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THE ANURA OF JAMAICA: A PROGRESS REPORT

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ABSTRACT

The Antillean island of Jamaica is inhabited by 17 native species of frogs and three introduced species. This anuran fauna has not been reviewed since 1940, and the present paper brings up to date the nomenclature of the Jamaican frogs, and in addition gives much new zoogeographic, altitudinal, ecological, and reproductive data on 16 native and two introduced species. New subspecies of *Eleutherodactylus cundalli*, *E. gossei*, and *E. pantoni* are described. The total native anuran fauna of Jamaica is discussed, both as far as its internal (within Jamaica) and external (other Antillean islands) relationships are concerned, and a zoogeographic picture of differentiation from two major evolutionary centers in Jamaica is presented in reference to the frogs of that island.

The frogs of Jamaica were last reviewed by LYNN (1940). At that time, LYNN recognized 17 species of anurans on the island of Jamaica, of which three (*Bufo marinus*, *Eleutherodactylus "martinicensis"*, *E. "ricordi"*) were considered introduced species. Taxonomic and distributional papers subsequent to LYNN's work are few: these include LYNN & DENT (1942, 1943), LYNN (1954), GOIN & COOPER (1950), and GOIN (1953). However, in a series of three papers, GOIN (1950, 1954, 1960) discussed the genetics and evolution of several Jamaican species of *Eleutherodactylus*; insofar as these aspects of their biology are concerned, the Jamaican members of the genus are consequently better known than are those of other Antillean islands.

Our interest in Jamaican frogs stems primarily from four collections made in Jamaica in the past decade: SCHWARTZ (with DAVID C. LEBER and RONALD F. KLINIKOWSKI) collected on the island between 9 June and 7 August 1961. A second collection was made by RICHARD THOMAS between 29 June and 10 September 1967. SCHWARTZ, with JAMES A. RODGERS, JR., collected very briefly in Jamaica in 1969. Finally, we (in the company of DALE E. BECKER and MICHAEL T. FELIX) collected in Jamaica between 1 and 25 August 1970. The result of these efforts is slightly over 2,000 freshly collected and carefully documented and preserved specimens, all of which add materially to our knowledge of the Jamaican herpetofauna. The purpose of the present paper is to summarize new data and to bring the knowledge of Jamaican frogs closer to that of the frogs of other Greater Antillean islands.

We acknowledge the assistance offered the senior author on 1961 by C. BERNARD LEWIS of the Institute of Jamaica, and the cooperation of our companions, Messrs. BECKER, FELIX, KLINIKOWSKI, LEBER, and RODGERS, in the field. We are especially grateful to RICHARD THOMAS for allowing us to report on his Jamaican material. All specimens are in the Albert Schwartz Field Series (ASFS). We have made no special effort to borrow the many specimens of Jamaican frogs available in museum collections; however, we have borrowed 155 selected frogs from the Museum of Comparative Zoology (MCZ), the Museum of Zoology, University of Michigan (UMMZ), and the United States National Museum (USNM) when we felt that these specimens would add to our concepts of variation within species. We wish to thank the curators of these collections for loans of often valuable specimens: ERNEST E. WILLIAMS, CHARLES F. WALKER, JAMES A. PETERS, and GEORGE R. ZUG. In addition to these collections, we have deposited paratypes of new taxa in the Carnegie Museum (CM).

All measurements are in millimeters and color designations are from MAERZ & PAUL (1950). In the case of males, we have selected (where available) the 25 largest specimens for our computations. In the case of females, our usage of "gravid and adult" specimens indicates that we have based our calculations upon all specimens whose snout-vent length is above that of the minimally sized gravid female. We thereby assume that all females above this minimal size are potentially capable of egg production. Measurements of eye and tympanum are longitudinal measurements.

As several new taxa have been proposed since the publication of LYNN's (1940) treatment of Jamaican frogs, we list below the species which we regard as inhabiting Jamaica. In addition to the proposal of new species since 1940, the nomenclature of Jamaican frogs has changed remarkably in the ensuing 30 years, and thus the list achieves some pertinence as a record of these changes:

BUFONIDAE
    Bufo marinus Linnaeus (introduced)

HYLIDAE
    Hyla brunnea Gosse
    Hyla crucialis Harlan
    Hyla marianae Dunn
    Hyla wilderi Dunn

LEPTODACTYLIDAE
    Eleutherodactylus alticola Lynn
    Eleutherodactylus andrewsi Lynn
    Eleutherodactylus cavernicola Lynn
    Eleutherodactylus cundalli Dunn
    Eleutherodactylus fuscus Lynn & Dent
    Eleutherodactylus gossei Dunn
    Eleutherodactylus grabhami Dunn
    Eleutherodactylus jamaicensis Barbour
    Eleutherodactylus johnstonei Barbour (introduced)
    Eleutherodactylus junori Dunn

Eleutherodactylus luteolus Gosse
Eleutherodactylus nubicola Dunn
Eleutherodactylus orcutti Dunn
Eleutherodactylus pantoni Dunn
Eleutherodactylus planirostris Cope (introduced)

Note that our usage of some of the above names (i.e., *luteolus*) differs from that of LYNN (1940), and in other instances (*johnstonei, planirostris*) there have been nomenclatural changes. We are grateful to RONALD I. CROMBIE of the United States National Zoological Park for pointing out the priority of *crucialis* Harlan over *lichenata* Gosse for the giant Jamaican hylid.

We have had no field experience with *E. alticola*, a species known only from high elevations in the Blue Mountains of extreme eastern Jamaica, and, although we heard *Bufo marinus* vocalizing and saw many individuals on the roads at night, we collected no specimens and thus have no new data to present on this bufonid. But we do have new information on all other Jamaican anurans. These new data include information on variation, distribution (both altitudinal and geographic), ecology, and vocalization; especially pertinent are data in coloration and pattern in living specimens and measurements of both sexes, which in most cases have never been reported. Our intent is to summarize the existing published information on these topics and to supplement it with new data resulting from our collections. We make no pretense that our contribution is final, but unless such data are published as they are gathered, little new information on any animal group reaches print. Definitive studies are the epitome, but less exhaustive studies fill existing gaps which might otherwise remain empty were it not for the publication of new information. The brief recent history of Jamaican frogs, presented above, shows how little attention has been paid to these animals. We herein attempt to remedy some of this neglect.

As far as is possible in a linear series, we have attempted to arrange the species within each genus in what seems to us a reasonable phylogenetic sequence. Our ideas are based primarily upon the work of DUNN on the hylids and GOIN on the leptodactylids (especially the *gossei* group), but we have departed to some slight extent from GOIN's suggested relationships. Our interpretations are noted in the text and are detailed in the discussion section of the present paper.

