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# The distribution and conservation status of the Dwarf Marsupial Frog (*Flectonotus fitzgeraldi*, Anura, Hemiphractidae) in Trinidad, Tobago, and Venezuela

**[1]Joanna Smith, [2*]Michael J. Jowers, [3]Renoir J. Auguste, [4]Paul Hoskisson, [5]Cammy Beyts, [5]Greig M. Muir, [6]Mark S. Greener, [1]Dan Thornham, [6]Isabel Byrne, [7]Rick Lehtinen, [7]Meredith Eyre, [8]Michael G. Rutherford, [9]John C. Murphy, [10]Mayke De Freitas, [11]Gilson A. Rivas, and [6]J. Roger Downie**

*[1]School of Natural Sciences, Bangor University, Bangor Wales LL57 2DG, UNITED KINGDOM [2]CIBIO/InBIO Research Center in Biodiversity and Genetic Resources, Porto University, Vairão, PORTUGAL [3]Department of Life Science, University of the West Indies, St. Augustine, TRINIDAD [4]Strathclyde Institute of Pharmacy and Biomedical Sciences, University of Strathclyde, Glasgow, Scotland G4 0RE, UNITED KINGDOM [5]Institute of Evolutionary Biology, School of Biological Sciences, University of Edinburgh, Edinburgh, Scotland, UNITED KINGDOM [6]School of Life Science, Graham Kerr Building, University of Glasgow, Glasgow, Scotland G12 8QQ, UNITED KINGDOM [7]Department of Biology, The College of Wooster, Wooster Ohio 44691, USA [8]26 George Street, Innerleithen, Scotland EH44 6LH, UNITED KINGDOM [9]Science and Education, Field Museum of Natural History, 1400 Lake Shore Drive, Chicago, Illinois 60616, USA [10]13 Levitt Lane, Waterbeach, Cambridge, CB25 9AZ, UNITED KINGDOM [11]Museo de Biologia, Facultad Experimental de Ciencias, Universidad del Zulia, Apartado Postal 526, Maracaibo 4011, VENEZUELA*

***Abstract.*— The Dwarf Marsupial Frog, *Flectonotus fitzgeraldi* (family Hemiphractidae), has been reported to occur only in Trinidad, Tobago, and the Paria Range of Venezuela. This species is listed as Endangered on the IUCN Red List, based on its small geographic distribution and the fragmentation of its habitat, which is said to be declining both in extent and quality. Using molecular methods, we confirm herein that the three populations do belong to the same species. However, extensive presence/absence and focused population surveys show that the frog's distribution is more extensive than previously reported in both Trinidad and Venezuela. In Trinidad and Tobago, the frog is abundant in forests wherever its host plants occur, notably the bromeliad *Heliconia bihai* (Balisier in Trinidad; Bijao in Venezuela) and the aroid *Xanthosoma jacquinii* (Elephant's Ear). In Venezuela, the species is frequently found where there is suitable habitat, but an exhaustive population study is needed to diagnose its current situation. No evidence was found of habitat decline in Trinidad and Tobago, but in Venezuela the loss of habitat is evident, mainly because of subsistence agricultural activities, which have been developing in northeast Venezuela since at least 1930. The Red List status of this species is in need of revision.**

**Keywords.** Amphibia, habitat loss, IUCN Red List, phytotelmata, southern Caribbean

***Resumen.*— La ranita marsupial *Flectonotus fitzgeraldi* (familia Hemiphractidae), se conoce solo de Trinidad, Tobago y la Región de Paria en Venezuela. La Lista Roja de la UICN cataloga esta especie como En Peligro, con base a su área de distribución geográfica reducida y a la fragmentación de su hábitat, el cual se reduce progresivamente tanto en su extensión como en su calidad. Usando métodos moleculares comparativos, en este trabajo se confirma que las tres poblaciones pertenecen a una misma especie. Sin embargo, un estudio poblacional y de presencia/ausencia demuestra que la distribución geográfica de este anfibio es más amplia que la señalada anteriormente, principalmente en Trinidad y en Venezuela. En Trinidad y Tobago, esta rana es frecuente en áreas boscosas siempre que sus plantas huéspedes estén presentes, principalmente bromelias, *Heliconia bihai* (balisier en Trinidad; bijao en Venezuela) y *Xanthosoma jacquinii* (oreja de elefante). En Venezuela, la especie es frecuente, pero se requiere un estudio poblacional más exhaustivo para diagnosticar con precisión su situación. No se encontró evidencia de un deterioro importante en la calidad de su hábitat en Trinidad y Tobago, pero en Venezuela la pérdida de hábitat es evidente, principalmente como resultado de las actividades agrícolas de subsistencia, que se desarrollan en el noroeste de Venezuela al menos desde 1930. El estado de esta especie en la Lista Roja precisa de una revisión.**

**Palabras clave.** Anfibia, perdida de habitat, Lista roja IUCN, fitotelmata, Sur del Caribe

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**Correspondence.** **michaeljowers@hotmail.com* (MJJ), *j.smith@bangor.ac.uk* (JS), *Renguste@gmail.com* (RJA), *paul.hoskisson@strath.ac.uk* (PH), *s1437006@sms.ed.ac.uk* (CB), *gmuir66@talktalk.net* (GM), *mark.s.greener@gmail.com* (MSG), *d.thornham@bangor.ac.uk* (DT), *isabelbyrne11@gmail.com* (IB), *NONE* (ME), *RLEHTINEN@wooster.edu* (RL), *Mike.Rutherford@sta.uwi.edu* (MGR), *serpentresearch@gmail.com* (JCM), *maykef@gmail.com* (MDF), *anolis30@hotmail.com* (GAR), *Roger.Downie@glasgow.ac.uk* (JRD)

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## Introduction

The neotropical frog family Hemiphractidae includes six tree frog genera (118 species described so far; Frost 2020), in which females incubate small clutches of large eggs on their backs, either openly (in *Stefania* and *Cryptobatrachus*) or in a more or less closed cutaneous pouch (all other genera). One member of a two-species genus, the Dwarf Marsupial Frog *Flectonotus fitzgeraldi* (Parker 1934), is found in Trinidad, Tobago, and the nearby Paria Biota region of Venezuela, which includes the Serrania de Paria, Cerros Campeare, and La Cerbatana. In this small species (maximum snout-vent length in males 21 mm and in females 25 mm), developing individuals (clutch size 2–6) hatch as late-stage larvae and are deposited by the female into phytotelmata, which are small bodies of water enclosed by leaves, such as bromeliad 'tanks.' These larvae do not feed but subsist on the remaining yolk (Kenny 1969) and soon enter the process of metamorphosis, which is indicated by forelimb emergence. Downie et al. (2004) found that metamorphosis was complete (tail reabsorption) after 4.5 ± 0.7 days. Duellman and Gray (1983) suggested that individual *Flectonotus* females were capable of producing several egg clutches in a year, but data are still needed to test this suggestion for *F. fitzgeraldi*. *Flectonotus fitzgeraldi* are arboreal at night, with males calling from leaves such as those of bromeliads and *Heliconia bihai*, which is said to occur primarily during a period of about one hour, from soon before until soon after sunset (Murphy 1997). During the day, they may be active in leaf litter on the ground (Duellman and Gray 1983).

*Flectonotus fitzgeraldi* was assessed as Endangered by La Marca et al. (2004) for the IUCN Red List, based on criteria B1ab(iii), on the grounds that its "extent of occurrence is less than 5,000 km², its distribution is severely fragmented, and that there is continuing decline in the extent and quality of its habitat" in all three regions. Its population status was judged to be declining. However, this assessment appears not to have been based on published research and included the statement that "further work is needed to establish the current population status of this species."

In the past, many anuran species were listed as occurring in Trinidad, Tobago, and northern Venezuela. However, modern assessments using molecular methods have not always supported these patterns. For example, the aromobatid *Mannophryne trinitatis* is now known to occur only in Trinidad, with the Venezuelan and Tobagonian populations assigned to *M. venezuelensis* and *M. olmonae*, respectively (Barrio-Amorós et al. 2006; Manzanilla et al. 2007, 2009). It is important, therefore, especially for a species classified as Endangered, to be certain that the same species occurs in all three areas.

Kenny (1969) reported the distribution of *F. fitzgeraldi* (then known as a member of the genus *Nototheca*) from surveys made during 1955–1961. He listed the frog as occurring "throughout Trinidad from sea level to the highest peaks," and listed several locations in the Northern Range (including the summit of El Tucuche, Trinidad's second highest mountain, the Aripo Valley, the mouth of Grande Riviere river, and Matelot); other locations were Rio Claro, Mayaro, and Tamana Hill. Later, Clarke et al. (1995) confirmed the presence of *F. fitzgeraldi* in two species of bromeliads on the summit of El Tucuche, but did not find it on Cerro del Aripo. Murphy (1997) added the Arima Valley, the road to Arena Dam, and Morne Bleu Ridge to the list of Trinidad records. He also listed Tobago locations at Northside Road, Hillsborough Dam, Speyside, and the Windward Road by Lambeau Crown Trace. The distribution map accompanying the IUCN Red List assessment (La Marca et al. 2004) shows *F. fitzgeraldi* occupying an area of 4,500 km² in all. This included areas in northeastern Venezuela, adjacent to Trinidad, of approximately 3,700 km²; an area of Trinidad, mainly in the central part of the Northern Range but extending a little south, of about 600 km²; and most of the northeast of Tobago, centered on the Main Ridge forest, of about 200 km². *A Field Guide to the Amphibians and Reptiles of Trinidad and Tobago* (Murphy et al. 2018) gives a similar picture for Tobago, but extends the Trinidad distribution somewhat to the west, east, and south, based on museum specimens and published records.

The aims of this paper are three-fold: a) to test whether the three populations of *F. fitzgeraldi* can safely be assigned to a single species using molecular methods; b) to collate recent data on the distribution and population size of *F. fitzgeraldi*, some published and some new in this paper, and c) to assess whether this species indeed qualifies for its current Endangered (EN) status.

