



## A new species of iguana *Brachylophus* Cuvier 1829 (Sauria: Iguania: Iguanidae) from Gau Island, Fiji Islands

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### Abstract

The south Pacific iguanas (*Brachylophus*) currently have three recognized living species in Fiji. Recent surveys have uncovered more specific variation (morphological and genetic) within the genus and have better defined the geographic ranges of the named species. One of these recent discoveries is a strikingly different iguana from all other island populations in Fiji which is restricted to Gau Island of the Lomaiviti Province. Gau is the fifth largest island in Fiji and maintains excellent upland forests in the higher elevations. We describe this population from Gau Island as a new species, *Brachylophus gau* sp. nov., in recognition of its type locality.

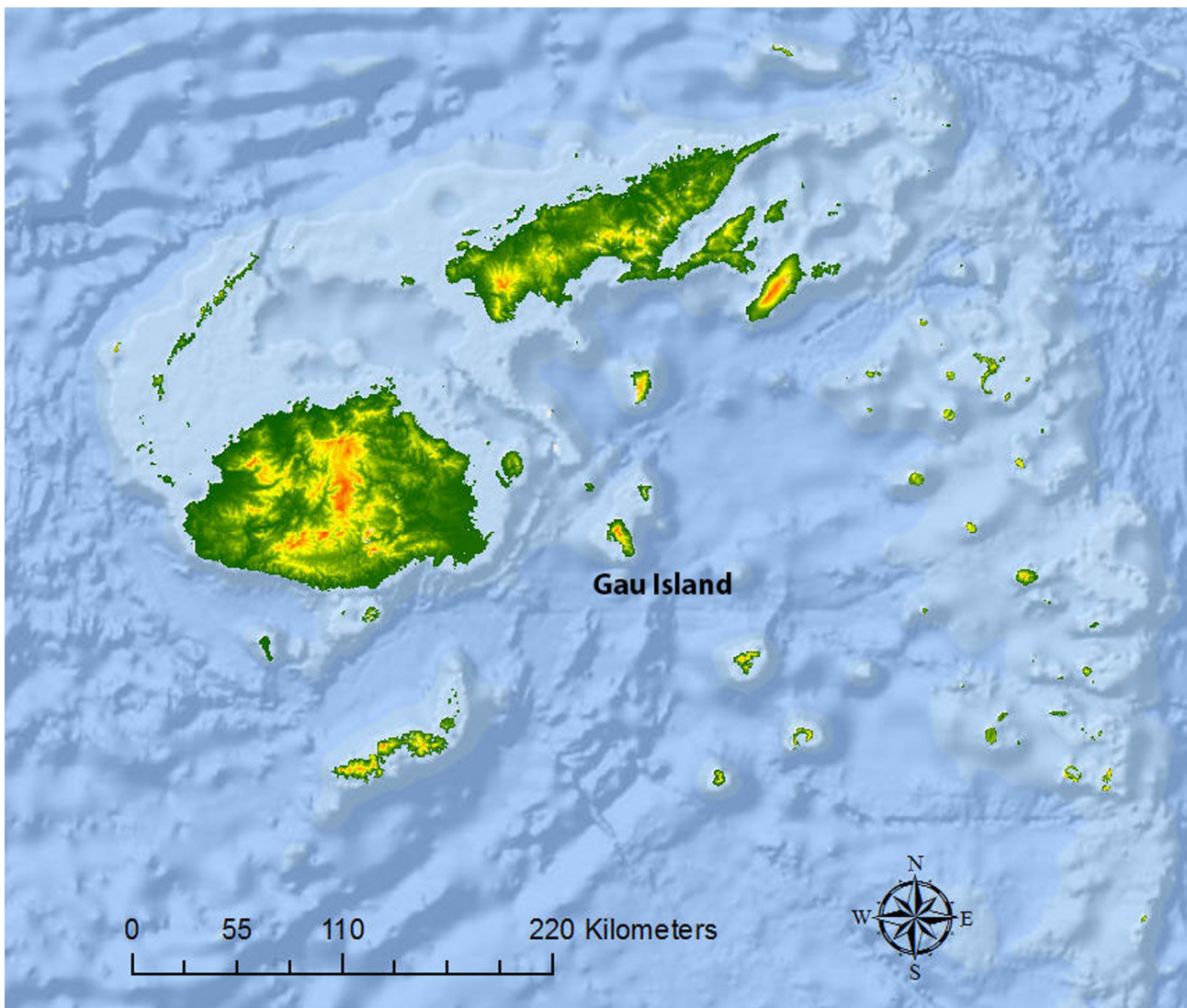
**Key words:** Pacific islands, endemism, conservation, Iguanian, *Brachylophus*, Gau Island