Our distribution maps attempt to present the known rangs of the various species and subspecies of Jamaican frogs.

Hyla brunnea Gosse

Hyla brunnea is the second largest of the Jamaican hylids, and the species is widely distributed throughout the island, both geographically and altitudinally (Fig. 48). Our twenty-five largest males (all with nuptial pads) have the following measurements: snout-vent length 42.1–50.6 (45.6); head length 16.0–18.7 (17.4); head width 16.0–19.2 (17.6); tympanum 2.9–3.8 (3.4); eye 5.9–7.8 (6.7); naris to eye 5.2–6.8 (6.0); femur 17.6–22.8 (19.7); tibia 20.0–25.8 (22.3); fourth toe from inner metatarsal tubercle 15.1–20.7 (17.9). The largest 25 females measure: snout-vent length 60.4–75.8 (65.7); head length 21.7–27.0 (23.7); head width 22.4–29.2 (24.8); tympanum 3.8–5.5 (4.5); eye 5.9–7.8 (6.7); naris to eye 7.3–10.5 (8.4); femur 26.2–34.3 (28.9); tibia 29.6–38.6 (32.3); fourth toe from inner metatarsal tubercle 24.1–32.8 (26.5). LYNN (1940: 20) gave 72.0 mm as the measurement of the largest frog (presumably female) which he had available, and our largest female slightly exceeds his in snout-vent length.

LYNN (1940: 20 and pl. I) discussed and figured the variation in dorsal color and pattern in *H. brunnea*. The species is exceptionally variably in dorsal pattern, with some specimens unicolor and patternless or virtually so, whereas others are marked with large and irregular dark blotches or mottling. The primary colors involved in the dorsal pattern are browns, with the ground color usually a medium brown and the pattern, if present, some darker shade, in some cases almost black. Usual dorsal colors are in the vicinity of Pl. 14A10. Occasional specimens were recorded as gray dorsally and one was distinctly red (Pl. 6K10). The venter is usually some shade of yellowish tan to brown, but occasional specimens are yellow below with no brown tints, or with only the throat brown. There is very often some yellow pigment in the groin, on the underside of the crura, and on the concealed surfaces; the hues in these regions are about Pl. 9L4 and Pl. 9J3, but they may be paler or even absent entirely. Such differences in color are not correlated with sex, ontogeny, nor geography. In some particular areas (notably at Windsor, Trelawny Parish) no specimens collected had any yellow in the groin; it seems probable that various demes of *H. brunnea* may have locally distinctive characteristics, perpetuated by the presumably great amount of local inbreeding in these primarily bromeliad-dwelling frogs.

DUNN (1926) stated that *Hyla brunnea* is the most common of the four Jamaican species of *Hyla*, a generalization well substantiated by collections reported by DUNN, LYNN (1940), LYNN & DENT (1943), GOIN & COOPER (1950), and by specimens collected by ourselves. This species has been taken in every parish except St. Mary and is known from as far west as Old Hope, Westmoreland, and as far east as Fair Prospect, Portland. The north-south distribution of the species appears limited to the central regions of the island except at its extreme ends where the island is narrow.

DUNN (1926) asserted that the habitat of *H. brunnea* is larger bromeliads in open woods. LYNN (1940) stated unequivocally that the species is exclusively a "wild pine" dweller. Our own experience is in agreement with that of DUNN. The apparently preferred habitat of the species is bromeliads, but not necessarily in open woods and certainly not exclusively. Although the majority of our specimens were taken by cutting bromeliads, both arboreal and terrestrial, we were successful in collecting *H. brunnea* from many other situations: several were collected on the leaves of shrubs up to seven feet above the ground, several on the sides of trees also up to seven feet above the ground, several on the ground and on rocks beside a river, one on the concrete railing of a bridge, several on paved and gravel roads at night, one on a coffee-tree branch adjacent to a rocky cliff, and one on the side of a palm six feet above the ground.

Altitudinally, *H. brunnea* seems to be as widespread as it is geographically, with sealevel records at several localities such as Port Antonio and Savanna-la-Mar. GOIN & COOPER had specimens from Morce's Gap in the Blue Mountains, approximately 5000 feet above sealevel, and we have heard the species calling at Hardwar Gap at 4250 feet. All other localities are widely dispersed at elevations intermediate between these two extremes.

Specimens: *Hanover*, Bushmount, 10.5 mi. (16.8 km) SE Lucea, 4; 2.9 mi. (4.6 km) S Askenish, 800 feet (244 m), 2. — *Westmoreland*, 2.5 mi. (4.0 km) S Medley, 2; 3.6 mi. (5.8 km) S Medley, 1; 4.1 mi. (6.6 km) S Askenish, 600 feet (183 m), 1; 3.0 mi. (4.8 km) N Town Head, 400 feet (122 m), 5; 2.8 mi. (4.3 km) N Cave, 1100 feet (336 m), 1; 2 mi. (3.2 km) SW Old Hope, 2. — *St. James*, 0.8 mi. (1.3 km) SW Catadupa, 1; 3.1 mi. (5.0 km) NE Cambridge, 400 feet (122 m), 1; 5.8 mi. (9.3 km) NE Maroon Town, 400 feet (122 m), 1; 3.3 mi. (5.3 km) SW Maroon Town, 1400 feet (427 m), 3; 3.1 mi. (5.0 km) NE Maroon Town, 800 feet (244 m), 4; 0.4 mi. (0.6 km) NE Mt. Horeb, 800 feet (244 m), 1; 0.8 mi. (1.3 km) W Mocho, 1; 0.5 mi

