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# FACTORS AFFECTING THE DISTRIBUTION AND STATUS OF THE GOLDEN TREE FROG, *PHYLLODYTES AURATUS*, IN TRINIDAD

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## SUMMARY

This study estimates a population of around 20,000 bromeliad-dwelling Golden Tree Frogs on one peak, El Tucuche, with another less defined population on Cerro del Aripo, but probably no other population of this frog in the world. The frogs and their tadpoles were found in only one species of large 'tank' bromeliad. Tank water volume was the major limiting factor, but another large bromeliad species contained no frogs, possibly due to competition with crabs. Efforts to open up paths to the two summits give cause for concern and make a conservation strategy essential.

## INTRODUCTION

The Golden Tree Frog, *Phyllodytes auratus* (Boulenger) is a bromeliad-dwelling hylid deriving its common name from two longitudinal dorsal iridescent gold stripes. *P. auratus* was discovered by F.W. Ulrich during an exploration of Trinidad's second highest peak, El Tucuche. Originally named *Amphodus auratus* (Boulenger, 1917), Bokerman (1966) found that *Phyllodytes* (Wagler, 1830) is an earlier name for the genus. *Phyllodytes* so far comprises only seven species, all bromeliad-dwellers, six located in Eastern Brazil (Caramaschi *et al.*, 1992), several thousand kilometres distant from *P. auratus*. Murphy and Humbert (1982) have suggested that climate change may account for this discontinuous distribution.

The Golden Tree Frog has previously been reported from only two locations in Trinidad, El Tucuche (Kenny, 1969) and the highest mountain, Cerro del Aripo (Read, 1982), and from only one species of bromeliad, the large epiphytic *Glomeropitcairnia erectiflora*. This bromeliad also occurs on the Paria peninsula of Venezuela, but *P. auratus* has not been found there. The frog may therefore be a Trinidad endemic. Given the frog's extremely restricted distribution, the Wildlife Section of the Trinidad Government was keen for a study to be made of its status. The work reported here was carried out in collaboration with the Wildlife Section on two successive University of Glasgow expeditions in 1993 and 1994.

## METHODS

### Study Sites

Trinidad's Northern Range is an extension of the coastal Cordillera of Venezuela. Although the average elevation of the main ridge is only 600m, two peaks exceed 900m (Cerro del Aripo, 940m; El Tucuche, 937m) and two others exceed 800m (Chaguaramal and Morne Blue).

Beard (1946) found that at around 800m a transition to true montane rainforest occurs in the Northern Range, the precise elevation of the transition depending on local climatic factors. A further transition to 'elfin woodland' occurs above 800m on Cerro del Aripo. Beard reported *G. erectiflora* from the montane forest of El Tucuche, Cerro del Aripo and Chaguaramal, but not from Morne Blue. Our group climbed all four peaks, initially with the help of local guides. Work on El Tucuche included several overnight watches.

### Bromeliad sampling

It is unfortunately not possible to sample *P. auratus* without destroying its habitat. The frogs are dorso-ventrally flattened and seem to spend the daylight hours compressed between the bases of leaves deep inside bromeliads. The tadpole stage is spent in the water held within the bromeliad 'tank'.

Given the conservation-sensitive nature of this study, it was agreed with the Wildlife Section that only bromeliads growing on fallen trees would be sampled on El Tucuche, a nature reserve. Bromeliads were identified by means of Smith and Pittendrigh's (1967) key. All reasonable sized bromeliads, irrespective of species, were sampled, in order to investigate the habitat preferences of *P. auratus*.

For each bromeliad, the following measurements were made on the intact plant: water pH and temperature; base circumference and longest leaf length. A large plastic bag was then placed over the plant, which was cut from its branch and then emptied into the bag. Leaves were stripped individually from the plant to check for frogs, tadpoles and invertebrates. Frogs and tadpoles were identified, measured and released into suitable-sized bromeliads of the same species. Larger invertebrates were counted and preserved for later identification. Water volume was measured with a measuring cylinder.

### Bromeliad and frog population estimate

Bromeliad numbers on El Tucuche were estimated from 18 5x5m quadrats located along the main ridge from 780-910m elevation. An estimate of the *P. auratus* population on El Tucuche was then made via an extrapolation from the proportion of opened bromeliads found to contain *P. auratus*.

## RESULTS

### El Tucuche

The summit of El Tucuche was cleared many years ago as a helicopter landing pad by the United States Army: little forest regeneration has occurred since and this 150m<sup>2</sup> area is covered in short grass. The surrounding ridges and slopes are densely vegetated and epiphytic bromeliads are abundant, especially *G. erectiflora* and *Tillandsia* spp.