### Introduction

The genus *Brachylophus* currently consists of three living (*B. bulabula*, *B. fasciatus*, and *B. vitiensis*) and one extinct (*B. gibbonsi*) species of iguanas from Fiji and Tonga in the South Pacific (Pregill & Steadman 2004; Keogh *et al.* 2008). Additionally the extinct monotypic iguana genus *Lapitiguana* was also known only from Fiji and was twice the length of the largest living *Brachylophus* (Pregill & Worthy 2003). Iguanas have had a deep history in the South Pacific and these three extant species are the only true iguanidae remaining in the South Pacific. These iguanas have possibly been present there for 40 million years and their closest relatives occur in the New World in the North American southwest deserts (Townsend *et al.* 2011). Keogh *et al.* (2008) recently reviewed *Brachylophus* using the available genetic and morphological data, resulting in the author's description of the new species *Brachylophus bulabula*. All three living species were restricted taxonomically to only the islands where either of these data sets was available in that study. This avoided the issue of over predicting the range of these species from islands where no actual data was collected. This was a conservative approach as the various Fijian iguanas have been mapped as occurring on many more islands in various papers (Gibbons 1981, 1985; Gibbons & Watkins 1982; Zug 1991; Morrison 2003) but since there are no vouchers from most of these islands they were left as species uncertain in this recent taxonomic treatise (see Figure 1 in Keogh *et al.* 2008). Since 2009, we have been visiting many of the islands where iguanas or their habitat are still known, but from which no tissue samples, morphological measurements, or specimens exist. Our goal is to better define the taxonomic diversity within the genus and identify manageable conservation units.

Iguanas have been known from Gau Island for decades but there had been no specimens previously identified in museum collections for analysis (Watling 1986). Recent conservation work on Gau for the Fiji Petrel has brought renewed field surveys, which have included several detections of these iguanas from around the island. This area of Fiji is poorly collected and poorly known herpetologically (Zug 1991), so it is not surprising that this population of *Brachylophus* might exhibit some distinctive characteristics. These characteristics uniquely

distinguish it from the other three described species and we describe this population as a new species. Additionally we revisited historic museum specimens to determine if any match this new species as recent reassessments of historical specimens have found specimens of systematic significance (Ineich & Fisher 2016).



**FIGURE 1.** Map showing location of Gau Island, the only known location for this iguana species. No further details mapped due to sensitive nature of the records.

## Materials and Methods

Morphological measurements and color pattern descriptions are based on six different live specimens, five preserved specimens (some of which were also observed in life), and photos of seven additional individuals collected on Gau Island. All recent preserved specimens are housed at the University of South Pacific Herpetology Collection, Suva, Fiji (SUVA H). A total of 232 specimens of other species, including possible undescribed species, of *Brachylophus* were examined for comparison representing 38 other island populations. Few voucher specimens of *Brachylophus* exist in museums, and most of these have no specific locality information, but we searched for any that might represent this new species. Previously the majority of these museum vouchers were studied resulting, in part, in the description of *Brachylophus bulabula* (Keogh *et al.* 2008) and the rediscovery of the type of *B. fasciatus* (Ineich & Fisher 2016). In this study most of the new *Brachylophus* specimens analyzed were captured live and measured in the field, and photographs were taken to document additional color pattern characteristics. These live photos are critical as the color and color patterns typically fade rapidly in preservative.

The following list provides the character names and definitions, some of which are straightforward. Previously in Keogh *et al.* (2008), many of these were utilized but not necessarily defined in the text. Some changes in how they were recorded then have occurred recently as we discovered a greater phenotypic diversity in Fijian iguana populations, and thus many new characters were added. Not all characters are discussed in the text as they were not found to vary much within our current *Brachylophus* dataset but might be found variable later as we add more island populations. Expanded definitions of all characters are presented in Appendix 1.

*Measurements:* Width at widest point of body bands; width at dorsal crest of bands; dorsal crest spine maximum height; dorsal crest spine maximum width; ear diameter; eye diameter; forearm length; head height; head length; head width; internarial distance; crus knee to heel; naris-eye length; width of nuchal band; width of pelvic band; tail height; tail length; trunk length, between limbs; snout length, edge of eye to end of snout; snout-vent length; mass for live specimens.

*Scalation:* Femoral pores, total of left and right side, exuding only; number of points on third digit combs; toe combs with fused scales; postmental paired; total postmentals; mental single or divided; parietal eye size; head scale size, shape; labial-nasal contact; rostral-nasal contact; nasal color and intensity; number of scales encircling nasals, including labials; postnasal enlarged and bordering entire posterior portion of nasal; internasals total; number of scales encircling rostral, including labials; size of postnasal/preocular scales; dorsal crest spines; nostril placement; nostril shape; number combs digit three; number combs digit two.

*Coloration:* number dorsal bands; eye color; nuchal pattern. Additionally notes are taken on throat patterns and color, nuchal pattern, tail color and banding.

### ***Brachylophus gau* sp. nov.**

#### **Gau Iguana (pronounced Ngau)**

Figs. 2–7

*Brachylophus fasciatus* Gibbons 1984 (first map showing island record); Zug 1991; Morrison 2003 (on maps as literature record).

*Brachylophus bulabula* Fisher, Harlow, Edwards, and Keogh 2008.