## Materials and Methods

*Flectonotus fitzgeraldi* specimens were collected at locations in Trinidad and Tobago, and Venezuela, under licenses from the Trinidad and Tobago Government Wildlife Section: Special Game Licenses issued for scientific purposes in 2012–2019 to John Murphy, Mike Rutherford, and Rick Lehtinen; and in Venezuela under the collection permit numbers 1375 and 0878 granted to Gilson A. Rivas by the República Bolivariana de Venezuela's Ministerio del Poder Popular para

Ecosocialismo y Aguas. Voucher specimens are deposited in the Museo de Biologia, Universidad del Zulia, Maracaibo (MBLUZ); Museo de la Estación Biológica de Rancho Grande, El Limón (EBRG), Museo de Historia Natural La Salle, Caracas (MHNLS), Rick Lehtinen field number (RML), and Museum of Zoology, University of West Indies (UWIZM). Animals used for genetic analysis were euthanized following the ASIH guidelines using MS-222 in water.

## DNA Analysis

Adults and tadpoles of *Flectonotus fitzgeraldi* were caught with hand nets. The DNA was sequenced from 11 tadpole tail tips and adults (Table 1). Whole genomic DNA was extracted using the DNeasy Blood and Tissue kit (QIAGEN, Hilden, Germany) following the manufacturer's instructions. One mitochondrial gene fragment, 16S rDNA, was used with primers 16SL and 16SH (Palumbi 1991) and the 16S primers reported by Wiens et al. (2005). Templates were sequenced on both strands, and the complementary reads were used to resolve rare, ambiguous base-calls in Sequencher v4.9 (Gene Codes Corporation, Ann Arbor, Michigan, USA). The lengths of the sequences were not the same for all individuals as different primers were used in different laboratories. All *Flectonotus* 16S rDNA sequences were downloaded from GenBank ($n = 5$), but the final alignment included only four of them as the only Brazilian specimen (*Flectonotus* sp.) showed very high divergence from all other species. The total dataset consisted of 15 individuals, including two individuals of *Flectonotus pygmaeus* from Venezuela which were used as an outgroup. Sequences were aligned in Seaview v.4.2.11 (Gouy et al. 2010) under ClustalW2 (Larkin et al. 2007) with default settings. The final alignment comprised 859 base pairs.

The most appropriate substitution model (TrN) was determined by the Bayesian Information Criterion (BIC) in jModeltest 2 (Posada 2008). Phylogenetic analyses were run to assess the relationships between localities, and taxa were inferred using the Bayesian Inference (BI) optimality criterion under the best-fitting substitution model. MrBayes v3 (Ronquist and Huelsenbeck 2003) was used with default priors and Markov chain settings, and with random starting trees. Each run consisted of four chains of 10 million generations, sampled every 10,000 generations. Phylogenetic relationships were also estimated using a Maximum Likelihood (ML) approach, as implemented in the software RAxML v7.0.4 (Silvestro and Michalak 2012), under the GTR model. All analyses were performed using the CIPRES platform (Miller et al. 2010). A median-joining haplotype network (Bandelt et al. 1999) was constructed using Popart v.1.7 (Leigh and Bryant 2015). Because of missing data in the original alignment, a shorter alignment (500 bp) was used for the network analysis.

## Survey Methods

**The temporal pattern of calling.** To establish the temporal pattern of calling in *F. fitzgeraldi*, in June 2006 an undisturbed site in Trinidad's Northern Range was chosen where the species had previously been recorded (Morne Bleu Ridge, Arima Valley, 10°43'37''N; 61°18'21''W, elevation 730 m; Murphy 1997). Starting from the radio-transmitter station at the west end of the trail, 20 sequential 100 m transects were marked out eastwards, using colored tape tied to trees. Trained observers walked the trail in pairs a total of eight times from June to August, from late afternoon until 2000 h, listening for both *F. fitzgeraldi* and *Pristimantis urichi*. Each 100-m transect required about 9 min to survey. Frog calls judged to be made from within a distance of approximately 5 m on either side of the trail were recorded (the numbers of frogs per transect were used for population estimates, as noted below, and this survey was repeated in June – August 2007). Since these species both call as dispersed individuals rather than in multi-individual choruses, a slow walk is a reliable way to estimate the number of calling frogs. To ensure there was no temporal bias in recording along the 2-km trail, the start times of the 20 transects were randomized.

**Presence/absence surveys.** Trinidad and Tobago: The observers who contributed to this study learned the call of *F. fitzgeraldi* either by listening to recordings made by Morley Read (no date recorded) or by Paul Hoskisson, or by visiting a site where *F. fitzgeraldi* is common and listening to the call at dusk, while also scanning the vegetation to obtain a sighting of the frogs. The surveys reported here used the frog's call as an evidence of presence, since searching for the frogs more directly can cause disturbance and may interfere with calling. Frogs were sometimes seen when listening was accompanied by torch use, but sightings were not used as a main criterion for presence. Surveys generally began just as light was fading, at about 1820 h, and continued until about 1930 h, when the calling declined in frequency. Some surveys were made by road from a vehicle, stopping to listen for calls. In this case, stops were made whenever a stand of *Heliconia bihai* was seen close to the road edge, since this plant had a strong association with *F. fitzgeraldi*. However, in the absence of *H. bihai*, stops were made every few hundred meters, since the frog also occurs in bromeliads on trees. Other surveys reported here were a component of regional Bioblitzes (DITOS consortium 2017) organized by the Trinidad and Tobago Field Naturalists' Club and the University of the West Indies Zoology Museum (2012–2019), which aimed to record every species encountered in an area over a 24-hour period. Two of the authors (John Murphy and Renoir Auguste) coordinated the herpetology group during these surveys, which involved a small team of observers walking slowly along forest trails from dusk

**Table 1.** *Flectonotus fitzgeraldi* vouchers, localities, and GenBank accession numbers.

| Voucher | Locality | GenBank accession number |
|---|---|---|
| MBLUZ 0395 | Venezuela, Cerro Humo, Península de Paria | MT968884 |
| MBLUZ 0448 | Venezuela, Cerro Humo, Península de Paria | MT968885 |
| EBRG 7337 | Venezuela, Cerro La Cerbatana | MT968886 |
| EBGR 7346 | Venezuela, Cerro Campeare | MT968887 |
| UWIZM.2015.18.4 | Trinidad, Aripo Savanna | MT968892 |
| UWIZM.2019.36 | Trinidad, Tamana | MT968883 |
| RML0115 | Tobago, Forest Reserve | MT968888 |
| RML0116 | Tobago, Forest Reserve | MT968889 |
| RML0117 | Tobago, Forest Reserve | MT968890 |
| RML0118 | Tobago, Forest Reserve | MT968891 |
| UWIZM.2012.27.23 | Tobago, Charlotteville (Flagstaff hill) | MT968882 |

onwards, listening for any frog calls, including those of *F. fitzgeraldi*. Another approach was the use of transects, where the number of frogs heard calling was recorded along a fixed length of trail. In some cases, audio recordings were made. Locations were recorded using a hand-held GPS device.

Venezuela: Data were assembled from the published literature and a revision of Venezuelan museum specimens (see specimen collection information above and Specimens Examined, Appendix 1).

Maps recording presence/absence were created with QGIS v3.0.2 software (https://www.qgis.org/en/site/) in WGS84 datum, using as a base layer the Google Terrain Hybrid (Map data ©2020 Google) as a base map (obtained through the Web Mapping Service in QGIS). GPS coordinates were contributed by the authors (see Supplementary Fig. S1). The extents of occurrence for *F. fitzgeraldi* were calculated for Trinidad, Tobago, and Venezuela individually using QGIS (version 3.0.2, Girona). GPS coordinates where the species was present were used to create a minimum convex polygon around the outermost coordinates within the country using the QGIS minimum bounding geometry tool applied using convex hull as the selected geometry type. The convex polygons thus created were clipped to their respective country's shape file so that areas of the polygons which extended into the sea were excluded. The areas of the clipped polygons were subsequently calculated to provide the extent of occurrence of the species for Trinidad, Tobago, and Venezuela in km$^2$ (see Supplementary Fig. S1).

**Population estimates**. Population densities were estimated for *Flectonotus fitzgeraldi* along Trinidad's Morne Bleu Ridge in 2006 and 2007 using transects at dusk, as described above (temporal pattern of calling). The number of calling males along a 100-m transect which was 10 m wide (1,000 m$^2$) was extrapolated to give the density in frogs per hectare. The site was surveyed again in 2012, 2013, and 2014, using the same methodology, except that only the first 150 m of the trail were surveyed. No specific population estimates were made in Tobago or in Venezuela (see Table 2 and comments in **Discussion**).

## Results

**DNA analysis.** All specimens from Venezuela (Paria Biota region) recovered the same haplotype, while the Trinidad and Tobago frogs recovered two and three haplotypes, respectively (Fig. 1). The phylogenetic analyses recovered a well-supported monophyletic clade of all *Flectonotus fitzgeraldi* with low genetic differentiation throughout the nominal species range, reflecting a low genetic variability throughout. Only the Venezuelan frogs were monophyletic.

**The temporal pattern of calling.** Figure 2 shows the temporal pattern of calling at Morne Bleu Ridge, Trinidad, for both *Flectonotus fitzgeraldi* and *Pristimantis urichi*. The figure shows clearly that while single *F. fitzgeraldi* individuals may occasionally call in the afternoon, almost all call activity is concentrated within a narrow time period between 1800 h and 1915 h. The pattern of *P. urichi* serves as a comparison to the dusk-centered calling pattern of *F. fitzgeraldi,* and to show that the short calling period of *F. fitzgeraldi* is not due to some external factor such as weather.