**Table 1**

Comparison of characteristics of *G. erectiflora* and *Tillandsia* sp. samples on El Tucuche. Data given as means  $\pm$  SD, numbers in brackets

Bromeliad feature	<i>G. erectiflora</i>	<i>Tillandsia</i>
Base circumference (cm)	44.8 $\pm$ 25.2 (20)	14.6 $\pm$ 6.0 (25)
Water content (ml)	697.9 $\pm$ 771.7 (2)	8.8 $\pm$ 15.4 (14)
pH of water	5.7 $\pm$ 0.8 (13)	5.4 $\pm$ 0.6 (5)
% Containing <i>P. auratus</i> adult	23	0
% Containing <i>P. auratus</i> tadpoles	15	0
% Containing <i>Flectonotus</i>	20	11.5

Data on sampled *G. erectiflora* and *Tillandsia* are shown in Table 1. *P. auratus* was found only in *G. erectiflora* and never in *Tillandsia*, though another Trinidadian bromeliad-dwelling frog *Flectonotus fitzgeraldi* occurred in both. The main difference between the two kinds of bromeliad was in size, particularly in tank volume. No *Tillandsia* contained as much as 70ml water, whereas 9 out of 20 *G. erectiflora* contained over 500ml. When *G. erectiflora* containing *P. auratus* adults were compared with those not containing *P. auratus*, the only significant difference was in water volume and not in pH or in measures of bromeliad size (Table 2).

**Table 2**

Comparison between characteristics of *G. erectiflora* on El Tucuche containing or not containing *P. auratus*. Data given as mean  $\pm$  SD, number in brackets. Significance measured by t tests.

Bromeliad feature	<i>P. auratus</i>		Significance
	Present	Absent	
Base circumference (cm)	58.9 $\pm$ 26.3 (6)	38.2 $\pm$ 23.0 (20)	N.S.
Longest leaf (cm)	59.8 $\pm$ 10.2 (6)	52.6 $\pm$ 19.5 (20)	N.S.
Water content (ml)	1368.1 $\pm$ 913.1 (6)	429.8 $\pm$ 532.4 (16)	P<0.01
Water pH	5.5 $\pm$ 0.8 (5)	5.5 $\pm$ 0.8 (11)	N.S.

The quadrat analysis gave a *G. erectiflora* density of 8.72/25m<sup>2</sup> over an area of approximately 259 x 10<sup>3</sup> m<sup>2</sup>. Extrapolating from our finding of 6 *P. auratus* from 27 bromeliads gives a population estimate of 19,878 individuals. Using methods in Fowler and Cohen (1990) upper and lower population limits are 29,476 and 13,418 respectively.

### Cerro del Aripo

When we first climbed Cerro del Aripo in 1993, a large area of forest at the summit (which is relatively flat) had recently been felled, with all the cut vegetation left in place. On our next visit in 1994, we were even more disturbed to find that the previously difficult path had been cleared and widened, making access to the summit of this peak quite straightforward.

From 5 *G. erectiflora* sampled in 1993, we found 3 containing *P. auratus* adults and/or tadpoles. Although *G. erectiflora* density seemed lower on Cerro del Aripo than on El Tucuche, the total number of bromeliads may be larger, since the area available at a high enough elevation is greater on this peak.

On Cerro del Aripo, a second large bromeliad species occurs, *Vriesia glutinosa*. These were sampled, along with additional *G. erectiflora* in 1994. *Vriesia* had significantly longer leaves, but in all other parameters, *V. glutinosa* did not differ from *G. erectiflora*. However, although we found *P. auratus* in three out of eight *G. erectiflora* on Cerro del Aripo, we found no *P. auratus* in the eight *V. glutinosa* we opened, nor did we find any *F. fitzgeraldi* in this bromeliad species.

Because of the treacherous conditions created by the tree-felling, we were unable to attempt a population estimate either of *G. erectiflora* or of Golden Tree Frogs on Cerro del Aripo.

## Chaguaramal

We found that a dirt road has been opened up to within 50m of the summit and that about half the area of the summit is now under cultivation. Much of the remaining forest is secondary and, although bromeliads were seen on the trees, there were no signs of either *G. erectiflora* or *V. glutinosa*. If *P. auratus* was present in the *G. erectiflora* noted by Beard as growing on this peak in 1946, it is presumably now extinct here.

## Morne Blue

We found that although there are settlements of people close to the summit of this mountain, the forest seems undisturbed. However, as Beard (1946) noted, it is lower montane forest in character, and we saw no evidence of the large tank bromeliads found on El Tucuche and Cerro del Aripo.