**Holotype.** SUVA H 0264; collected in forest patch 1 km behind Nukuloa Village, Gau Island, Republic of Fiji (18°2'46.68"S; 179°18'11.41"E, datum WGS84); 243 meters in elevation; collected by Robert Fisher, Peter Harlow, Tuverea Tuamotu, Joeli Vadada, Maleli Biciloa, Mark O'Brien, Poasa Qalo, 1 July 2013.

**Paratypes.** SUVA H 0265 female collected same date, collectors, and locality as holotype (Figure 1). SUVA H 0266–0267 were collected at Nalaqere Creek (18°2'25.91"S; 179°17'12.05"E) on 2 July 2013, by the same collectors as the type. SUVA H 0273 was collected at Waitabua Hill (18°2'S; 179°18'E, WGS84), Gau Island, 439 meters in elevation, on 10 July 2013 by Mark Fraser and Poasa Qalo. BMNH 55.8.16.1-2 collected at Sawaieke (17°59'14"S; 179°15'12"E), Gau Island, between 12 and 27 September 1854 by John MacGillivray.

**Diagnosis.** This species has a unique combination of color pattern characters that distinguish it from all other species of described *Brachylophus* (Figures 2–7, Table 1). It also does not match any museum specimens we have previously seen in collections, except two from the BMNH that previously lacked specific locality info. These specimens are included in the type series as we were able to determine their provenance as Gau Island (see below in **Provenance of Historic Specimens** section). Although added to the type series, their measurements are left out of comparisons, but included in Table 2. We found that there are no locality specific museum vouchers that could represent extinct island populations of this species. Otherwise, this species differs from *B. vitiensis* by having sexually dichromatism, with banded males and females that are either unicolor or with small spots, and a maximum snout vent length for both sexes of 153 mm, versus 255 mm for *B. vitiensis*. It differs from *B. bulabula* and *fasciatus* in that males and females have green throats, whereas in these species males have white solid or white with green/grey spots or blotches, as do the females in most populations. Although in certain populations the females in *B. bulabula* and *fasciatus* the throat will be unicolor green, but never the males. It differs from the other three species by having a primarily green colored nasal scale. The mean snout vent length is 149.2 and max size for *B. gau* is 153 mm (n = 7), versus adult *B. fasciatus* with a mean 154.5 mm SVL and a maximum 176 mm SVL (n = 57) and *B. bulabula* with a mean 156.6 mm and a maximum 195 mm SVL (n = 23) (Table 1).

**TABLE 1.** Summary of the distinguishing characters between the four *Brachylophus* species.

	<i>B. gau</i>	<i>B. vitiensis</i>	<i>B. bulabula</i>	<i>B. fasciatus</i>
Sexual color pattern dichromatism	+	-	+	+
Nuchal band present in males	partial	+	+	-
Females with dorsal bands	-	+	-	-
Males with wide dorsal bands	+	-	+	-
Max size < 154 mm	+	-	-	-
Throat white or white with spots	-	-	+	+
Eye color in life	coppery	tan-gold	red	gold
Nasal scale color and intensity (see Figure 4 in Keogh <i>et al.</i> 2008)	green, similar to adjacent scales, light orange inside rim sometimes	yellow-orange entire nasal and extending to adjacent scales	yellow for entire nasal scale	orange but only around rim of scale
Habitat	Wet forest	Dry forest	Wet forest	Dry forest

**TABLE 2.** Measurements and scale counts of the holotype, paratypes, and other measured individuals of *Brachylophus gau* sp. nov.

	SPRH 0264 (Holotype)	SPRH 0265 (Paratype)	RNF 13-3-3 (Released)	RNF 13-3-4 (Released)	SPRH 0267 (Paratype)	SPRH 0266 (Paratype)	SPRH 0273 (Paratype)	BMNH 55.8.16.2 (Paratype)	BMNH 55.8.16.1 (Paratype)
Sex	M	F	F	M	M	M	F	M	F
SVL	150	122	153	108	152	153	145	113	127
TL	regenerated	370	440	325	483	510	414	320	412
Mass (gm)	80	55	118	36	92	-	-	-	-
Total pores	31	26	30	31	28	40	28	23	29
Dorsal Crest spines	67	71	77	68	67	82	71	86	73
Max spine height	1.6	1.6	1.7	1.6	1.5	1.8	1.3	1.1	1.9
Subocular scales	fused on one side, enlarged on other	fused on both sides	-	-	fused on both sides	fused on both sides	enlarged on both sides	-	-
HW	19.3	15.2	17.9	15.1	19.4	20.1	19.6	16	19
HL	31.4	26	31.5	24.3	32.2	32.4	29.9	25.9	30
HH	18.1	14.7	17.4	13.6	20	19.4	18.7	16.6	19.6
Trunk length	62.5	65.8	74	48.4	70.7	77.5	81	59	68
Forearm length	24.7	24.5	27.5	18	27.7	26.8	29.2	21.7	26.2
Crus-knee to heel	29	26	30.1	22.3	32.1	29.8	29.6	25.3	30.6
Snout length	14.2	11.9	13.3	10.6	14.3	13.4	13.3	11	13.5
HL/SVL (%)	20.93	21.31	20.59	22.50	21.18	21.18	20.62	22.92	23.62
TL/SVL	-	3.033	2.876	3.009	3.178	3.333	2.855	2.832	3.244
HW/HL (%)	61.465	58.462	56.825	62.140	60.248	62.037	65.552	61.776	63.333