(0.8 km) W Mocho, 1; 3.0 mi. (4.8 km) NW Garlands, 1500 feet (458 m), 1; 4.2 mi. (6.7 km) SW Spring Vale, 1000 feet (305 m), 5; 0.8 mi (1.0 km) SE Plum Park, 1200 feet (366 m), 1; 1.5 mi. (2.3 km) SE Plum Park, 1200 feet (366 m), 1; 1.8 mi. (2.9 km) SE Plum Park, 1200 feet (366 m), 2; 0.3 mi. (0.5 km) SE Jericho, 1400–1500 feet (427–458 m), 4. — *Trelawny*, Windsor, 14; Hyde, nr. Clark's Town, 5; 6.4 mi. (10.2 km) N Burnt Hill, 1000 feet (305 m), 1; 3.8 mi. (6.1 km) N Burnt Hill, 1400 feet (427 m), 1; 1.5 mi. (2.3 km) N. Burnt Hill, 1600 feet (488 m), 1; 1.8 mi. (2.9 km) S Stonehenge, 1000 feet (305 m), 1; 7 mi. (11.2 km) NE Maroon Town, 400 feet (122 m), 1; 2.5 mi. (3.9 km) N Quick Step, 1100 feet (336 m), 1; 1.4 mi. (2.2 km) N Quick Step, 3; 1.2 mi. (1.9 km) N Quick Step, 1000 feet (305 m); 0.9 mi. (1.4 km) N Quick Step, 1300 feet (397 m), 1; 0.7 mi. (1.1 km) N Quick Step, 1000 feet (305 m), 3; 0.7 mi. (1.1 km) S Quick Step, 1000 feet (305 m), 1. — *St. Elizabeth*, 1.8 mi. (2.9 km) NE Mulgrave P. O., 1400 feet (427 m), 1; 1.5 mi. (2.4 km) NE Mulgrave P. O., 1300 feet (397 m), 2. — *St. Ann*, 3.4 mi. (5.4 km) S Moneague, 2000 feet (610 m), 1; 3.1 mi. (5.0 km) S Moneague, 1800 feet (549 m), 1; 3.0 mi. (4.8 km) S Moneague, 1900 feet (580 m), 3; 1.8 mi. (2.9 km) S Moneague, 1; 1.5 mi. (2.4 km) S Moneague, 1200 feet (366 m), 3. — *Manchester*, 4 mi. (6.4 km) SE Craig Head, 1; 5.2 mi. (8.3 km) NW Mile Gully, 900 feet (275 m), 1; 3.7 mi. (5.9 km) SW Mandeville, 1900 feet (580 m), 2. — *St. Catherine*, 2 mi. (3.2 km) W Ewarton, 1; 3 mi. (4.8 km) W Ewarton, 1; 3 mi. (4.8 km) W Lluidas Vale, 1800 feet (549 m), 1; 2.8 mi. (4.5 km) W Lluidas Vale, 1800 feet (549 m), 1; 1.3 mi. (2.1 km) W Lluidas Vale, 1; ± Lluidas Vale, 1; 7.9 mi. (12.6 km) N Worthy Park, 1200 feet (366 m), 5; 5.7 mi. (9.1 km) N Worthy Park, 1600 feet (488 m), 2. — *Portland*, Port Antonio, 8; 0.5 mi. (0.8 km) S Fellowship, 1; Seamans Valley, 1; 8 mi. (12.8 km) S Seamans Valley, 11; 4.5 mi. (7.2 km) S Fair Prospect, 4; 5.3 mi. (8.5 km) SSW Fair Prospect, 1100 feet (336 m), 1; 6.0 mi. (9.6 km) SSW Fair Prospect, 2.

Hyla marianae Dunn

Our four specimens of *H. marianae* include one gravid female and three adult males. The males have the following measurements: snout-vent length 27.5–31.0; head length 9.7–11.6; head width 9.7–12.0; tympanum 1.5–1.8; eye 3.8–4.6; naris to eye 3.2–3.4; femur 11.4–12.4; tibia 14.2–17.3; fourth toe from inner metatarsal tubercle 10.4–12.7. The single female measures: snout-vent length 34.0; head length 11.5; head width 11.9; tympanum 1.7; eye 4.2; naris to eye 3.8; femur 16.4; tibia 18.8; fourth toe from inner metatarsal tubercle 13.6.

In one male, the dorsal ground color was recorded as orange-brown with the eye region somewhat darker; the venter in this specimen was pale yellow-green. The dorsum is unspotted and there is no dark interocular bar. In the series of one female and two males from Moneague, the dorsa varied between tan and dull pale green. The female and one male had the dorsum dotted with reddish tan to brownish dots, whereas the other male was unmarked dorsally and was close in green hue to that of *H. wilderi*. The two specimens which are dorsally dotted have a narrow dark interocular bar, but the two unicolor and undotted specimens lack this feature. The iris was recorded as bronzy.

This *Hyla*, like *H. crucialis*, has been reported from very few localities and specimens (Fig. 49). DUNN (1926) had ten specimens from Spaldings, Clarendon, and Hollymount, St. Catherine. Three of his frogs were taken from "wild pines" in rather thick woods, which led him to generalize that *H. marianae* is a deep woods dweller. The only additional specimen reported by LYNN (1940) was from Windsor, Trelawny. GOIN & COOPER (1950) added a single record from Sweetwater, St. James. Neither of the last two papers mentioned habitat data with their collections. Our four frogs were taken from bromeliads in deciduous forest ranging in elevation from 1800 to 2000 feet (549 to 610 m). The altitudinal range of *H. marianae* is from 400 feet (122 m) at Windsor, Trelawny, to 2900 feet (895 m) at Spaldings, Clarendon. At this time, the voice of *H. marianae* remains unreported.

Specimens: *Trelawny*, 0.4 mi. (0.6 km) N Burnt Hill, 1800 feet (549 m), 1. — *St. Ann*, 3.4 mi. (5.4 km) S. Moneague, 2000 feet (610 m), 3.

Hyla wilderi Dunn

Of the four species of Jamaican hylids, *H. wilderi* is the smallest. Of our series of 126 specimens, the twenty-five largest males have the following measurements: snout-vent length 24.3–27.9 (25.5); head length 8.0–9.2 (8.5); head width 8.7–10.1 (9.5); tympanum 1.5–2.0 (1.7); eye 2.9–3.7 (3.2); naris to eye 2.1–2.8 (2.4); femur 10.7–12.0 (11.4); tibia 13.0–14.5 (13.7); fourth toe from inner metatarsal tubercle 8.2–11.1 (9.8). The twenty-five largest females measure: snout-vent length 24.2–29.2 (26.4); head length 8.2–9.6 (8.8); head width 9.0–10.4 (9.7); tympanum 1.4–2.1 (1.7); eye 2.7–3.7 (3.3); naris to eye 2.1–2.9 (2.5); femur 10.4–12.8 (11.6); tibia 13.1–14.7 (14.0); fourth toe from inner metatarsal tubercle 9.1–10.7 (9.9). LYNN (1940: 25) gave maximum size of his series of *H. wilderi* as 30 mm and stated that there appeared to be no significant difference in size between the two sexes. None of our frogs equals his maximum length, and there is a small amount of sexual dimorphism in size, with females being slightly larger than males.

In life, *H. wilderi* is most often pale yellowish green, but THOMAS recorded specimens from Burnt Hill as being both off-green and reddish brown, the latter a color which we ourselves have never encountered in the species. The upper eyelids are silvery and the belly is white. The interocular bar varies from pale silvery to metallic yellow-green, and the undersides of the limbs and throat are pale green, in contrast to the ventral color. The interocular bar is usually bordered both anteriorly and posteriorly by dark brown, but the brown pigment may be restricted or limited to a series of dark dots along the margins of the bar. Occasional specimens (for example, ASFS V12446, V19649, V19653, V19686) have irregular and asymmetrical silvery blotches, outlined with brown (and thus involving the same colors as the interocular bar) on the occiput and scapular region.