**Presence/absence surveys.** Presence/absence survey results are shown in Table 2 and Fig. 3. GPS locations are given in Supplementary Table S1. For Trinidad and Tobago, most of the results are derived from survey data published here for the first time, with a few data points drawing on recently published papers. In Trinidad, we only failed to find any *Flectonotus fitzgeraldi* in a few surveyed locations (mainly Icacos in the southwest, and

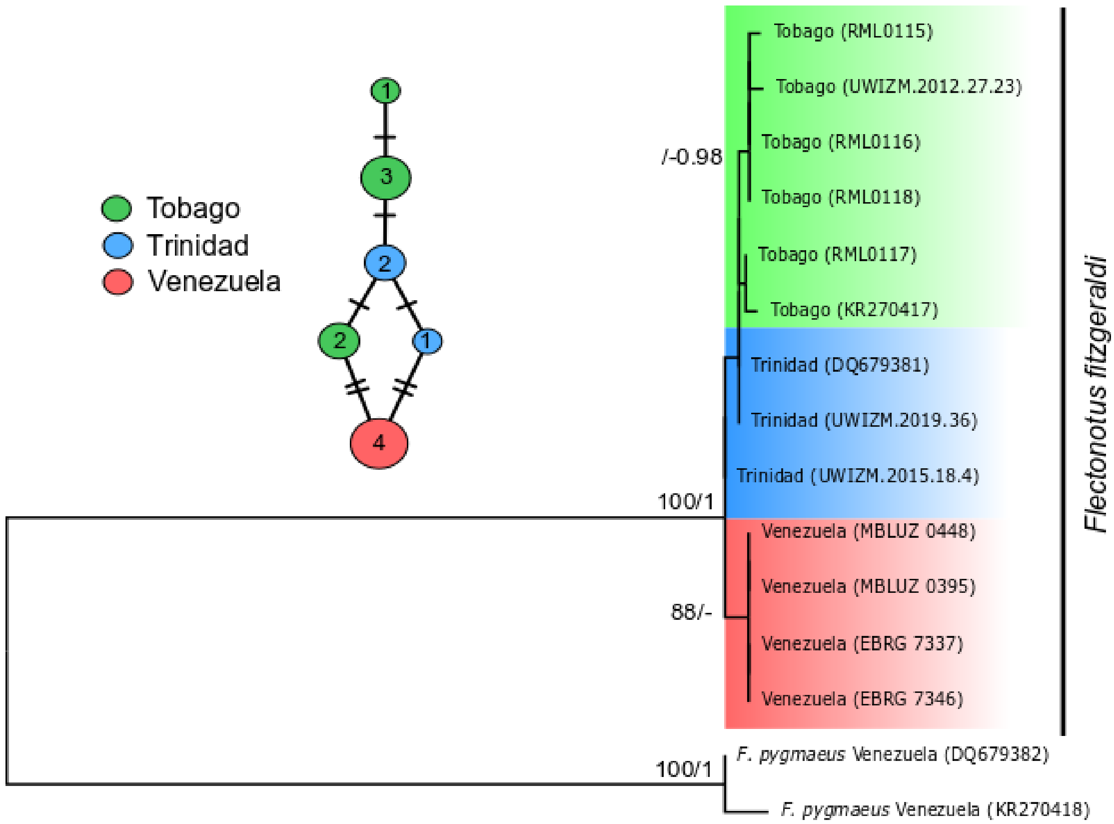


**Fig. 1.** Best Maximum Likelihood (ML) tree of *Flectonotus fitzgeraldi* populations from Trinidad, Tobago, and Venezuela. Values at the nodes are comprised of ML posterior probabilities (> 75%) and Bayesian Inference probabilities (> 95%). In the Medium-Joining network, numbers in circles represent the number of sequences with the same haplotype and dashes are number of substitutions.

the Port of Spain conurbation in the northwest). The largest areas remaining to be surveyed are in the southwest and south-central regions. In Tobago, the northeast has been surveyed extensively and *F. fitzgeraldi* has been found throughout. However, central Tobago is mountainous with few roads, and a large area remains unsurveyed. In Venezuela, systematic surveys were not conducted. Nevertheless, *F. fitzgeraldi* is reported as occurring throughout the Paria Peninsula and further west in northern Venezuela, including Cerros Campeare and La Cerbatana as well as the Turimiquire massif, as predicted by Rivas et al. (2018), and including sites from near sea level to 1,200 m asl. Most records from Venezuela come from disturbed locations within natural habitat areas, mainly along the edges of patches cleared for shifting agriculture or in gardens near paved roads. Our observations in the northeastern portion of the country were made at night; most frogs were detected visually, except six specimens that were heard calling at night (ca. 2000 h) in Campeare on 13 November 2016. Six specimens were observed staying on leaves of *Dracaena*, an ornamental plant (Asparagaceae), during a survey that was carried out for visual inspection between 1700 and 2100 h. Specimens from La Cerbatana were observed resting inside the axil of a bromeliad, presumably *Tillandsia* sp. At Cerro Humo, individuals were observed on large leaves, possibly belonging to the aracean genus *Xanthosoma*.

Although these surveys were not intended to estimate population sizes, the number of calling males at any particular site was recorded in both Trinidad and Tobago in 2019. While the population of *F. fitzgeraldi* present was not quantified, the numbers of calling males were often considerable, especially in extensive stands of *Heliconia bihai*, with up to 35 being counted at Flagstaff Road in Tobago.

**Population estimates.** Population estimates for Morne Bleu Ridge, Trinidad, are shown in Table 3. The estimates are broadly similar across the years, except for 2006, which was the first year of these surveys, when the methodology was still being developed. The team leader for that year (JS) considers that the low average numbers resulted from the surveys starting too early in

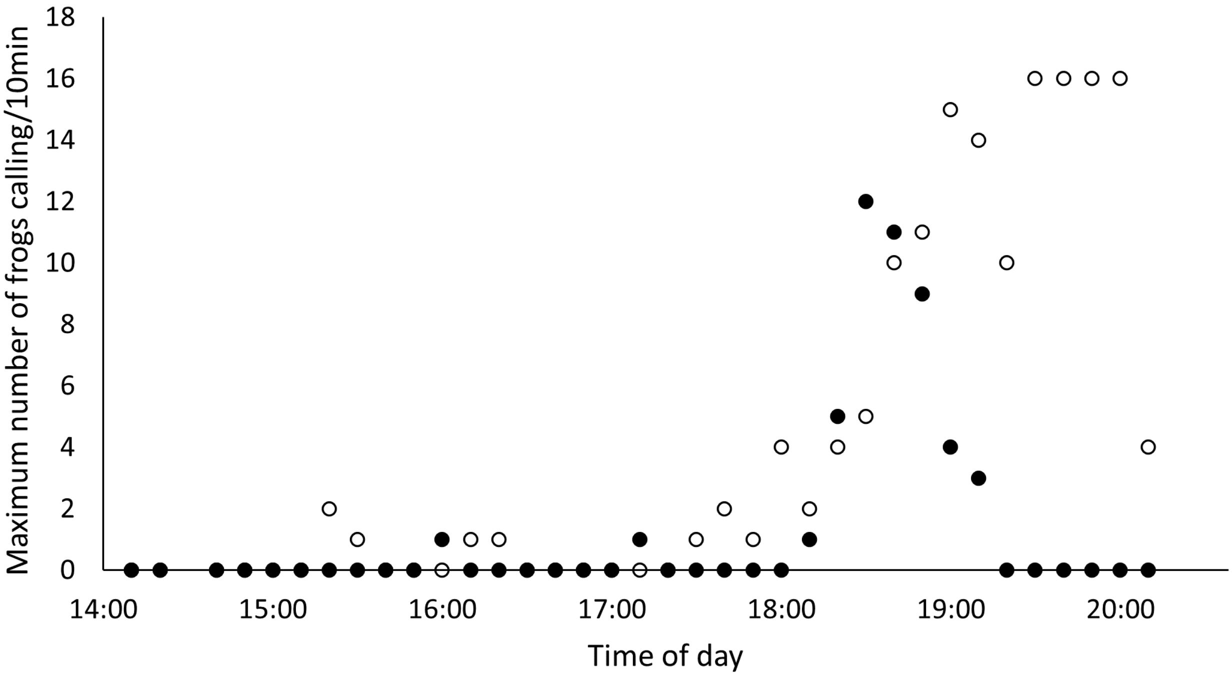


**Fig. 2**. Maximum numbers of frogs calling per 10 minutes during eight transects along the Morne Bleu ridge in 2006 (filled circles: *Flectonotus fitzgeraldi*; empty circles: *Pristimantis urichi*).

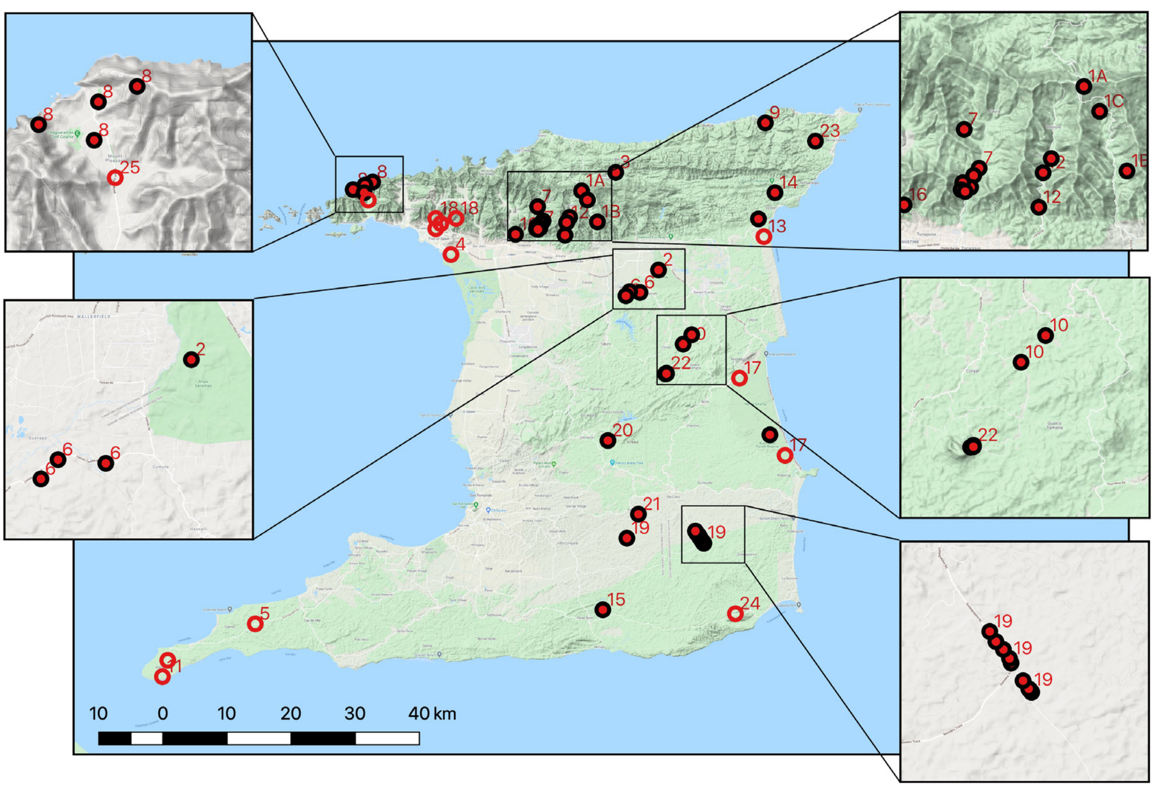


**Fig. 3A.** Map showing both presence and absence of *Flectonotus fitzgeraldi* as reported in this study in Trinidad. Location numbers correspond to those in Table 2.