**Description of holotype.** Holotype is an adult male (Figure 2–3). Meristics are as follows: snout vent length 150 mm, tail length regenerated, live weight 80 gm, head length 31.4 mm, head width 19.3 mm, head height 18.1 mm, and jaw length 24.4 mm. It has 16 elongated/enlarged upper labials (9 left, 7 right) and 17 elongated/enlarged lower labials (8 left, 9 right). Rostral enlarged and triangular wide at base, apparently split on the left side and contacts with nasal scale only on the right side. Mental is incised half way anteriorly, with three postmental scales between the labial scales. Tympanum is translucent and unpigmented, vertical and oval in shape with less height (5 mm) than the eye is wide (6.4 mm). Nostril scale squarish with egg shaped opening raised dorsally within the scale, pale orange in color within the opening, fades to light-green over the rest of the scale. Parietal eye small and scale containing parietal eye similar in size to surrounding parietal. Supraocular head scales smallest, other head scales larger and polygonal shaped, a fused subocular scale on the right side, enlarged subocular scales on the left side. Dewlap is small in size, slightly rounded and unicolor with the throat. Poorly defined gular pouch covered with smaller scales.



**FIGURE 2.** Illustration of the holotype (SUVA H 0264; left) and paratype female (SUVA H 0265; right) of *Brachylophus gau* **sp. nov.** The painting is from photographs of these specimens and others from life. Measurements to scale within illustration. The holotype is missing later 2/3 of tail, but tail drawn here based on photos from other males. Painting by Cindy Hitchcock.



**FIGURE 3.** Preserved holotype of *Brachylophus gau* sp. nov. (SUVA H 0264): A) dorsal view; and B) ventral view. Note distinctive striping on rear legs and diffuse banding on dorsal, and lack of differentiation in throat color from ventrum and no spotting, also tail lacking any distinctive ventral banding. Photo by Baravi Thaman.

Two nuchal bands on right side, one originating at tympanum and continuing posteriorly, reaching nuchal crest, the other above shoulder, left side contains one band with some spotting; two dorsal body bands, both with a dorsal bifurcation leading to green infusion within the bands similar to a saddle at the dorsum, one axial band, and all bands not completely colored, with some background diffusion. Tail regenerated and three tail bands, banding

fades posteriorly into background tail coloration. Nuchal crest poorly defined, 67 modified scales, up to 1.6 mm in height and 2.3 mm in width on the nuchal region. Dorsal scales small and conical shaped. Ventral scales much larger than dorsal ones, elongated and strongly keeled, with posterior ends pointed and elevated.



**FIGURE 4.** Photo of a live male *Brachylophus gau* sp. nov., illustrating the green throat and diffusion within the dorsal bands. Photo by Joerg Kretzschmar.

Limbs long and thin covered with keeled scales similar in size to ventral ones; forearm length 24.7 mm, crus-knee to heel 29 mm. Digits elongated, palms covered with small keeled scales. Third digit of hind feet contains a denticulate comb on proximate phalynx with some fusion of scales. Toenails very long and not worn. Total of 28 enlarged exuding femoral pores (15 left; 13 right). Tail laterally compressed in cross section, weakly crested for first 30% then undifferentiated. Anterior dorsal scales on tail smaller than ventral ones. All tail scales keeled and posteriorly all scales become similar in size and larger.

**Color in life.** Head is emerald green with a white stripe lining the lower jaw just at margin. No blue on face. Eye is copper or coppery brown, and a light orange rim around the interior of the nostril. Throat color is unicolor green but hints of some grey bars. No color break but a subtle transition between throat and venter. Dorsal body background color is an avocado green and transitions to a sulfurous green ventrally. There are two wide bands across the back of a blue/grey green color, but diffused with background color and head color via individual scales. The bands do not cross to the ventral side and break into saddles at dorsal crest. Tail with three bands colored as body, but the last two very faded, this is first third of tail then brown bands towards the anterior. The tail maintains a white lateral border. Hindlimbs with striking recurved bars colored as with body stripes. Forelimbs are unicolor. Dorsal crest scales are green and become less distinctive towards anterior.

**Color in alcohol.** Overall dorsal color is greatly darkened with banding less distinctive but still present. Ventral maintains light-green to blue-grey coloration. Dewlap remains unicolor and not distinctive from ventral coloration. Striking leg banding is obscured. Nasal scale retains light orange color within rim. Parietal eye relatively obscure. Tympanum translucent. Tail becomes brownish and bands become less obvious towards tip.