DUNN (1925: 162) pointed out the correlation of presence of the interocular bar with sex. Our series amply confirms his comments. Of 43 males, only four have the interocular bar present and 39 lack it. Of 54 females, 41 have the interocular bar and 13 lack it. In DUNN's series, six males had the bar and 22 males lacked it, whereas 38 females had the bar and six lacked it. Combining data from these two series, ten males have the interocular bar and 61 lack the feature, and 79 females have the bar and 19 lack it. The ratio of bar/no bar is thus 1:6 in males, and 4:1 females.

When DUNN (1925) described *H. wilderi* on the basis of 119 specimens from Moneague, St. Ann, he mentioned only the fact that all specimens were taken from "wild pines". In 1926, DUNN had additional specimens from Spaldings, Clarendon, and also had determined that BARBOUR's specimens of pale green "young *Hyla brunnea*" from Mandeville, Manchester, were in reality *H. wilderi*. LYNN (1940) reported *wilderi* to be quite common in "wild pines" about Mandeville and to have a fairly wide range in the central part of the island above 1000 feet. LYNN also cited a voice record from Shettlewood, Hanover. LYNN & DENT (1943) secured a series of *H. wilderi* from bromeliads in the Cockpit Country near Quick Step, St. Elizabeth, and heard the call of the species at Stony Hill, St. Andrew.

All but one (see the account of *E. planirostris*) of our specimens came from bromeliads, both arboreal and terrestrial, without any preference. Like LYNN &

DENT, we have specimens from the Quick Step road, both in the parishes of St. Elizabeth and Trelawny. In addition, we have specimens in Trelawny Parish from the Windsor area and along the Burnt Hill-Stonehenge road. Specimens from west of Lluidas Vale and north of Worthy Park are the first reported from St. Catherine Parish and our specimens from south of Askenish are the first from Westmoreland Parish. We also have good series from St. Ann Parish, south of Moneague on Mt. Diablo, and St. James Parish at Plum Park, Jericho, and northeast of Cambridge (Fig. 50).

Whereas previous data led LYNN (1940) to generalize that *H. wilderi* was restricted to elevations above 1000 feet (305 m), we have records from as low as 400 feet (122 m) at Windsor, Trelawny, and at the same elevation at Glasgow, St. James.

DUNN (1926) reported the call of *H. wilderi* to be a six-note call, which he likened to the faint ticking of a telegraph instrument. We, however, recorded the call as one of five notes, with the first four notes very rapid and with emphasis on the final "tick".

Specimens: *Westmoreland*, 4.2 mi. (6.7 km) S Askenish, 600 feet (183 m), 6. — *St. James*, 1.1 mi. (1.8 km) N Montpelier, 600 feet (183 m), 1; 3.0 mi. (4.8 km) NE Cambridge, 900 feet (275 m), 2; 0.8 mi. (1.3 km) SE Plum Park, 1200 feet (366 m), 1; 1.8 mi. (2.9 km) SE Plum Park, 1200 feet (366 m), 1; 0.3 mi. (0.5 km) SE Jericho, 1400–1500 feet (427–458 m), 1. — *Trelawny*, Windsor, 22; 2.2 mi. (3.5 km) NW Windsor, 400 feet (122 m), 1; 3.0 mi. (4.8 km) NW Windsor, 400 feet (122 m), 5; 3.1 mi. (5.0 km) S Stonehenge, 1400 feet (427 m), 2; 4.0 mi. (6.4 km) S Stonehenge, 1400 feet (427 m), 2; 4.8 mi. (7.7 km) S Stonehenge, 1600 feet (488 m), 1; 6.4 mi. (9.2 km) N. Burnt Hill, 1000 feet (305 m), 1; 3.9 mi. (6.2 km) N Quick Step, 1100 feet (336 m), 2; 3.3 mi. (5.3 km) N Quick Step, 1300 feet (397 m), 3; 1.4 mi. (2.2 km) N Quick Step, 1; 0.9 mi. (1.4 km) N Quick Step, 1300 feet (397 m), 2; 0.7 mi. (1.1 km) N Quick Step, 1200 feet (366 m), 2. — *St. Ann*, 3.0 mi. (4.8 km) S Moneague, 1900 feet (580 m), 25; 3.1 mi. (5.0 km) S. Moneague, 1800 feet (549 m), 6; 3.4 mi. (5.4 km) S. Moneague, 2000 feet (610 m), 1. — *Manchester*, 0.7 mi. (1.1 km) E Troy, 1. — *St. Catherine*, 3.5 mi. (5.6 km) W Lluidas Vale, 2000 feet (610 m), 11; 3 mi. (4.8 km) W Lluidas Vale, 1800 feet (549 m), 2; 2.4 mi. (3.8 km) W Lluidas Vale, 1600 feet (488 m), 6; 2 mi. (3.2 km) W Lluidas Vale, 3; 5.7 mi. (8.1 km) N Worthy Park, 1600 feet (488 m), 2.

Hyla crucialis Harlan

A single non-gravid female was secured between Worthy Park and Ewarton. Measurements are: snout-vent length 83.5, head length 29.8, head width 31.8, tympanum 6.2, eye 10.0, naris to eye 9.2, femur 40.5, tibia 45.2, fourth toe from inner metatarsal tubercle 35.3. The dorsum in life was pale green, mottled and variagated with darker green, whereas the venter was pure white, as were the concealed surfaces of the femora. The iris was red-brown, shot with gold and with a gold pupillary ring.

Hyla crucialis, even though known from very few specimens, seems to be rather widely distributed across the island (Fig. 51). It has been previously reported from Bluefields, Westmoreland (GOSSE, 1851), Spaldings, Clarendon (DUNN, 1926), Malvern, St. Elizabeth (DUNN, 1926), Cumberland District (DUNN, 1926), and Mandeville, Manchester (LYNN, 1940). Calling males have been reported from Walderston, Manchester (DUNN, 1926), Shettlewood, Hanover (LYNN, 1940), and Chapelton, Clarendon (LYNN & DENT, 1943). We have voice records from 8 mi. S Seamans Valley, Portland (25 June 1961), 0.5 mi. W Mocho, St. James (16 July 1961), and 0.8 mi. W Mocho (22 July 1961).

DUNN (1926) was the first to describe the habits and habitat of *H. crucialis* in detail. He considered the species to be a hollow-limb dweller. Our specimen, which was collected on a wet paved road during a nocturnal rain, contributes little to either disproving or substantiating DUNN's contentions. The area in which we secured our specimen was one of deciduous woods; we were attracted to the frog by its bright red eye-shine.