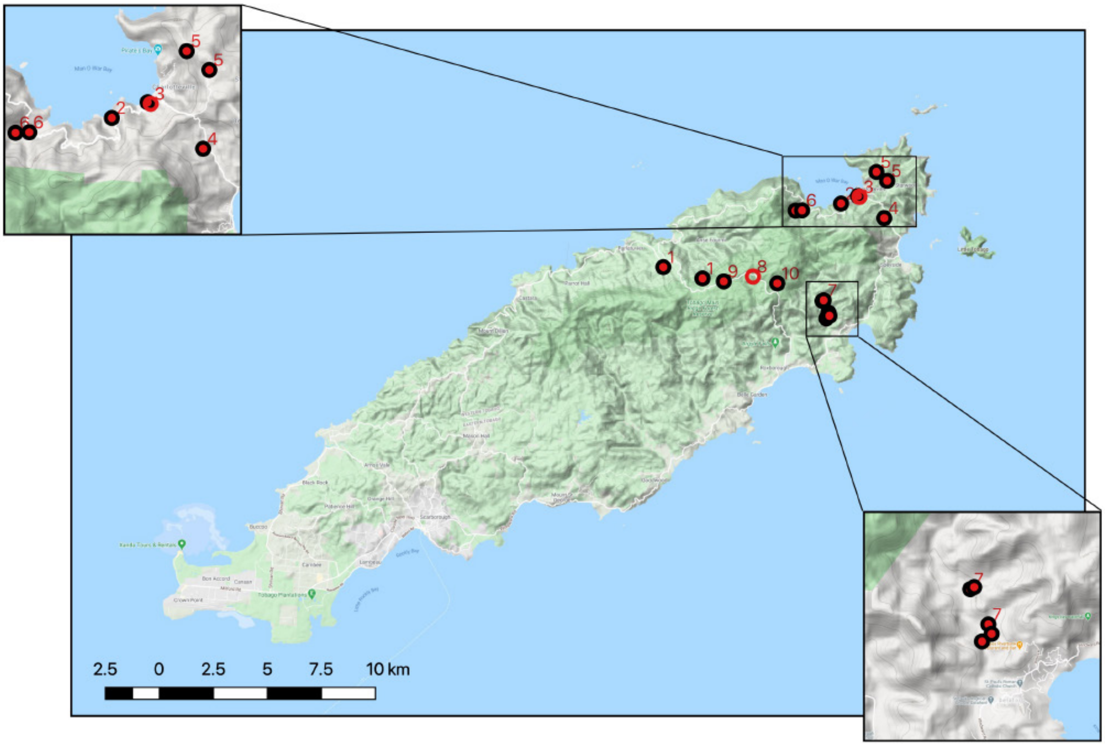


**Fig. 3B.** Map showing both presence and absence of *Flectonotus fitzgeraldi* as reported in this study in Tobago. Location numbers correspond to those in Table 2.

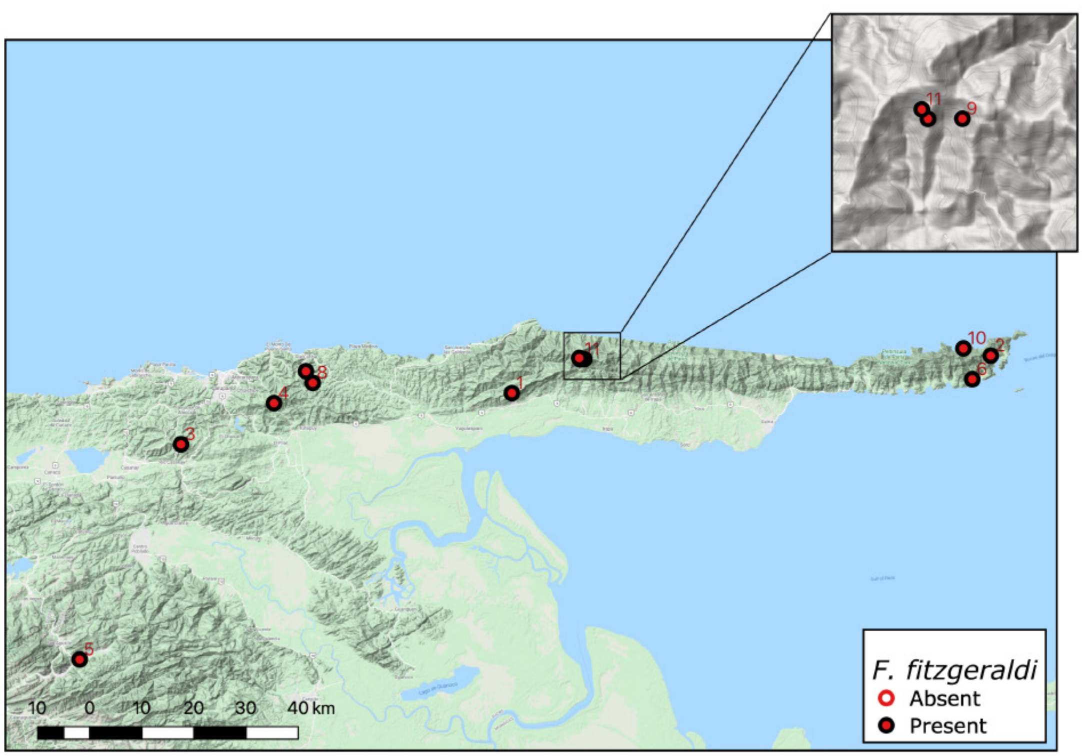


**Fig. 3C.** Map showing both presence and absence of *Flectonotus fitzgeraldi* as reported in this study in Venezuela. Location numbers correspond to those in Table 2.

**Table 2.** Results from presence/absence surveys for *Flectonotus fitzgeraldi* in A) Trinidad; B) Tobago, 2006–2019; and C) Venezuela. Numbers in parentheses following locations refer to numbers on the maps (Fig. 3). GPS co-ordinates for all locations are given in Supplementary Material 1. Superscripts in the "Year" column indicate sources of data: [1]Ogilvy et al. 2007; [2]Smith 2008; [3]Greener 2015; [4]Bioblitz species lists (Rutherford 2013, 2014, 2017, 2018 a,b,c); [5]Authors' unpublished field notes; [6]Auguste et al. 2015, Auguste and Hailey 2018; [7]Auguste 2019; [8]Mohammed et al. 2014; [9]Eyre 2013; [10]Rivas' unpublished field notes; [11]Rivas et al. 2018; [12]Barrio-Amorós et al. 2019; [13]Duellman and Gray 1983; [14]MBLUZ; [15]EBRG; [16]MHNLS.

**A) Trinidad**

| Location | Year | Survey type | Findings on *F. fitzgeraldi* |
|---|---|---|---|
| Arima Valley (1A): Morne Bleu | 2006[1], 2007[2], 2012[3], 2013[3,4], 2014[3], 2019[5] | Audio path transects; Bioblitz | Always present at Morne Bleu ridge, Springhill Estate, Simla |
| (1B): Simla | As above | | |
| (1C): Springhill Estate | 2006[1], 2007[2] | | |
| Aripo Savanna (2) | 2015[6] | Audio and visual path transects | Abundant in marsh forest, but absent from savanna. Voucher collected 2015 |
| Brasso Seco (3) | 2019[5] | Audio path transects | Present |
| Caroni Swamp, northern section (4) | 2016[4] | Bioblitz | Absent |
| Chatham (5) | 2019[5] | Audio transects | Absent |
| Cumuto-St. Raphael Road (6) | 2019[5] | Audio road transect | Present wherever *Heliconia bihai* occurred (common) and in large bromeliads on trees, Arena Forest entrance |
| Caura Valley (7) | 2012[3], 2013[3], 2014[3], 2019[5] | Audio transects | Present at two roadside sites, both before village; seven other locations |
| Edith Falls (8) | 2019[5] | Audio path transects | Present; four locations |
| Grand Riviere (9) | 2019[5] | Audio path transects | Present |
| Guaico-Tamana Road (10) | 2019[5] | Audio road transect | Present at several sites between Cunaripo and Nestor, and along track to Tamana Hill, wherever *H. bihai* present |
| Icacos (11) | 2017[4], 2019[5] | Bioblitz; audio road transects | Absent: forest trails by Grand lagoon; Southern Main Road |
| Lopinot Valley (12) | 2019[5] | Audio road transects | Present; three locations |
| Matura Beach Road (13) | 2019[5] | Audio road transect | Absent |
| Matura Forest (14) | 2016[7], 2019[5] | Audio path transects | Present |
| Moruga (15) | 2019[5] | Audio transects | Present |
| Mount St. Benedict (16) | 2012[3], 2013[3], 2014[3] | Audio transects | Present |
| Nariva Swamp (17) | 2014[4], 2016[7] | Bioblitz; audio and visual transects | Heard at Bush Bush, but not at Kernahan or Plum Mitan |
| Port of Spain (18) | 2016[4] | Bioblitz | Absent at all sites checked (Botanics, St Ann's, Mount Hololo, Lady Chancellor) |
| Rio Claro, roads south (19) | 2019[5] | Audio road transect | Present; 12 locations |
| Tabaquite (20) | 2019[4] | Bioblitz | Present |
| Tableland (21) | 2019[5] | Audio transect | Present |
| Tamana Cave (22) | 2019[5] | Audio and visual path transect | Present; three locations. Voucher collected 2019 |
| Toco (23) | 2018[4] | Bioblitz | Present: Cumana forest trail |
| Trinity Hills (24) | 2014[8], 2016[7] | Audio road transects | Heard at Edward Trace, 2014 but not in 2016 |
| Tucker valley (25) | 2012[4] | Bioblitz | Absent |