**Variation.** The diagnosis above describes some of the variability in this species for the main characteristics that distinguish it from the other living forms (Table 1). Variability in scalation and measurements for *B. gau* are reported in Table 2. Overall it's a gracile species with long legs and tail. Additional variability in this species is described here and includes either fused or elongated subocular scales in all of the paratypes. Relatively high femoral pore counts. Short dorsal crest height, but high number of dorsal crest scales. Males with two wide dorsal bands, a pelvic band, and a partial nuchal band. Background color of males and females the same lime green. Females have small blue spots anteriorly when looked at closely.



**FIGURE 5.** Photos of two live female *Brachylophus gau* sp. nov., illustrating the overall green coloration and light spotting. Photos by Mark Fraser and Theo Blossom.





**FIGURE 6.** Photo of preserved male paratype of *Brachylophus gau* sp. nov., (BMNH 55.8.16.2) collected during September 1854 by John MacGillivray on Gau Island. Photo by Sam Fisher.



**FIGURE 7.** Photo of preserved female paratype of *Brachylophus gau* sp. nov., (BMNH 55.8.16.1) collected during September 1854 by John MacGillivray on Gau Island. Photo by Sam Fisher.

**Etymology.** The specific epithet is for the only island where the species is known to occur, Gau.

**Comparisons.** Table 1 reports the most important characters that distinguish between *B. gau* and the other three living *Brachylophus* species. One important difference is that this species has fused or elongated subocular scales, and these scales are as long or longer as the eye, this condition is rare in *Brachylophus*, and absent in most populations. Dorsal crest scales average 53.2 with a range of 45–60 ( $n = 50$ ) for *B. vitiensis* and for *B. bulabula* dorsal crest scales vary in number between 55–88 with an average of 66.2 ( $n = 14$ ). *B. gau* has a greater count than these two species with an average of 71.8 and a range of 67–82 ( $n = 7$ ), and a lower count than *B. fasciatus* which averages 74.6 with a range of 52–94 ( $n = 48$ ). It also has the shortest dorsal crest scales of any species, with a maximum height of 1.8 mm ( $n = 7$ ). So comparing it to *B. vitiensis*, it is much shorter, with longer legs and tail, thinner build with fewer dorsal crest spines. Its nasal is mostly the same color as the head with a slight orange tinge on the rim. It has unicolor females, versus the banded females of *B. vitiensis*. When compared to *B. bulabula*, this species is shorter by almost 25%, it has a uniform lime green throat, with few black spots, versus white throat in

males that may have grey/green or black barring. It lacks a strong nuchal band in males, and has very little orange on the nasal scale. Finally comparing *B. gau* to *B. fasciatus*, it has much wider dorsal bands in males, and a more coppery eye, versus the gold eye of *B. fasciatus*. It lacks the pastel light blue that *B. fasciatus* tends to have on the anterior of the face, and instead has unicolor lime green head color.

**Distribution.** *Brachylophus gau* appears restricted to the large inland forest patches on Gau Island (Figure 1). Iguanas were reported from Gau by Watling (1986), but no specimens were collected or described. It continues to be widespread in high quality forest habitat in the interior of Gau Island (Figure 8), with some individuals also in degraded forest closer to the coast (Figure 9). Gau is about 136 sq. km. in size and is the fifth largest island in Fiji.



**FIGURE 8.** Photo showing extensive intact patch of moist forest at higher elevations on Gau Island. Photo courtesy of NatureFiji-MareqetiViti.

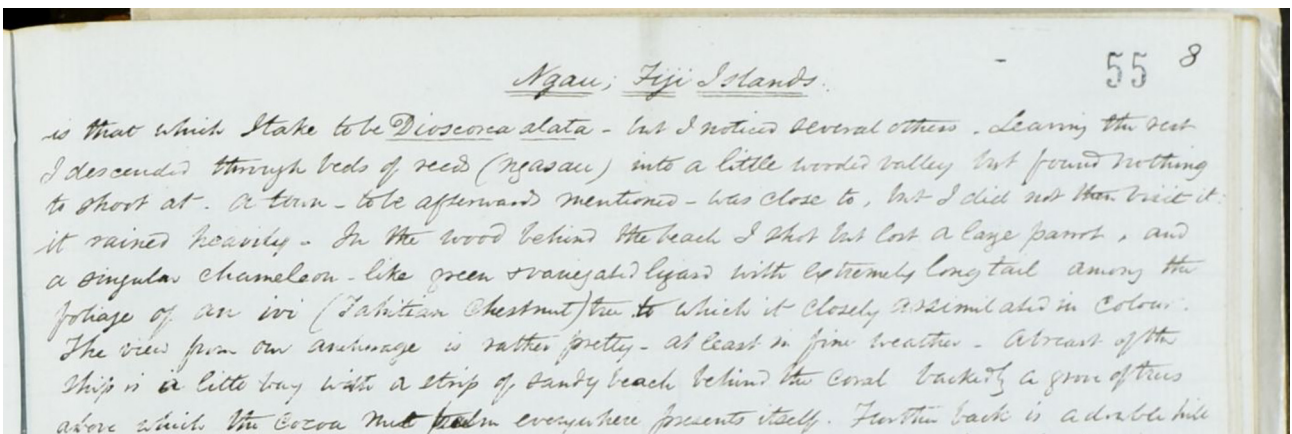
**Provenance of historic specimens.** The two specimens at the Natural History Museum, London (BMNH 55.8.16.1-2) were obviously *Brachylophus gau* based on morphology, but lacked specific locality information except that they were submitted by John MacGillivray, esq. and from H.M.S. *Herald*. A more complete log of the overall expedition of the *Herald* within Fiji is presented by David (1995). By examining his expedition notes we were able to determine that John MacGillivray directly discusses finding and collecting an iguana on Gau Island (as he spells it Ngau) on page 55, on line 4 (Figure 10; MacGillivray 1855):