One other observation is of interest. On the night of 17 August 1970, we collected along the road which skirts the eastern edge of Dolphin Head Mountain in Hanover and Westmoreland parishes between Askenish and Town Head. Despite torrential afternoon rains and large choruses of several species of frogs (including *Hyla brunnea*) we heard no *H. crucialis*. Since there as yet are no records of the species from this far western mountainous region, it is possible that *H. crucialis* is absent from the Dolphin Head area.

Specimens: *St. Catherine*, 4 mi (6.4 km) W Ewarton, 1600 feet (488 m), 1.

Eleutherodactylus jamaicensis Barbour

Eleutherodactylus jamaicensis is widespread in Jamaica and is typically a bromeliad-dwelling species. Of our series of 108 individuals, the 27 largest males have the following measurements: snout-vent length 19.0–22.0 (20.2); head length 7.4–8.5 (7.9); tympanum 1.5–2.2 (1.8); eye 2.4–3.1 (2.7); naris to eye 1.9–2.6 (2.3); femur 8.1–10.1 (9.2); tibia 8.4–10.7 (9.2); fourth toe 6.8–8.8 (7.7). Thirty gravid and adult females measure: snout-vent length 22.0–29.0 (25.8); head length 8.3–11.3 (9.7); head width 8.5–11.4 (9.7); tympanum 1.5–2.3 (2.0); eye 2.0–3.4 (2.9); naris to eye 2.3–3.8

(2.9); femur 9.3–12.4 (11.0); tibia 10.2–13.0 (11.5); fourth toe 8.5–11.5 (9.8). Very young individuals with snout-vent lengths of 7.5, 8.3, and 8.6 mm are also included in the series; the smallest of these must be very close to size at hatching.

LYNN (1940: 53) stated that the pattern in *jamaicensis* "varies but little", but that "the ground color ranges from slate-black to cream buff; the interocular bar is a constant character and there are always some irregularly distributed dark blotches on the back. Of 178 specimens only two had light stripes along the mid-dorsal line." LYNN's material was primarily from eastern and central Jamaica. Our series, from western, central, and eastern Jamaica, suggests that the species is far more variable both in pattern and coloration than LYNN conceived. In fact, there is an almost bewildering array of combinations of pattern elements when frogs from throughout the island are examined.

We have divided our material into three geographic regions: 1) western Jamaica and the Cockpit Country (Westmoreland, St. James, Trelawny, St. Elizabeth parishes); 2) central Jamaica (Manchester, St. Ann, St. Catherine parishes); and 3) eastern Jamaica (Portland Parish, including both low elevations and high elevations in and near the Blue Mountains).

The 108 specimens may secondly be segregated into four basic patterns: *1*) parentheses – *i.e.*, a pair of pale, elongate, and slightly curved sacral blotches on a dark ground; *2*) dorsolateral stripes; *3*) pale rump; and *4*) unicolor. Details of coloration of these patterns are discussed below. For the moment, we are concerned only with variation in the pattern itself, not in its coloration.

Of these four patterns, parentheses is the most common, occurring in 41.7 per cent (45 frogs) of the entire sample. However, in the central and eastern samples, parentheses is less common than dorsolateral stripes and pale rump (central) and dorsolateral stripes (eastern). In the western sample, parentheses includes 44.2 per cent (27 frogs) and is more than twice as common as dorsolateral stripes. Dorsolateral stripes show the second highest frequency in the entire sample (28.7 per cent), but this pattern is less common in western Jamaica than it is in eastern and central Jamaica, where it is one of two bimodes in the central series and is slightly more common (10 versus nine specimens) than parentheses in the eastern sample. Unicolor dorsum is third in total number of frogs, but this pattern is almost exclusively limited to the western sample, where 14 of 61 (23.0 per cent) frogs show it. In the central sample there are two unicolor individuals and only one in the eastern sample. Pale rump, on the other hand, is the modal condition in the central sample (23.9 per cent); this pattern is very uncommon in western specimens (one of 61 frogs) and in eastern specimens (one of 29 frogs).

Two additional dorsal pattern features are imposed upon the four basic dorsal patterns already noted: a distinct pale interocular bar (not to be confused with a pale snout anterior to the dark interocular bar) and a dorsal pale hairline. Of these, pale interocular bar occurs in 17 specimens of the total sample (15.7 per cent) and has its highest frequency in western (seven specimens) and central (six specimens) frogs. In order of decreasing frequency, pale interocular bar is associated with parentheses (nine frogs)-dorsolateral stripes (four)-pale rump (three)-unicolor (one).

Middorsal pale hairline shows an even more peculiar distribution. It occurs in only 11 individuals, nine of which are from the central sample and only two from the eastern sample. No western *E. jamaicensis* (61 individuals) shows the hairline. Hairline occurs with almost equal frequency in frogs with dorsal parentheses (four), pale rump (four), and dorsolateral stripes (three). The lack of unicolor-hairline association is doubtless due to the fact that this dorsal pattern is commonest in the western sample where hairline apparently does not occur.

In coloration, *E. jamaicensis* shows a variety of hues. The commonest dorsal color is dark brown (Pl. 16A8), somewhat lighter posteriorly, with a black to very dark brown interocular bar proceeded by a paler (golden, reddish, tan) snout. The dorsal ground color may also be some shade of gray. In many individuals, especially those considered as pale rump in pattern, the sacral region is distinctly tan (Pl. 13L8) to reddish brown (Pl. 8H11, Pl. 7C12), this color continues onto the hindlimbs. The parentheses vary from cream to buffy or even pale orange, depending upon the shade of the dorsal coloration itself. If dorsolateral stripes are present, these are golden tan to tan, cream, or orange. The interocular bar is white to cream, and very vivid, regardless of the dorsal coloration. Unicolor frogs are some shade of reddish brown or even orange, and in the unicolor condition, there may be a few irregularly scattered dark brown to black flecks on the back. One unicolor specimen was noted as having the back red with a yellow interocular bar, an altogether handsome individual. In the unicolor condition, the sides are often dark brown, and these, combined with the black to brown mask, sharply delimit the bright dorsal coloration. The venters vary from dusky gray to pale gray or almost white, but many specimens with reddish brown dorsa have this color continued onto the throat and venter as a reddish wash. The brachia are often reddish and usually have one distinct black crossband. The hindlimb coloration varies with that of the posterior portion of the dorsum; those frogs with posteriorly reddish dorsa have that color continued onto the hindlimbs. There are usually two femoral and two crural dark crossbands, the distinctness of these bands dependent upon the shade and intensity of the hindlimb color. Although not typical of all frogs with dorsolateral stripes, BARBOUR's (1910) figure of the holotype of *E. jamaicensis* shows one variant with a pale ground, poorly defined dorsolateral stripes, conspicuous parentheses, and a truncate triangular interocular bar area. The central dark mottling between the dorsolateral stripes in this specimen is often a concomitant feature in pale frogs with dorsolateral stripes.