**B) Tobago**

| Location | Year | Survey type | Findings on *F. fitzgeraldi* |
|---|---|---|---|
| Bloody Bay stream (1) | 2012[9], 2019[5] | Daytime plant searches; audio path transects | Present in *Xanthosoma*; heard from *H. bihai* away from stream |
| Cambleton (2) | 2019[5] | Audio and visual transects | Abundant in *H. bihai* all along trail; absent from bamboo |
| Charlotteville (3) | 2015[4], 2019[5] | Bioblitz; audio transects | None heard or seen along various forest trails, 2015, 2019. |
| Doctor's river (4) | 2019[5] | Audio and visual transects | Seen and heard among *H. bihai,* three visits |
| Flagstaff hill (5) | 2012[5], 2019[5] | Audio road transects | Abundant in roadside *H. bihai* stands; absent from bamboo. Voucher collected 2012 |
| Hermitage river (6) | 2019[5] | Audio and visual transects | Abundant in *H. bihai*, not overhanging the stream, three visits |
| Louis D'Or streams (7) | 2019[5] | Audio and visual transects | Present among *H. bihai* mainly, two visits |
| Main Ridge, Spring trail (8) | 2019[5] | Audio and visual transects | Absent; few *H. bihai* in this dark closed canopy site; two visits |
| Main Ridge, Gilpin trail (9) | 2019[5] | Audio path transects | Heard among streamside *H. bihai* |
| Main Ridge, central (10) | 2010[5], 2012[9] | Daytime plant searches; audio path transects | Present in *Xanthosoma*; heard among streamside *H. bihai*. Vouchers collected 2010 |

**C) Venezuela**

| Location | Year | Survey type | Findings on *F. fitzgeraldi* |
|---|---|---|---|
| Cachipal (1) | 2017[10,14] | Visual transects | Present; vouchers collected |
| Camino desde Macuro-a Los Chorros (2) | 2003[16] | Visual transects | Present: vouchers collected |
| Cerro Campeare (3) | 2016[10,11,15] | Specimen collection | Several seen calling from *Dracaena* plants |
| Cerro La Cerbatana (4) | 2016[11,15] | Visual transect | Present: vouchers collected |
| La Margarita (5) | 2013[15] | Specimen collection | Present; vouchers collected |
| Macuro (6) | 2013[12] | Specimen observed | Present: photographed |
| Mauraco (7) | 1978[13,15] | Specimen collection | Present: vouchers collected |
| Marauquito (8) | 1978[16] | Specimen collection | Present: vouchers collected |
| Quebrada Las Melenas (9) | 2002, 2003[11,16] | Visual transects | Present |
| Uquire (10) | 1993[15] | Specimen collection | Present: vouchers collected |
| Cerro Humo (11) | 2015[10,14] | Visual transect | Present: vouchers collected |

**Table 3.** Number of calling males of *Flectonotus fitzgeraldi* recorded at Morne Bleu Ridge, Trinidad. Data represent means based on eight surveys in 2006 and 2007; and five surveys in 2012–2014.

| Year | Mean ($\pm$ SE) | Maximum |
|---|---|---|
| 2006 | 19.5 $\pm$ 4.7 | 80 |
| 2007 | 44 $\pm$ 35.1 | 105 |
| 2012 | 51 $\pm$ 15 | 80 |
| 2013 | 49 $\pm$ 29 | 94 |
| 2014 | 64 $\pm$ 27 | 94 |

the evenings, before the calling pattern had been fully determined. Mean as well as maximum numbers are shown. These numbers are for calling males only, so they must be considerable underestimates of the actual populations. Taken together, the mean and maximum numbers suggest that no significant change has occurred over the nine-year span of these surveys.

**Extent of occurrence.** Maps showing the extent of occurrence in each country are shown in Supplementary Fig. S1. The areas of occurrence are Trinidad: 2,922.4 km²; Tobago: 30.1 km²; and Venezuela: 3,713.4 km², yielding an overall total of 6,665.9 km².

## Discussion

In cases where a species is widely distributed, and especially when its range is disjunct, it is important to assess whether significant intraspecific variation occurs. Duellman and Gray (1983) reported no significant morphological differences between the three respective populations of *Flectonotus fitzgeraldi* from Trinidad, Tobago, and Venezuela. The data here show highly similar genetic divergence between populations, while the Trinidad and Tobago animals were more closely related between them than to those from Venezuela. The lack of shared haplotypes suggests some degree of genetic isolation among all three localities.

La Marca et al. (2004) assessed the conservation status of *F. fitzgeraldi* as Endangered, on grounds of its area of occurrence being less than 5,000 km², its distribution being severely fragmented, and continuing declines in the extent and quality of its habitat. However, this assessment was not based on any published research. In order to obtain field data, it was necessary to establish an optimized survey methodology. These frogs call from the leaves of host plants, which encompass phytotelmata (bromeliads, *Heliconia*). Audio surveys at the time just following sunset are the best survey method for establishing presence or absence, either by walking, or by the use of a frequently stopping vehicle which can cover a longer distance at the critical time. With this method, we confirmed the frog's presence in the forests of the northeastern half of Tobago, and found it to occur wherever the host plants are common. In Trinidad, we greatly increased the frog's known occurrence to include the whole of the Northern Range mountains and the full length of the eastern half of the island; however, more surveys are needed to establish its extent in southwestern Trinidad. Our surveys in Venezuela have been less extensive, but the frog's presence was established further west and south than previously recorded. The total combined area of occurrence in the three countries is 6,665.9 km².

The assessment of frog population size in the tropics is highly problematic. Species such as *F. fitzgeraldi* are widely distributed and may call throughout the year (Kenny 1969); they do not congregate to breed over a short time at a few established ponds. Only males call, and not necessarily every night. Greener et al. (2017) found that day-time visual sampling of the Trinidad stream frog underestimated the actual population (as established by removal sampling) by a factor of about three. Similarly, Lehtinen et al. (2016) showed, using new methods, that the Tobago stream frog, *Mannophryne olmonae*, is more abundant and widespread than previously considered. Our population estimates for *F. fitzgeraldi* should not, therefore, be regarded as true measures of the adult male population, let alone the total numbers of all classes of these frogs. However, we do think that our numbers could be valuable in assessing trends, when compared with future surveys using similar methods in the same locations. The data from Trinidad's Morne Bleu Ridge should be particularly useful in the future for assessing changes in a relatively undisturbed site.

In Venezuela, habitat loss in the Paria Peninsula is not a new issue (Kaiser et al. 2015), having been documented as early as the beginning of the 1940s. Beard (1945) found that local people were responsible for habitat disturbance mainly in the southern versant of the mountains, and that human density appeared to be too low to be in accordance with the vast area already deforested at that time. A similar case occurs in La Cerbatana, where a continued deforestation occurs below 500 m (maximum altitude 1,000 m), but to a lesser degree than in Campeare, where natural vegetation only remains on the summits of the mountains (ca. 950 m). Finally, the natural forest formations present in the Turimiquire range are subject to some strong threats, as observed during a visit to the southeast side of the massif in 2006. The mountain area between 300 m and 1,200 m is severely affected by human activities. Pristine forests have been lost while the landscape has shifted to agricultural spaces and areas for human settlements. Land is mainly used to cultivate tomato and coffee, and to a lesser extent for livestock. Deforestation and cattle grazing have caused erosion and loss of nutrients in the soils. Additionally, these activities have encouraged the excessive use of agrochemicals, mostly monophosphates, affecting the mountain water bodies. Recently, however, most of these crops appear abandoned. Tate (1935) mentioned that the high elevations of Turimiquire did not escape deterioration, and noticed important areas devoted to coffee crops near 2,000 m elevation in the massif.

In conclusion, La Marca et al. (2004) estimated the total extent of occurrence of *F. fitzgeraldi* to be less than 5,000 km² and assessed its population to be declining. The low extent of occurrence, distribution in three separate countries, and declines in extent and quality of habitat led to a status assessment of Endangered. We show here that the species' extent of occurrence is well over 6,000 km² (Supplementary Fig. S1), that there is no evidence of population decline where we have been able to measure it (Trinidad), and that the extent and quality of habitat in two countries (Trinidad and Tobago) show no signs of decline. However, because there are threats to habitat in the country with the largest area inhabited by the species (Venezuela), it is probably best to regard *F. fitzgeraldi* as Vulnerable.

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**Appendix 1. Specimens examined.**

*Flectonotus fitzgeraldi*. VENEZUELA: Monagas: La Margarita, Turimiquire, 1,200 m, 10°10’32”N, 63°30’24”W (EBRG 7034-35). Sucre: Mauraco, N del Pilar, 10°40’17,62”N, 63°06’38,64”W (EBRG 519-520). Marauquito, Península de Paria, 400 m, (MHNLS 10859). Vertiente Sur de Cerro Humo, Península de Paria, 800 m, 10°42’ N, 62°37’ W (MBLUZ 0395, 0448). Alrededores de las Melenas, Península de Paria, 10°41’32.1”N, 62°37’24.9”W (MHNLS 15741, 16187). Camino desde Macuro a los Chorros, Península de Paria, 500 m, 10°41’54”N, 61°54’45”W (MHNLS 16199-17201). Uquire, vertiente Norte de la Península de Paria, 150 m, 10°43’N, 63°58’ W (EBRG 2585). Cachipal, Península de Paria, 10°38’02.5”N, 62°45’01.8”W (MBLUZ 447). Cerro La Cerbatana, ~800 m, 10°37’ N -63°10’ W (EBRG 7336–7337). Cerro Campeare, 800 m, 10°32’45.4”N, 63°19’45.6”W (EBRG 7343–7346). Macuro, Península de Paria (photographed in Barrio-Amorós et al. 2019: 54).