In the wood behind the beach I shot but lost a large parrot, and a singular chameleon—like green + variegated lizard with extremely long tail among the foliage of an ivi (Tahitian Chestnut) tree to which it closely assimilated in colour.

Later he summarizes his reptile samples from Gau Island collected between September 12<sup>th</sup> and 27<sup>th</sup>, 1854, and highlights the *Brachylophus*, and accurately points out that as of this time there were no samples yet in the British Museum (MacGillivray 1855). Additionally he discusses/collected *Gehyra vorax*, *Laticauda* sp. and *Candoia bibroni* from Gau Island. This is from page 59 of his notes (Figure 11):



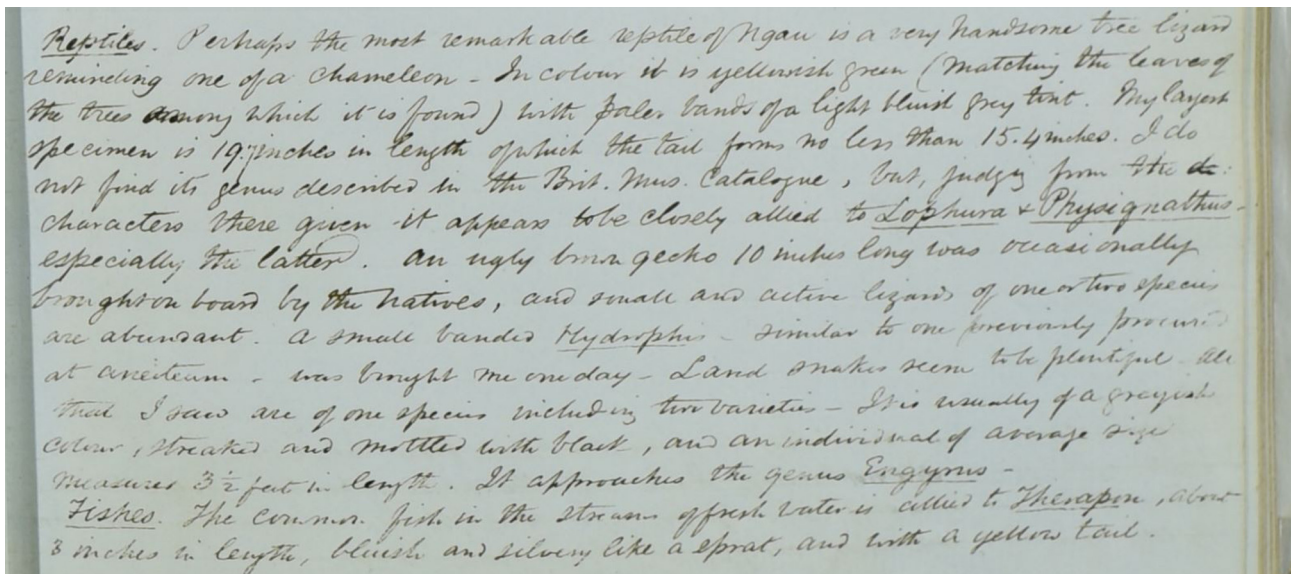
**FIGURE 9.** Photo showing coastal mangroves and lowland forest patch on Gau Island, but severe habitat degradation between these coastal habitats and the intact forest at higher elevations. Photo courtesy of NatureFiji-MareqetiViti.



**FIGURE 10.** Partial scan of page 55 of Volume II of John MacGillivray's private journal from 12–27 September, 1854, discussing field work near Sawaieke Village on Gau Island (MacGillivray 1855). This is his first time finding an iguana in the field. Scan courtesy of National Archives, Kew.

Reptiles. Perhaps the most remarkable reptile of Ngau is a very handsome tree lizard reminding one of a chameleon. In colour it is a yellowish green (matching the leaves of the trees among which it is found) with paler bands of a light bluish grey tint. My largest specimen is 19.7 inches in length of which the tail forms no less than 15.4 inches. I do not find its genus described in the Brit. Mus. Catalogue, but, judging from the characters there given it appears to be closely allied to Lophura + Physignathus especially the latter. An ugly brown gecko 10

inches long was occasionally brought on board by the natives, and small and active lizards of one or two species are abundant. A small banded Hydrophis—similar to one previously procured at Aneitium, was brought me the one day. Land snakes seem to be plentiful all that I saw are of one species including two varieties. It is usually of a greyish colour, streaked and mottled with black, and an individual of average size measures 3 ½ feet in length. It approaches the genus Engyurus.