SCHWARTZ (1969:114) noted that inguinal glands are lacking in *E. jamaicensis*. This statement is in error. Both supra-axillary and inguinal glands are present in the species. However, they are visible only in living frogs which are pale, or in frogs which have faded due to long preservation. In having both glandular areas, *E. jamaicensis* resembles, of the Jamaican species, *E. luteolus*. Although presence of these glandular areas does not necessarily denote close relationship (see SCHWARTZ, 1969: 102), it is conceivable that *E. jamaicensis* is an extremely aberrant member of the *gossei* assemblage (see GOIN, 1954, for included members) rather than an aberrant member of the *auriculatus* group, as SCHWARTZ (1969) suggested.

Before our collections, *E. jamaicensis* was known from eight parishes and as far west as Sweetwater, St. James, and as far east as Bath, St. Thomas. The previously established northern boundary is also Sweetwater, whereas the southern boundary is Mandeville, Manchester, in the west, and Bath, St. Thomas, in the east. We collected *E. jamaicensis* from two additional parishes and, besides extending its known range to the west and north, filled in many gaps between known localities (Fig. 52). Our St. Catherine localities are the first reported from that parish, and our Westmoreland site is also a first for that parish, besides extending the boundary of *E. jamaicensis* approximately 30 miles to the west. Specimens collected at and near Windsor and south of Stonehenge, on the northern and eastern edges of the Cockpit Country, and along the Quick Step road entering the Cockpit from the south, indicate that *E. jamaicensis* is probably distributed throughout this karst region. In our collection are specimens from south of Fair Prospect, Portland, the only ones reported from the northeastern corner of the island. Specimens from northeast of Cambridge and southeast of Plum Park mark the farthest northwestern records of the species.

LYNN (1940) reported that specimens had been taken from localities ranging in elevation from 1500 feet (458 m) to 4000 feet (1220 m), giving the impression that *E. jamaicensis* is an eleutherodactyl of moderately high elevations. We have specimens from 4250 feet (1296 m) at Hardwar Gap, but we also have material from as low as 400 feet (122 m) at Windsor, Trelawny.

LYNN (1940) and LYNN & DENT (1943) indicated that their specimens had been taken from "wild pines" (bromeliads). Like them, we collected all but one of our specimens from bromeliads, both arboreal and terrestrial. Some of the arboreal bromeliads were as low as 4 feet (1.2 m) above the ground, whereas others were high in trees. The habitats ranged from dense forest to isolated clumps of trees in a pasture and to trees along open road margins. The terrestrial bromeliads were usually found growing on limestone road-cuts, or, as at Windsor, on limestone outcroppings along the path leading into the interior of the Cockpit Country. The one specimen not taken from a bromeliad was taken in the petiole base of a "bird-of-paradise" plant (*Heliconia*) south of Fair Prospect.

It should be noted that GRANT (1940: 74) reported the collection of *E. jamaicensis* under piles of trash and coconut husks with *Sphaerodactylus oxyrhinus* along the northeastern coast. Surely this is a case of misidentification, since *E. jamaicensis* is such a confirmed bromeliadicole that to encounter it in coastal trash piles is most unlikely. Additionally, LYNN, who examined all of GRANT's material, did not list specimens from GRANT's cited locality (Boston Bay) for the above occurrence.

Several males were taken while calling from bromeliad leaves south of Seamans Valley, Portland. These males were emitting a four-note "tick" (SCHWARTZ, 1969: 114). These data are similar to the two and four note calls reported by GOIN & COOPER (1950: 8), although they likened the call to a series of whistles.

DUNN (1926) noted that, when handled, *E. jamaicensis* exuded a bright blue slime from its sides and thighs. RICHARD THOMAS in 1967 also noted this occurrence on one occasion (we never noted it); he compared the color of the slime to that of the blue iridescent earthworms which also inhabit the same bromeliads.

Specimens: *Westmoreland*, 4.2 mi. (6.7 km) S Askenish, 600 feet (183 m) 2. — *St. James*, 3.0 mi. (4.8 km) NE Cambridge, 900 feet (275 m), 2; 0.8 mi. (1.3 km) SE Plum Park, 1200 feet (366 m), 3; 0.3 mi. (0.5 km) SE Jericho, 1400–1500 feet (427–

458 m), 13; 1.2 mi. (1.9 km) SE Jericho, 1600 feet (488 m), 6. — *Trelawny*, Windsor, 6; 2.2 mi. (3.5 km) NW Windsor, 400 feet (122 m), 5; 1.6 mi. (2.6 km) S Stonehenge, 1200 feet (366 m), 2; 3.9 mi. (6.2 km) N Quick Step, 1100 feet (336 m), 4; 3.3 mi. (5.3 km) N Quick Step, 1300 feet (397 m), 2; 1.4 mi. (2.2 km) N Quick Step, 1; 1.2 mi. (1.9 km) N Quick Step, 1000 feet (305 m), 1; 0.9 mi. (1.4 km) N. Quick Step, 1300 feet (397 m), 1. — *St. Elisabeth*, 4.4 mi. (7.0 km) NW Raheen, 1100 feet (336 m), 5; 4.6 mi. (7.4 km) NW Raheen, 1100 feet (336 m), 1. — *Manchester*, 3.7 mi. (5.9 km) SW Mandeville, 1900 feet (580 m), 5. — *St. Ann*, 3.4 mi. (5.4 km) S Moneague, 2000–2100 feet (610–641 m), 4; 3.0 mi. (4.8 km) S Moneague, 1900 feet (580 m), 1. — *St. Catherine*, 3.5 mi. (5.6 km) W Lluidas Vale, 2000 feet (610 m), 8; 2 mi. (3.2 km) W Lluidas Vale, 1600 feet (488 m), 12. — *Portland*, 8 mi. (12.8 km) S Seamans Valley, 13; 4.5 mi. (7.2 km) S Fair Prospect, 2; Hardwar Gap, 8.