**Jo Smith** is a general zoology enthusiast, who accidentally ended up studying and falling in love with treefrogs over the course of her Ph.D. on adhesion in the Hylidae, which involved many enjoyable years going back and forth to Trinidad from Glasgow on field work. She is now a Senior Lecturer at the Bangor University, Wales, where she tries her best to remind their very keen zoology with herpetology students that snakes are not the only herps.

**Michael J. Jowers** is an evolutionary biologist with broad interests in the processes and the timings of speciation. His work focuses on tropical island biogeography, phylogeography, systematics, population genetics, taxonomy, and conservation. Michael is deeply involved in amphibian and reptile studies from the islands of Trinidad and Tobago (Lesser Antilles), but he is also interested in other organisms such as birds, mammals, and insects. He actively leads studies throughout South America, Africa, Europe, and Asia.

**Renoir J. Auguste** is a Trinidad and Tobago herpetologist. Renoir received his M.Sc. in Biodiversity Conservation from The University of the West Indies, St. Augustine Campus, Trinidad and Tobago, and is interested in the ecology and conservation of amphibians and reptiles. He has conducted herpetological surveys across Trinidad and Tobago for national baseline surveys aimed at improving protected areas, as part of his academic degrees. He also volunteers with the local environmental NGO Trinidad and Tobago Field Naturalists’ Club, in which he has held the position of President for three years.

**Paul A. Hoskisson** is Professor of Molecular Microbiology at the Strathclyde Institute of Pharmacy and Biomedical Sciences (Scotland) and the Royal Academy of Engineering Research Chair in Engineering Biology. While his research is primarily focused on the biosynthesis of antibiotics, but he also maintains research interests in amphibian reproduction, behavior, and conservation. Paul is a member of Royal Society of Biology Council.

**Cammy Beyts** is a Ph.D. student in Behavioral Ecology at The University of Edinburgh, Scotland, within the Institute of Evolutionary Biology. Cammy's research investigates the effects of local adaption and the development environment on inter-individual differences in tadpole behavior in species such as *Engystomops pustulosus* and *Leptodactylus fuscus*. Cammy has been conducting her fieldwork in Trinidad since 2018, and regularly assists with additional projects on a variety of herpetofauna while there.

**Greig McInnes Muir** is a recent Zoology graduate from the University of Edinburgh, Scotland. Greig cultivated a passion for herpetology during his undergraduate research project on the repeatable inter-individual differences in behavior of the model species *Engystomops pustulosus*, while on expedition to Trinidad. Currently working within the pharmaceutical industry, Greig is still a keen naturalist and is always looking for ways to keep connected to nature, conservation, and behavioral ecology.

**Mark Steven Greener** developed an interest in amphibians and reptiles at a young age. He further cultivated this passion at the University of Glasgow, Scotland, where he participated in and led several scientific expeditions. Following this, Mark moved to the Wildlife Health Ghent lab group at the University of Ghent, Belgium, pursuing a Ph.D. on the dynamics of chytrid fungus in Northern Europe. He has been a part of multiple projects and has published several papers on the amphibians and other wildlife of Trinidad.

**Daniel G. Thornham** is a zoologist and entomologist at the School of Natural Sciences, Bangor University, North Wales, looking at relationships in phytotelm ecology, biomechanics, and proximate behavioral ecology. Using pitcher plants (Nepenthaceae) and bromeliads (Bromeliaceae) as model ecological systems, Dan explores the specializations of animals living in the aerial aquatic habitats formed by these plants. In Bangor, Dan teaches undergraduate research skills, invertebrate biology, and field techniques modules, and holds a number of academic roles in the School. He has been visiting Trinidad periodically since 2000 and loves nothing more than eating doubles after a long climb into the canopy to explore the bromeliads.

**Isabel Byrne** is an Irish researcher who received a B.Sc. in Zoology from the University of Glasgow, Scotland. Her previous research focused on the herpetofauna of the rainforests and coast of the North East of Tobago, with special interest in the Tobago Glass Frog, *Hyalinobatrachium orientale tobagoense*. In 2020, she completed an M.Sc. in *One Health: Humans, Animals, and the Environment*, at the Royal Veterinary College and the London School of Hygiene and Tropical Medicine in England. She is currently working as a research assistant at the London School of Hygiene and Tropical Medicine on the analysis of spatial and environmental data related to malaria vector abundance, and epidemiological risk analysis.

**Richard ("Rick") Lehtinen** has studied the ecology, evolution, behavior, and conservation of amphibians and reptiles for 25 years. He has authored or co-authored over 50 books, monographs, and research articles on amphibians and reptiles with primary interests in the specializations of plant-breeding frogs, the evolution of parental care behavior, and the long-term study of population dynamics. Primarily a field biologist, Rick has enjoyed probing the secrets of nature in Costa Rica, Madagascar, Taiwan, Trinidad and Tobago, and the United States. He holds a Ph.D. from the University of Michigan and is currently Professor of Biology at the College of Wooster (Ohio, USA).

**Meredith Eyre** worked as a student in Dr. Lehtinen's group at the College of Wooster (Ohio, USA), and under his guidance, her senior thesis explored the natural history and habitat selection of *Flectonotus fitzgeraldi* in Tobago. She continues to be inspired by the research opportunities created for her at the undergraduate level, and after completing her M.S. at the Ohio State University, she has dedicated herself to the development of similarly empowering opportunities for others. She currently serves as a Laboratory Instructor at Carlow University (Pennsylvania, USA), where she delights in working primarily with introductory-level students as they begin their journey into the field of biology.

**Michael G. Rutherford** is a naturalist based in Scotland. A lifelong interest in animals led him to a degree in Zoology from Glasgow University, Scotland, followed by a masters in conservation biology at James Cook University, Australia. His jobs have included research assistant studying skinks in Queensland, tropical house zookeeper for Newquay Zoo (England), curator of invertebrates for Glasgow Museums (Scotland) and curator of the University of the West Indies Zoology Museum in Trinidad and Tobago. His research interests include reptiles, land snails, millipedes, oilbirds, and biological recording.

**John C. Murphy** is a naturalist with a focus on snakes. When he is not hiking in the desert or examining specimens in the lab, he is often writing about reptiles. Murphy is a retired science educator who got serious about his lifelong fascination with lizards and snakes in the early 1980s when he and his family made their first trip to Trinidad. The work on Trinidad and Tobago provided valuable lessons that shaped his views of nature and evolution, and today he is still working on the eastern Caribbean herpetofauna. In the 1990s, he did some work on homalopsid snakes in Southeast Asia with others from the Field Museum (Chicago, Illinois, USA). He now resides in southeastern Arizona and is involved in multiple projects on arid habitats and the impacts of climate change on biodiversity. His most recent book is *Giant Snakes, a Natural History* (with co-author Tom Crutchfield). Born and raised in Joliet, Illinois, he first learned about reptiles on his grandfather's farm by watching Eastern Garter Snakes emerge from their winter dens and Snapping Turtles depositing their eggs at the edge of a cattail marsh.

**Mayke De Freitas Santos** is a conservationist with postgraduate studies in International Environmental Law (SOAS) and Conservation Leadership (University of Cambridge, England) who has worked for various international NGOs both in Venezuela and Europe. Mayke focuses on the governance of protected areas, as well as remote sensing and habitat quality assessments of amphibian species. He is a contributor to the IUCN Red List for several species of amphibians and reptiles from the Peninsula de Paria, Venezuela, where he has worked since 2011.

**Gilson A. Rivas** was born in Caracas, Venezuela. He currently serves as co-editor of the scientific journal *Anartia*, and is a collection manager at the Museo de Biología de la Universidad del Zulia, Maracaibo—a Venezuelan centennial university that began academic activities on 11 September 1891. For over two decades, Gilson has been devoted to the taxonomy and conservation of the neotropical herpetofauna, having authored or co-authored more than 100 academic publications, and describing over 30 new species of amphibians and reptiles, and a new genus of dipsadine snake, *Plesiodipsas*. Gilson is the author (with G. Ugueto) of the book *Amphibians and Reptiles of Margarita, Coche, and Cubagua*; and together with M. De Freitas, H. Kaiser, C.L. Barrio-Amorós, and T.R. Barros produced *Amphibians of the Península de Paria: a Pocket Field Guide*. Gilson's research interests are focused on the herpetofauna of the Venezuelan coastal range and insular ecosystems, as well as the influences of invasive species and human development and their impact on the native fauna.

**J. Roger Downie** is a semi-retired Professor of Zoological Education at the University of Glasgow, Scotland. During his long association with Trinidad and Tobago, he has contributed to research on amphibians and marine turtles in collaboration with Glasgow students, and many others, on numerous research expeditions.

**Supplementary Fig. S1** Maps showing the GPS coordinates where *Flectonotus fitzgeraldi* was found to be present and clipped polygon shapes used to calculate the total area of occurrence for *F. fitzgeraldi* in Trinidad, Tobago, and Venezuela (Supplementary Fig. S1a–c). The areas of occurrence are Trinidad: 2,922.4 km$^2$; Tobago: 30.1 km$^2$; and Venezuela: 3,713.4 km$^2$.