**FIGURE 11.** Partial scan of page 59 of Volume II of John MacGillivray's private journal from 12–27 September, 1854, discussing the reptiles collected on Gau Island during his trip there on the HMS *Herald* (MacGillivray 1855). He extends his discussion of the iguana from Gau in this section. Scan courtesy of National Archives, Kew.

**Discussion and Conservation implications.** Our lack of knowledge of diversity within *Brachylophus* in the southwest Pacific has the potential of permitting the extirpation and extinctions of other divergent populations of iguanas (Harlow *et al.* 2007). The Gau iguana appears to be a single island endemic, as are several other iguana populations that most likely warrant species status (Fisher *et al.* unpub.). The nearest populations of *Brachylophus* to *B. gau* are *Brachylophus* cf. *bulabula* on Nairai Island, approximately 15 km to the northeast (Figure 12), and *Brachylophus* cf. *bulabula* on Wakaya Island approximately 43 km to the northwest (Fisher *et al.* 2013). Further analysis needs to be conducted to determine the relationships of these populations to *B. gau*. As with other populations of iguanas in Fiji, this species is restricted to intact patches of forest and lives high in the canopy (Figure 13). Currently much of the low to mid elevation forest on Gau is highly degraded and no longer serves as iguana habitat, and iguanas are not known to cross these grassy or unsuitable plantation habitats to get to other forest patches (Figure 12). Nothing is known of its reproduction but other species of *Brachylophus* lay one clutch of a few eggs (4–6) per year or every two years. These are placed in a shallow hole in the soil under the forest canopy.

Revisiting conservation strategies for this group of enigmatic iguanas in Fiji is a priority, as there continues to be many threats in addition to forest loss and fragmentation, including invasive mammals such as mongoose, cats, and rats, and these iguanas continue to be harvested for the illegal wildlife trade. Local outreach and education will be an important tool in their long-term protection and the protection of their habitats into the future. Gau Island had previously been identified as a site of conservation significance for Fiji due to its retention of an altitudinal range of moist forest in a large single block that supports Fiji's only endemic seabird (Olson *et al.* 2010). Although approximately 40% of Gau contains forested habitats, many of these habitats occur as isolated patches at the lower elevations. Although alien invasive species are widespread on the island, cats in particular have the greatest impacts on iguanas (Gibbons 1984; Priddel *et al.* 2009). Thorough surveys across the island are required to determine the actual range of the species, to identify critical hotspots of high abundance, and to identify cat control areas. Whether this species is found in the highest uplands of the island is also unknown, as we only surveyed coastal and at mid-elevation forests, with the highest record of an iguana being approximately 440 meters elevation.

As Gau Island is the home of the only endemic sea bird in Fiji (Watling 1986), it is presumed to have high levels of endemism in other groups as exemplified by our study here and studies on groups such as invertebrates and plants (Keppel *et al.* 2010; Sarnat & Moreau 2011). In a comparison of 1 ha vegetation plots across the Pacific, Gau had the highest level of recorded tree endemism (56.5%) across islands (Keppel *et al.* 2010). So with Gau Island there still is great opportunity to work with the local communities to conserve what is left of significant habitat patches that can serve for both the conservation of the endemic iguana and the rest of the endemic biodiversity on the island (Remling & Veitayaki 2016).



**FIGURE 12.** Photo from mid-elevation on Gau Island, looking across to Nairai Island, which is the next closest island that currently is occupied by iguanas. Extreme habitat degradation is shown looking across the landscape, with invasive grasslands and plantations separating coastal forest patches from higher elevation intact forest. Photo courtesy of NatureFiji-MareqetiViti.

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**FIGURE 13.** Photo showing typical forest composition within healthy forest patches on Gau Island. Because of cyclone disturbance history, these patches maintain a diversity of different tree size classes (Keppel *et al.* 2010). Photo courtesy of NatureFiji-MareqetiViti.

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## APPENDIX

Description of the characters recorded for the iguana specimens. Some characters can only be recorded from living iguanas. As the field study has progressed, additional characters have been added. Due to the technical difficulties in returning to previously visited sites, and finding iguanas for capture and measurement, some characters are unrecorded for some islands/populations. Additionally, some of the extreme value ranges recorded are from museum specimens with locality data that cannot be validated. It is probable that each of the three described species include additional variation within them that represented additional undescribed forms. Measurements are taken with dial calipers, except the snout vent length, which is typically taken with a stiff ruler, and the tail length which is taken with a soft vinyl or fiberglass tape measure. All measurements are recorded in millimeters. All counts and measurements are taken on the left side of the body, if possible. Most counts are recorded from both sides and the average or left one is reported.

### Measurements:

*Width at widest point of body bands:* This is measured horizontally at the widest point along the lateral side of the iguana. Width is measured for each band starting with anterior, but on the left side only.