Eleutherodactylus johnstonei Barbour

Eleutherodactylus johnstonei is one of two introduced species of *Eleutherodactylus* in Jamaica. Of our series of 84 specimens, the 25 largest males have the following measurements: snout-vent length 21.5–24.8 (23.7); head length 7.5–8.5 (8.0); head width 7.8–9.0 (8.4); tympanum 1.3–1.8 (1.5); eye 2.2–3.2 (2.9); naris to eye 2.1–2.7 (2.4); femur 8.1–9.8 (9.0); tibia 9.0–10.6 (10.0); fourth toe 8.2–9.8 (9.0); tibia/snout-vent length × 100 37.8–47.0 (42.0). Twenty-three gravid females measure: snout-vent length 24.7–31.6 (27.8); head length 8.4–11.3 (9.5); head width 8.8–11.5 (9.9); tympanum 1.4–2.2 (1.8); eye 3.0–3.8 (3.4); naris to eye 2.3–3.5 (2.7); femur 9.4–12.4 (10.7); tibia 10.4–13.4 (11.8); fourth toe 9.0–12.2 (10.4); tibia/snout-vent length × 100 40.8–47.4 (42.6).

Eleutherodactylus johnstonei is a Lesser Antillean species, known from the islands of Grenada, Barbados, St. Vincent, St. Lucia, Martinique, Antigua, Barbuda, Montserrat, Nevis, St. Christopher, St. Eustatius, Saba, and St. Martin. SCHWARTZ (1967: 17 *et seq.*) pointed out that the various island populations of *E. johnstonei* show mensural and proportional differences when compared with each other. The Jamaican population was apparently brought to Jamaica in 1890, when the frogs were released in the Kingston and Pedro Farm areas (LYNN & DENT, 1943).

Comparison of our mensural data above with those presented by SCHWARTZ (1967: 22–23) shows that in general the Jamaican populations of *E. johnstonei* are large in most measurements. Males are close in most means to those of a series of 10 males from St. Vincent, although Jamaican males have longer fourth toes (mean 9.0 versus 8.5 in St. Vincent) and have low tibia/snout-vent length ratios when compared not only with St. Vincent (mean 40.4) but with other Lesser Antillean populations. Jamaican females, on the other hand, are larger than St. Vincent females and are closest in mean snout-vent length to females from Barbuda. Other means are close to those of Grenadan *E. johnstonei* (head length, head width, tympanum). Tibia and fourth toe means are greater than those of any Lesser Antillean population. The female tibia/snout-vent length ratio in Jamaican frogs is likewise low (42.6); only Saba and St. Lucia females have lower means than those of Jamaican females. It seems likely that selective factors have not only been working upon the various Lesser Antillean populations but also upon the Jamaican population since its original introduction 80 years ago.

Eleutherodactylus johnstonei is known to have been originally introduced in Jamaica simultaneously at Kingston, St. Andrew, and Pedro Farms, St. Ann, in the late 1800's (LYNN & DENT, 1943). Subsequent introductions in the same approximate area are also outlined in detail in the LYNN & DENT paper. DUNN (1926) had reported eleven specimens collected at Hope Gardens, a suburb of Kingston. All specimens reported by LYNN (1940) were also from the Kingston area. The only additional record included by LYNN & DENT (1943) was from Chapelton, Clarendon. GOIN & COOPER (1950) added specimens from Kellits, Clarendon, and Four Paths, another Kingston suburb.

Some eighty years after its arrival in Jamaica, *E. johnstonei* appears to have become well established but to have experienced rather limited migration from the sites of the original introductions (Fig. 53). Exceptional occurrences are voice records from Hanover and St. James parishes, where we heard *E. johnstonei*'s distinctive call from cane fields between Sandy Bay and Lucea in Hanover Parish and at the mouth of the Montego River in St. James Parish. These localities seem more to indicate another re-introduction to the western end of the island rather than migration from the original sites. All of our specimens, as well as those previously noted by others, are within range of the original localities and can be reasonably accounted for by migration. The most remote locality where we collected *E. johnstonei* is Mandeville, Manchester, where we took the frogs calling from banana, ginger, sugar cane, coffee, and bamboo plants.

Our St. Ann frogs came from St. Ann's Bay and Ocho Rios, where at the latter locality specimens were secured under *Cocos* trash in a grassy grove. The remainder of our *E. johnstonei* are from St. Catherine Parish. Specimens from Worthy Park (where the species is exceptionally abundant) were collected calling from trees and shrubs, in one case from a limb 5 feet (1.5 m) above the ground. Specimens from the Lluidas Vale area were collected calling on low shrubs and on sugar cane plants in a small cane field surrounded by woods and limestone cliffs. One specimen from west of Ewarton was taken on the road at night during a light rain.

Although GOIN & COOPER (1950) found *E. johnstonei* to be a bromeliad dweller, we collected only one specimen from a low arboreal bromeliad north of Worthy Park. At several localities, where *E. johnstonei* was the dominant *Eleutherodactylus* heard and collected at night, bromeliad cutting during the day yielded no specimens.

We also have voice records from along the Rio Cobre gorge and scattered records thence to Lionel Town in southern Clarendon. We feel that these frogs may have reached this area from the sites of the original introductions.

Altitudinally, *E. johnstonei* seems to occupy low to intermediate elevations from sea level to about 1800 feet (549 m); the latter high record is from west of Lluidas Vale in St. Catherine.

Specimens: *Manchester*, Mandeville, 1. — *St. Ann*, 1.5 mi. (2.4 km) E Aenon Town, 51; 2.1 mi. (3.4 km) ENE Aenon Town, 1800 feet (549 m), 1; 2.2 mi. (3.5 km) E St. Ann's Bay, 2; 4.4 mi. (7.0 km) NW Ocho Rios, 4. — *St. Catherine*, 2.8 mi. (4.5 km) W Lluidas Vale, 1800 feet (549 m), 11; 1.3 mi. (2.1 km) W Lluidas Vale, 1; Lluidas Vale, 2; Worthy Park Estate, 1000–1250 feet (305–381 m), 7: Worthy Park, 1000 feet (305 m), 2; 5.7 mi. (9.1 km) N Worthy Park, 1600 feet (488 m), 1; 2 mi. (3.2 km) W Ewarton, 1.