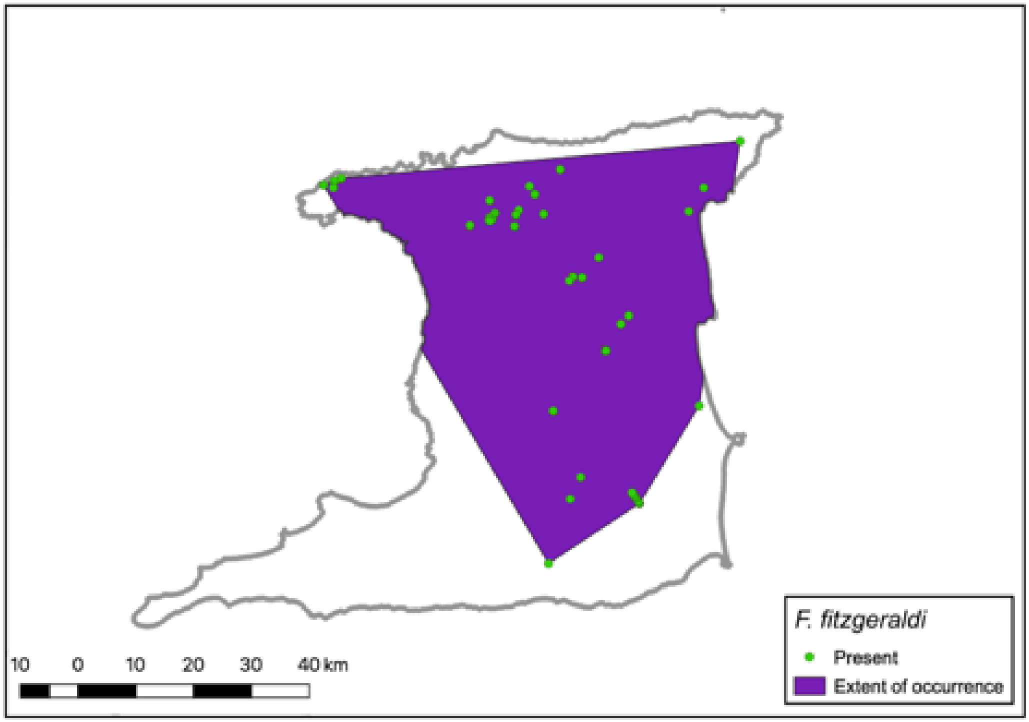


**Fig. S1a.** Presence and total area of *Flectonotus fitzgeraldi* occurrence in Trinidad.

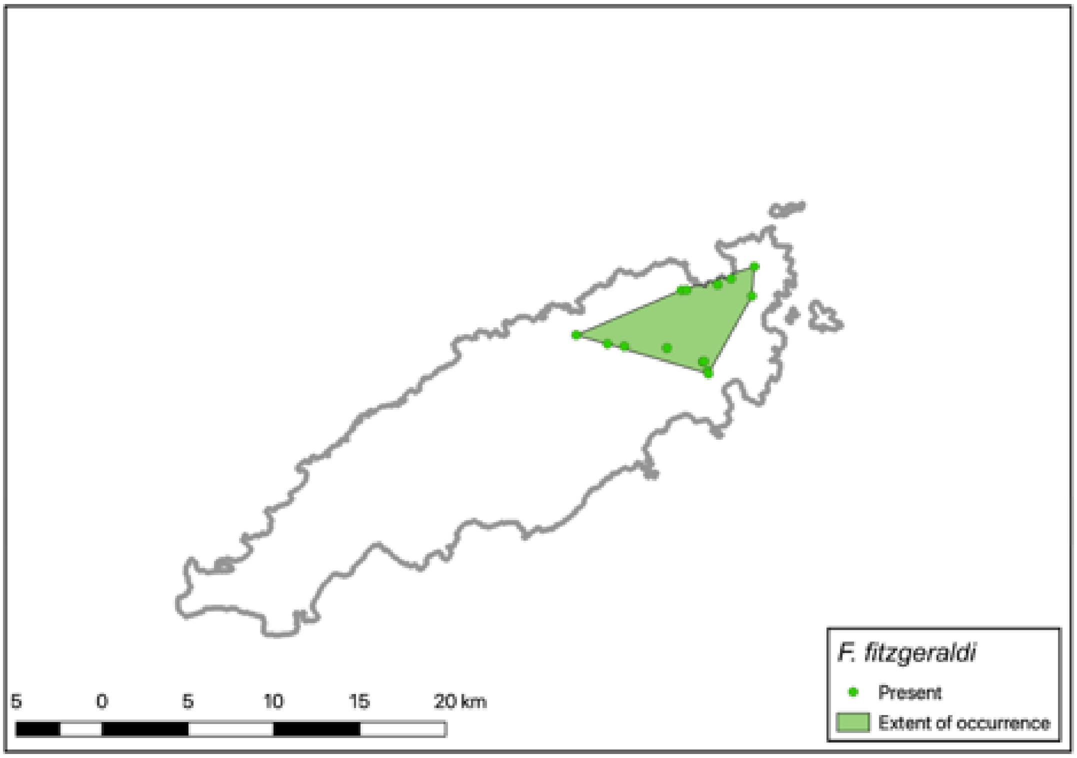


**Fig. S1b.** Presence and total area of *Flectonotus fitzgeraldi* occurrence in Tobago.

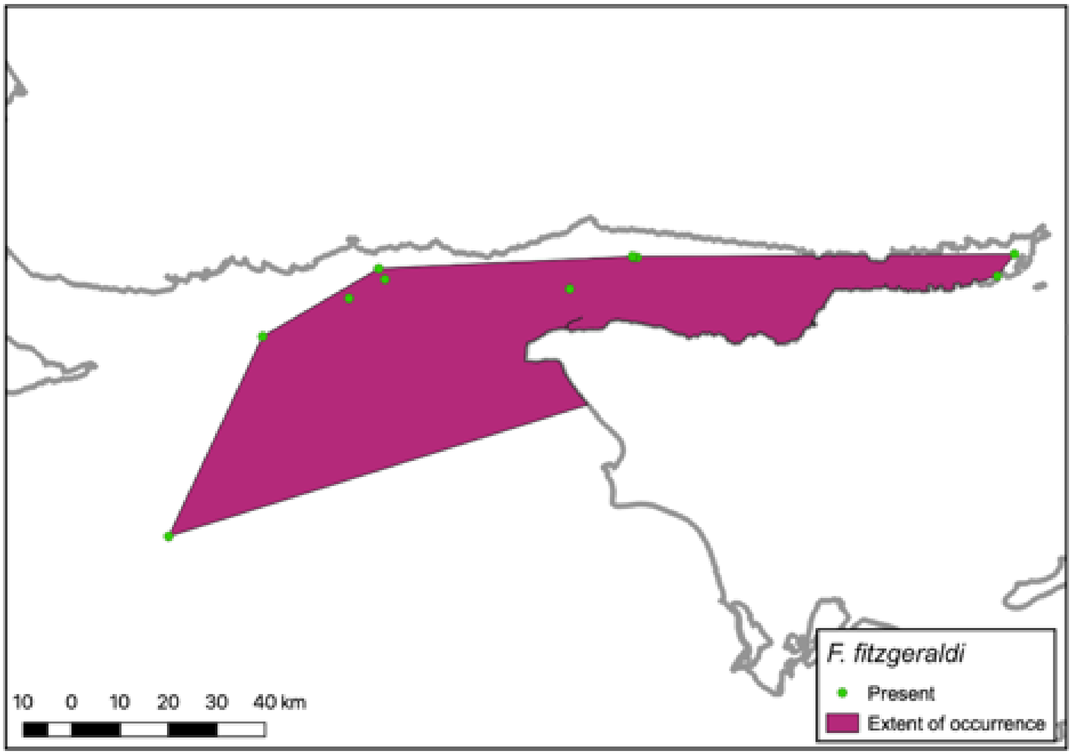


**Fig. S1c.** Presence and total area of *Flectonotus fitzgeraldi* occurrence in Venezuela.

**Supplementary Table S1.** Complete dataset of sites in Trinidad, Tobago, and Venezuela surveyed for *Flectonotus fitzgeraldi* in this study. The "Site no." column refers to the numbered locations in Fig. 3 and Table 2.

| Year(s) | Country | Location | Site no. | Coordinates | Present / absent | Source |
|---|---|---|---|---|---|---|
| 2019 | Tobago | Bloody Bay Stream | 1 | 11°17'26.5"N; 60°38'00.7"W | Present | Authors' unpub. field notes, 2019 |
| 2012 | Tobago | Bloody Bay Stream | 1 | 11°17'9.8"N; 60°37'00.9"W | Present | Eyre 2013 |
| 2019 | Tobago | Cambleton Trail | 2 | 11°19'01.5"N; 60°33'29.5"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Manowar Cottages (Charlotteville) | 3 | 11°19'12.6"N; 60°33'03.7"W | Present | Authors' unpub. field notes, 2019 |
| 2015 | Tobago | Manowar Cottages (Charlotteville) | 3 | 11°19'11.5"N; 60°33'01.5"W | Absent | Rutherford 2018a |
| 2019 | Tobago | Doctors River | 4 | 11°18'39.7"N; 60°32'23.7"W | Present | Authors' unpub. field notes, 2019 |
| 2012 | Tobago | Flagstaff Hill Charlotteville | 5 | 11°19'48.7"N; 60°32'35.5"W | Present | Authors' unpub. field notes, 2012 |
| 2019 | Tobago | Flagstaff Hill Windward Road | 5 | 11°19'35.4"N; 60°32'19.2"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Hermitage River | 6 | 11°18'51.0"N; 60°34'39.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Hermitage | 6 | 11°18'51.4"N; 60°34'29.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Louis D'Or Streams | 7 | 11°16'36.0"N; 60°33'58.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Louis D'Or Streams | 7 | 11°16'10.0"N; 60°33'52.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Louis D'Or Streams | 7 | 11°16'37.0"N; 60°33'56.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Louis Original | 7 | 11°16'18.5"N; 60°33'48.8"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Louis Second | 7 | 11°16'13.8"N; 60°33'47.2"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Main Ridge (Spring Trail) | 8 | 11°17'12.5"N; 60°35'43.9"W | Absent | Authors' unpub. field notes, 2019 |
| 2019 | Tobago | Main Ridge (Gilpin Trail) | 9 | 11°17'05.3"N; 60°36'28.4"W | Present | Authors' unpub. field notes, 2019 |
| 2010, 2012 | Tobago | Main Ridge (central) | 10 | 11°17'02.2"N; 60°35'06.8"W | Present | Authors' unpub. field notes, 2010, Eyre 2013 |
| 2006, 2007, 2012, 2013, 2014, 2019 | Trinidad | Morne Bleu (Arima Valley) | 1A | 10°43'37.0"N; 61°18'21.0"W | Present | Ogilvy et al. 2007; Smith 2008; Greener 2015; Rutherford 2014; Authors' field notes, 2019 |
| 2006, 2007, 2012, 2013, 2014, 2019 | Trinidad | Simla (Arima Valley) | 1B | 10°41'01.0"N; 61°16'59.9"W | Present | Ogilvy et al. 2007; Smith 2008; Greener 2015; Rutherford 2014; Authors' field notes, 2019 |
| 2006, 2007 | Trinidad | Springhill Estate (Arima Valley) | 1C | 10°42'51.1"N; 61°17'51.4"W | Present | Ogilvy et al. 2007; Smith 2008 |
| 2015 | Trinidad | Aripo Savanna | 2 | 10°36'59.0"N; 61°11'47.0"W | Present | Auguste et al. 2015; Auguste and Hailey 2018 |
| 2019 | Trinidad | Brasso Seco | 3 | 10°45'10.3"N; 61°15'26.0"W | Present | Authors' unpub. field notes, 2019 |
| 2016 | Trinidad | Caroni Swamp, Northern Section | 4 | 10°38'16.8"N; 61°29'29.8"W | Absent | Bioblitz, 2016 |
| 2019 | Trinidad | Chatham | 5 | 10°07'17.1"N; 61°46'11.8"W | Absent | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Cumuto St. Raphael Road | 6 | 10°35'06.0"N; 61°13'22.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Cumuto St. Raphael Road | 6 | 10°35'10.0"N; 61°14'15.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Cumuto St. Raphael Road | 6 | 10°34'49.0"N; 61°14'34.0"W | Present | Authors' unpub. field notes, 2019 |

