provided for the frogs, also collected from the botanical garden and incorporated within the enclosure after autoclaving. These comprised coconut husks, rocks (approximately 15-20 cm diameter) and decaying leaf litter. Pots containing native plants such as *Palaquium hornei* (Sapotaceae) and the palm *Heterospathe phillipsii* (Arecaceae) were also added.

Frog monitoring: The frogs were found to be mostly active at night. Four low-light digital video cameras were therefore installed to record their nocturnal activity near the potential egg-laying sites.

Egg clutch searches: All potential egg-laying sites were searched for *P. vitianus* eggs using a hand torch as necessary, twice weekly during the routine cleaning of the enclosure in the morning between 08:00-09:00 h. This particular search time was preferable as the frogs were hiding in their daytime refugia and therefore foraging and

other activities of the frogs would not be affected.

Identification of gravid females: Each female frog was routinely monitored throughout the wet season in order to closely track their reproductive status. Identification of gravid females could be rapidly ascertained in a dark room by shining a bright light source (from a hand-held torch) through the body of the frog when (from prior experience with other anuran species) it was hoped that developing ova would be visible.

CONSEQUENCES

Frog behaviour prior to egg-laying: Night-time surveillance using video cameras and twice-weekly morning searches, revealed that several male and female frogs were present inside or near the potential egg-laying sites throughout the assumed breeding season (November-February) given that most anurans in subtropical/tropical regions that experience a dry and wet season breed in the wet months of the year. At the beginning of the breeding season, the frogs may have been involved in mate selection thus often several adult male and adult female frogs were present within the same egg-laying sites at particular time (e.g. see Fig. 1).

Identification of gravid females: It was found that gravid females could indeed be identified by shining a light source through their body, as creamy, round eggs were visible through their translucent skin (Fig. 3). There were two gravid females noted on 10 November, 2006. The other three females were non-gravid through the study period.

Amplexus: The amplexus of the frogs was not captured despite incorporating video camera monitoring. This was probably because the frogs mated in a very densely vegetated area of the enclosure not covered by the cameras.

Egg clutches and laying sites: On 21 December 2006 and 7 January 2007, single *P. vitianus* egg clutches were located at 08:30 h during the routine morning egg searches. The December clutch was found in a nest scrape within section of bamboo stem lined with soil (Fig. 4), whilst the January clutch was found in a scrape located under a moist rotting log (Fig. 5). Just before egg-laying, the pairs probably excavated their nest scrapes within the selected egg-laying sites.

Each of the 'nests' comprised a shallow scrape 1-2 cm deep x c.8 cm in diameter. The clutch within the bamboo stem was laid predominantly on a damp soil substrate, while the clutch underneath the log was laid on a mix of soil-litter mix and was partially covered with fine leaf litter. After egg-laying, a single male frog was observed within the periphery of each clutch and was probably guarding his eggs.

These two egg clutches were subsequently removed for rearing in the laboratory (Narayan *et al.* 2007).



Figure 3. Round eggs of a gravid female *P. vitianus* (snout-vent length 70 mm) visible through the translucent underbelly skin.



Figure 4. Fertile eggs (n=49) of *P. vitianus* located within a bamboo egg-laying site within the enclosure.



Figure 5. Fertile eggs (n=45) of *P. vitianus* located underneath a rotting log egg-laying site within the enclosure.

Conclusions: Beneath one of the rotting logs and within a giant bamboo stem were preferred by the frogs as potential egg-laying sites out of a range of several other refugia provided in the outdoor enclosure. Why these were chosen is uncertain but most likely because they fulfilled certain criteria such as providing optimum moisture and humidity, security for the mating pairs to lay their eggs and subsequent security for the eggs to develop. Presumably these egg-laying sites chosen, resembled sites where one might expect to find them in the wild.

We recommend that those licensed and wishing to captive-breed Fijian ground frogs should provision a variety of natural egg laying sites in order to stimulate the breeding of *P. vitianus* in captivity.

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