*Width at dorsal crest of bands:* Width is measured for each body band but at the dorsal crest. Again a measurement is taken for each band starting with the most anterior one.

*Dorsal crest spine maximum height*: This is measured at the highest spine, which is typically within the first 15 spines anteriorly.

*Dorsal crest spine maximum width*: This is measured at the widest spine which is typically within the first 15 spines anteriorly. Measured where the spine hits the crest of the body.

*Ear diameter*: This is taken at the longest cross-section axis of the ear.

*Eye diameter*: This is measured across eye, at the widest point.

*Forearm length*: Measured from the inside of the palm to the outside of the elbow, while the arm is bent 90 degrees.

*Head height*: This is measured as the widest point between the parietals on top of the head to the gulars under the throat.

*Head length*: This is measured from the rostrum to the rear edge of the lower mandible on the lateral side of the head.

*Head width*: This is measured as the widest point on the sides of the head approximately at the temples. Perpendicular to the body axis.

*Internarial distance*: This is the distance between the interior side of one naris to the interior side of the other naris.

*Crus knee to heel*: This is measured as the distance from the outside of the knee to the base of the heel.

*Naris-eye length*: Measured from the nearest point of the eye to the posterior edge of the nasal opening.

*Width of nuchal band*: If present it is measured where it hits the dorsal crest.

*Width of pelvic band*: If present it is the band that crosses to the dorsal crest above the hind legs.

*Tail height*: The highest point posterior to the hind legs. For males, two measurements are taken, one at hemipenes and another at highest point posterior to hemipenes.

*Tail length*: Measured from posterior edge of cloaca to tip of tail. As the tails have no fracture planes, and a modified scale at tip, it was easy to determine if tail was complete. Any variance from complete tail was noted.

*Trunk length*: Measured from the posterior insertion of the forelimbs to the anterior insertion of the hindlimbs.

*Snout length*: Measured as the anterior edge of eye to end of snout (rostral scale).

*Snout-vent length*: From the tip of rostral scale to the cloaca.

*Mass for live specimens*: Taken in grams with a pescola scale. Iguanas were either balanced on a tared rubber band or placed in a tared cloth sack.

#### **Scalation:**

*Femoral pores, total of left and right side, exuding only*: For males, only pores with obvious dilation and exudate were counted. Additionally, smaller pin-hole pores were counted for males and females, and for males a total of both was recorded.

*Number of points/tines on third digit combs*: The third toe has a modified set of discrete enlarged scales. Counted on both left and right side; left side used for comparisons.

*Toe combs with fused scales*: This character is whether there is evidence of fusion between the tines on the combs of the toes if the combs are present.

*Postmentals paired*: Yes if paired; no if odd number.

*Total postmentals*: Count of scale row directly behind mental, not counting labials.

*Mental single or divided*: Conditions were entire, divided, or quarters of divided (i.e. half).

*Parietal eye size*: Large or small were the conditions, large was the eye aperture similar in size to adjacent scales, small the aperture was more of a pin-hole or almost absent.

*Head scale size and shape*: The scales in the center of the top of the head between the eyes and posterior to the parietal eye. This is qualitative as to size and shape. Typically they were either small and knobby, or larger and polygonal shape and flat.

*Labial-nasal contact*: Whether the labial scales contact directly the nasal scale or not. Recorded for both sides.

*Rostral-nasal contact*: Whether the rostral scale contacts the nasal scales directly or not. Recorded for both sides.

*Nasal color and intensity* (see also Keogh et al. 2008): This is the color of the scale, and how bright that color is. Also whether the color of the scale expands to adjacent scales or is confined to that scale. This character is maintained in preserved specimens pretty well although the color does become somewhat muted.

*Number of scales encircling nasal scales, including labials*: This is the total count of scales touching, even at a corner, the nasal scales. Recorded for both sides.

*Postnasal scale enlarged and bordering entire posterior portion of nasal*: This is the condition of a fused set of postnasal scales bordering the posterior of the nasal scale, or whether they are not fused.

*Internasals total*: Total scales between nasal and directly posterior of rostral.

*Number of scales encircling rostral, including labials*: Count of scales adjacent to the rostral scale. Some might touch just at a point or angle and these are included in the count.

*Size of postnasal/preocular scales*: Larger or smaller; generally if there are < 10 scales between nasal and preocular scales then they are larger, > 10 generally smaller.

*Dorsal crest spines*: Count of the dorsal crest spines, from the first differentiated midline scale at posterior of head to the one centered over the mid-point of the hind limbs.

*Nostril placement*: The nostril opening either centered within nostril scale, or offset. If offset then direction of offset is noted.

*Nostril shape*: The shape of the nostril opening is typically rounded, triangular, oval or egg shaped, or slit like.

*Number combs digit three*: The count of how many "toe combs" on the hindfoot of digit three if any. They could be present and then a count is given, absent, or enlarged.

*Number combs digit two*: The count of "toe combs" on the hindfoot of digit two if any. They could be present and then a count is given, absent, or enlarged.