**Supplementary Table S1 Continued.** Complete dataset of sites in Trinidad, Tobago, and Venezuela surveyed for *Flectonotus fitzgeraldi* in this study. The "Site no." column refers to the numbered locations in Fig. 3 and Table 2.

| Year(s) | Country | Location | Site no. | Coordinates | Present / absent | Source |
|---|---|---|---|---|---|---|
| 2012, 2013, 2014 | Trinidad | Caura Valley | 7 | 10°40'02.0"N; 61°22'08.0"W | Present | Greener 2015 |
| 2012, 2013, 2014 | Trinidad | Caura Valley | 7 | 10°40'27.1"N; 61°22'09.0"W | Present | Greener 2015 |
| 2019 | Trinidad | Caura Valley | 7 | 10°42'17.7"N; 61°22'06.1"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Caura Valley | 7 | 10°41'06.1"N; 61°21'38.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Caura Valley | 7 | 10°40'52.6"N; 61°21'48.3"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Caura Valley | 7 | 10°40'30.9"N; 61°21'54.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Caura Valley | 7 | 10°40'39.3"N; 61°22'08.9"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Caura Valley | 7 | 10°40'26.2"N; 61°22'11.9"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Caura Valley | 7 | 10°40'23.0"N; 61°22'04.3"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Edith Falls | 8 | 10°44'21.3"N; 61°36'50.2"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Edith Falls | 8 | 10°44'05.9"N; 61°36'50.8"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Edith Falls | 8 | 10°43'45.3"N; 61°37'04.1"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Edith Falls | 8 | 10°43'27.7"N; 61°36'54.5"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Grande Riviere | 9 | 10°49'19.0"N; 61°02'39.9"W | Present | Authors' unpub. field notes |
| 2019 | Trinidad | Guaico Tamana Rd. | 10 | 10°31'33.0"N; 61°08'57.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Guaico Tamana Rd. | 10 | 10°30'46.0"N; 61°09'41.0"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Icacos Southern Main Road | 11 | 10°04'13.7"N; 61°53'39.9"W | Absent | Authors' unpub. field notes |
| 2017 | Trinidad | Icacos | 11 | 10°02'51.4"N; 61°54'07.2"W | Absent | Rutherford 2018c |
| 2019 | Trinidad | Lopinot Valley | 12 | 10°41'23.9"N; 61°19'22.4"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Lopinot Valley | 12 | 10°40'57.8"N; 61°19'37.6"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Lopinot Valley | 12 | 10°39'54.0"N; 61°19'45.7"W | Present | Authors' unpub. field notes, 2019 |
| 2019 | Trinidad | Matura Beach Road | 13 | 10°39'46.8"N; 61°02'47.6"W | Absent | Authors' unpub. field notes |
| 2019 | Trinidad | Matura Forest | 14 | 10°41'16.0"N; 61°03'15.4"W | Present | Authors' unpub. field notes, 2019 |
| 2016 | Trinidad | Matura Forest | 14 | 10°43'27.8"N; 61°01'50.9"W | Present | Auguste et al. 2019 |
| 2019 | Trinidad | Moruga | 15 | 10°08'28.0"N; 61°16'32.2"W | Present | Authors' unpub. field notes, 2019 |
| 2012, 2013, 2014 | Trinidad | Mt. St. Benedict | 16 | 10°39'58.4"N; 61°23'59.1"W | Present | Greener 2015 |
| 2014 | Trinidad | Bush Bush Wildlife Sanctuary, Nariva Swamp | 17 | 10°23'09.6"N; 61°02'16.8"W | Present | Rutherford 2017 |

**Supplementary Table S1 Continued.** Complete dataset of sites in Trinidad, Tobago, and Venezuela surveyed for *Flectonotus fitzgeraldi* in this study. The “Site no.” column refers to the numbered locations in Fig. 3 and Table 2.

| Year(s) | Country | Location | Site no. | Coordinates | Present / absent | Source |
|---|---|---|---|---|---|---|
| 2016 | Trinidad | Plum Mitan, Nariva Swamp | 17 | 10°27’54.7”N; 61°04’52.3”W | Absent | Auguste et al. 2019 |
| 2016 | Trinidad | Kernahan, Nariva Swamp | 17 | 10°21’25.9”N; 61°00’59.0”W | Absent | Auguste et al. 2019 |
| 2016 | Trinidad | St. Ann’s, Port of Spain | 18 | 10°40’52.3”N; 61°30’21.6”W | Absent | Rutherford 2018b |
| 2016 | Trinidad | Mt. Hololo, Port of Spain | 18 | 10°41’18.2”N; 61°29’03.8”W | Absent | Rutherford 2018b |
| 2016 | Trinidad | Botanic Gardens, Port of Spain | 18 | 10°40’26.4”N; 61°30’47.5”W | Absent | Rutherford 2018b |
| 2016 | Trinidad | Lady Chancellor, Port of Spain | 18 | 10°41’18.2”N; 61°30’47.5”W | Absent | Rutherford 2018b |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’03.5”N; 61°07’55.1”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’03.4”N; 61°07’55.4”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’05.9”N; 61°07’56.9”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’06.2”N; 61°07’57.6”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’07.0”N; 61°07’58.2”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’15.1”N; 61°08’04.0”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’29.1”N; 61°14’29.1”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’33.0”N; 61°08’16.3”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’37.5”N; 61°08’17.9”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’46.6”N; 61°08’24.2”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°14’54.6”N; 61°08’31.9”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Rio Claro, roads south | 19 | 10°15’04.8”N; 61°08’38.2”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Tabaquite | 20 | 10°22’40.8”N; 61°16’06.2’W | Present | Bioblitz, 2019 |
| 2019 | Trinidad | Tableland | 21 | 10°16’30.0”N; 61°13’30.0”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Tamana Caves | 22 | 10°28’16.2”N; 61°11’11.5”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Tamana Caves | 22 | 10°28’19.6”N; 61°11’06.5”W | Present | Authors’ unpub. field notes, 2019 |
| 2019 | Trinidad | Tamana Caves | 22 | 10°28’17.0”N; 61°11’10.9”W | Present | Authors’ unpub. field notes, 2019 |
| 2018 | Trinidad | Cumana Forest, Toco | 23 | 10°47’47.0”N; 60°58’23.5”W | Present | Bioblitz, 2018 |
| 2016 | Trinidad | Trinity Hills | 24 | 10°08’08.5”N; 61°05’13.2”W | Absent | Auguste et al. 2019 |
| 2014 | Trinidad | Trinity Hills | 24 | NA | Present | Mohamed et al. 2014 |
| 2012 | Trinidad | Tucker Valley | 25 | 10°42’50.4”N; 61°36’33.1”W | Absent | Rutherford 2013 |
| 2017 | Venezuela | Cachipal | 1 | 10°38’02.5”N; 62°45’01.8”W | Present | MBLUZ 447; Rivas’ unpub. field notes, 2017 |
| 2003 | Venezuela | Camino desde Macuro a Los Chorros (vía Uquire) Península de Paria | 2 | 10°41’54.0”N; 61°54’45.0”W | Present | MHNLS 16199–16201 |

**Supplementary Table S1 Continued.** Complete dataset of sites in Trinidad, Tobago, and Venezuela surveyed for *Flectonotus fitzgeraldi* in this study. The "Site no." column refers to the numbered locations in Fig. 3 and Table 2.

| Year(s) | Country | Location | Site no. | Coordinates | Present / absent | Source |
|---|---|---|---|---|---|---|
| 2016 | Venezuela | Cerro Campeare | 3 | 10°32'45.4"N; 63°19'45.6"W | Present | Rivas' unpub. field notes, 2016; Rivas et al. 2018; EBRG |
| 2016 | Venezuela | Cerro La Cerbatana | 4 | 10°37'05.8"N; 63°10'45.3"W | Present | Rivas et al. 2018; EBRG |
| 2013 | Venezuela | La Margarita, Turimiquire | 5 | 10°10'32.0"N; 63°30'24.0"W | Present | EBRG 7034–35 |
| 2013 | Venezuela | Macuro, Península de Paria | 6 | 10°39'08.0"N; 61°56'11.0"W | Present | Barrio-Amorós et al. 2019 |
| 1978 | Venezuela | Mauraco, N del Pilar | 7 | 10°40'17.6"N; 63°06'38.6"W | Present | Duellman and Gray 1983; EBRG 519–520 |
| 1978 | Venezuela | Marauquito, Península de Paria | 8 | 10°39'06.0"N; 63°05'56.0"W | Present | MHNLS 10859 |
| 2002, 2003 | Venezuela | Quebrada Las Melenas | 9 | 10°41'32.1"N; 62°37'24.9"W | Present | Rivas et al. 2018; EBRG |
| 1993 | Venezuela | Uquire, Península de Paria | 10 | 10°42'34.0"N; 61°58'22.0"W | Present | EBRG 2585 |