## *P. auratus* – adults and tadpoles

Table 3 shows the association between all adults and tadpoles found. We only once found two frogs together and in nearly every case, frogs were found along with tadpoles. We were unable to determine the sexes of the adult frogs. Tadpole numbers per tank were small (1-6). This was not, we think, because these were the remnants from a larger clutch, most of which had metamorphosed, since we found tadpoles at a wide range of developmental stages.

Table 3

Association between tank water volume, number of frogs and number of tadpoles: complete data on *P. auratus*.

Water volume (ml)	No. of adult frogs	No. of tadpoles
706	1	0
1117	1	2
571	1	1
1124	1	0
1617	1	6
3074	1	1
3465	2	3
210	1	0
2210	0	1

## Invertebrates

A rich fauna of invertebrates was recorded from the large tank bromeliads, including insects, myriapods, oligochaetes, arachnids and crustaceans (see Clark & Ward, 1995 for a complete list). Most were detritus feeders. The only significant difference between the faunas of *V. glutinosa* and *G. erectiflora* was the presence in the former and total absence from the latter of plentiful numbers (more than five per bromeliad) of a brachyuran crab. Using Chace and Hobbs's (1969) key, these could be *Pseudothelphusa garmani*, the Trinidad Forest Crab, which is abundant in the island's upland forest. However, this species can attain a carapace width of 8 cm (much too big to live in bromeliad tanks) and has not previously been recorded from bromeliads. Julius Boos (personal communication) believes from an examination of our specimens that they are most probably juvenile *P. garmani*. The crabs we found are not either *Metopaulias depressus*, the Jamaican Bromeliad Crab nor a member of the genus *Sesarma*, one of the few crab genera known to contain some permanent bromeliad-dwellers (Abele, 1972).



**Plate 1.** Golden Tree Frog on bromeliad leaf



**Plate 2.** Bromeliad habitat of the Golden Tree Frog in Trinidad

## DISCUSSION

This study has confirmed the existence of populations of the Golden Tree Frog at the summits of two mountains in Trinidad, El Tucuche and Cerro del Aripo, and effectively rules out its occurrence elsewhere on the island. The estimated adult frog population of around 20,000 on El Tucuche alone may seem healthy, but this must be regarded as a crude estimate only, since restrictions on sampling meant we could not investigate factors such as territoriality and height preference which could seriously affect our estimate. Territoriality is a feature of other *Phyllodytes* species (Caramaschi *et al.*, 1992). Our estimate may also be affected by our inability to determine the sexes of the frogs we found.

The frogs (and their tadpoles) were all found in the large 'tank' bromeliad *G. erectiflora*. The main factors behind preference for this bromeliad species appeared to be tank size and particularly water content. However, the other large bromeliad species, *V. glutinosa*, contained comparable water volumes but no frogs. The *V. glutinosa* specimens we opened contained variable numbers of crabs, and there may therefore be a competitive interaction between *P. auratus* and these crabs. We noticed that on Cerro del Aripo, *V. glutinosa* tended to grow on lower branches than *G. erectiflora* and may therefore be more accessible to the crabs. However, we suspect that there must be more to this micro-habitat preference than which animal, crab or frog, gets to the tank first.

Many features of the biology of *P. auratus* remain unknown: we attempted, as have others (Kenny, 1969; Read, 1982) to record the call, but without success. Kenny also attempted unsuccessfully to observe breeding. He found, as did we, small numbers of tadpoles per tank and noted that these could be found all year round. This suggests a spawning strategy well adapted to conditions: a small amount of water per tank, but available all year round. However, whether all eggs are laid in a single tank, or distributed amongst several, is not known.

The conservation status of *P. auratus* gives cause for concern. The disappearance in recent years of *G. erectiflora* from a third peak (Chaguaramal) may have extinguished a third population of *P. auratus*. Now the two remaining sites, El Tucuche and Cerro del Aripo, are being made more accessible to people by the cutting of paths, placing of seats and erection of supporting handrails at steep points.

In general, increasing access to the wilder parts of Trinidad should be helpful to conservation, as it will reduce pressure for exploitative uses such as quarrying. However, there ought to be a clear access policy that aims to conserve the most sensitive areas and their flora and fauna. For example, paths on Cerro del Aripo could take people around the mountain, but not to the summit, thereby protecting the rare 'elfin woodland' ecosystem and the Golden Tree Frog. Our discovery of clear felling at the summit, apparently by a youth section of the Trinidad army, suggests an absence of policy, or its implementation, so far.

There clearly is an opportunity for education here. The Trinidad Wildlife Section has had considerable success in recent years with a voluntary warden system aimed at protecting nesting sea turtles. So far, nothing has been done to highlight the need to protect frogs and the Golden Tree Frog in particular.

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