Eleutherodactylus cundalli Dunn

Eleutherodactylus cundalli is a member of the *ricordi* group of *Eleutherodactylus* (see SCHWARTZ, 1958: 1–2). As LYNN (1940: 43) pointed out, *E. cundalli* is "one of the most widespread of Jamaican frogs", occurring from western to eastern Jamaica, and along the north coast. Apparently the species is absent from much of the south coast from southeastern Westmoreland Parish (Beeston Spring) to the vicinity of Kingston, St. Andrew Parish. Although *E. cundalli* has been reported from Portland Point, Clarendon, by LYNN & DENT (1943), the specimens upon which this record is based were later assigned to a new species (*E. cavernicola*). Thus, *E. cundalli* remains unknown in western and central Jamaica south of a line drawn between Beeston Spring-Mandeville-Chapelton-Worthy Park. These localities with Port Maria on the north coast serve as the known limits of a western population of *E. cundalli*. In eastern Jamaica, there occurs another population, delimited on the west by Port Antonio-Hardwar Gap-Stony Hill-vicinity of Kingston. LYNN & DENT (1943: 238–239) commented upon the large size of western *E. cundalli*, and indeed LYNN (1940: 44) noted that he had never seen any specimens as large as 40 mm, the length cited by DUNN (1926: 121) for the original material. LYNN (1940: 44–46) noted that the largest female from Chester Vale was 36 mm "long" and the largest male from the same locality was 31 mm "long". Note that neither DUNN not LYNN gave precise measurements for their material, nor did they specifically state that their "length" was snout-vent length.

GOIN & COOPER (1950: 4–5) named *Eleutherodactylus lynni*, based upon four specimens from Sweetwater, St. James Parish, in western Jamaica. The species was considered valid by COCHRAN (1961: 45) and GORHAM (1966: 84), but the senior author long suspected that *E. lynni* was a strict synonym of *E. cundalli*. We have examined the holytype (USNM 127976) and one paratype (USNM 117735). Both are gravid females. The holotype is indeed a very large frog (snout-vent length now 45.3 mm) but nonetheless it is only slightly larger than the largest of our series of western *E. cundalli* (42.5 mm). The paratype has a snout-vent length of 34.0 mm and falls within the range of this measurement of our series of gravid females. There is nothing distinctive above either specimen to distinguish them from our long series of western *cundalli*. We have collected intensively and extensively in the vicinity of the type locality of *E. lynni* and in other upland areas in St. James Parish without securing any frogs which we consider different from *E. cundalli*. We therefore feel strongly that *E. lynni* is a synonym of *E. cundalli*, and that GOIN & COOPER were to some extent misled into its description by the fact that they were more familiar with the much smaller *E. cundalli* population in eastern Jamaica.

We have also examined the holotype of *E. cundalli* (MCZ 11126), for which DUNN gave only the most general of measurements (40 mm "long"). The specimen is an adult female (oviducts convoluted and enlarged, but no enlarged ova) with a present snout-vent length of 37.8, head length 15.0, head width 15.2, tympanum 2.8, eye 4.9, naris to eye 5.6, femur 16.5, tibia 17.7, fourth toe 16.0, and tibia/snout-vent length × 100 46.8. The large size of the specimen compared with eastern individuals indicates clearly that the nominate subspecies is the more western population, as is expected from the site of collection of the holotype (Spaldings).

We have examined a total of 394 *E. cundalli* (as well as the holotype, MCZ 11126) from throughout the range of the species; these specimens amply confirm the fact that central and western *E. cundalli* are very obviously much larger than are eastern specimens, from both upland and lowland areas. Although our measurements do not agree precisely with those given by LYNN and others, they do show that both eastern and western-central specimens are readily separated from each other on the basis of size and in length of the hindlimbs. At present there are no specimens known from between the two populations; the nearest approximations of them known to us are at Worthy Park, St. Catherine (ASFS) and Stony Hill, St. Andrew (LYNN & DENT, 1943) – a distance of about 24 miles (38 km). It is possible that the species is absent from a corridor in east-central Jamaica, bounded on the west by Port Maria-Worthy Park, and on the east by Port Antonio-Stony Hill-Kingston, but this fact remains to be confirmed. At marginal localities, we have no difficulty in assigning the samples to one or the other (western-central or eastern) populations. Since eastern Jamaica has apparently been a local center of specific and subspecific endemism (see beyond for discussion), we feel confident that the two *E. cundalli* populations well merit nomenclatural recognition as subspecies. The larger west and central populations are the nominate form since Spaldings lies within the known range of the large subspecies. The eastern form is named below.

Eleutherodactylus cundalli cundalli Dunn

Eleutherodactylus cundalli DUNN, 1926, Proc. Boston Soc. Nat. Hist. *38*: 121; type locality Spaldings, Clarendon Parish (altitude 2900 feet), Jamaica; holotype MCZ 11126.

Eleutherodactylus lynni GOIN & COOPER, 1950, Occ. Papers Mus. Inst. Jamaica *4*: 4; type locality Sweetwater, near Horse Guards Road, St. James Parish, Jamaica; holotype USNM 127976.

Definition: A subspecies of *E. cundalli* distinguished by large size (males to 39 mm, females to 45 mm snout-vent length; see comments above on *E. "lynni"*), hindlimbs short, the heels meeting but not overlapping when the femora are held at right angles to the body axis, and vomerine tooth row long, extending as far laterad as, or beyond, the lateral margins of the choanae.

Variation: The series of the 25 largest male *E. cundalli* has the following measurements: snout-vent length 29.5–38.8 (32.6); head length 12.9–16.5 (13.9); head width 12.1–15.6 (13.2); tympanum 2.7–3.7 (3.1); eye 3.9–5.2 (4.4); naris to eye 4.1–5.1 (4.7); femur 13.2-16.4 (14.4); tibia 14.2–16.9 (15.4); fourth toe 12.8–16.2 (14.1); tibia/snout-vent length × 100 43.6–50.8 (47.4). Thirty five gravid and adult females measure: snout-vent length 33.0–42.5 (37.9); head length 12.7–17.9 (15.3); head width 11.4–17.2 (14.8); tympanum 2.2–3.2 (2.7); eye 3.9–5.7 (5.0); naris to eye 4.4–6.6 (5.5); femur 14.3–19.1 (16.6); tibia 15.5–20.2 (17.9); fourth toe 14.5–18.8 (16.3); tibia/snout-vent length × 100 42.0–53.2 (47.3).

The series of 229 *E. c. cundalli* may be divided into four basic pattern types: *1*) mottled, *2*) picket, *3*) dorsolateral pale stripes, and *4*) dorsal line, either a hair-line or a line somewhat broader but never a middorsal band. In addition to these four pattern types, two sorts of combinations occur: *5*) dorsal hairline plus dorsolateral pale stripes, and *6*) picket plus dorsolateral stripes. The most common pattern in *E. c. cundalli* is mottled; 135 frogs (59.0 percent) fall into this category. Fifty-five frogs (24.0 percent) have dorsolateral stripes, and 20 frogs (8.7 percent) have a dorsal line. All other patterns and pattern combinations have a much lower frequency, with nine frogs (3.9 percent) picket, seven frogs (3.1 percent) hairline plus dorsolateral stripes, and three frogs (1.3 percent) picket plus dorsolateral stripes. Comparison of these frequencies with those of the eastern subspecies will be noted below.

Eleutherodactylus c. cundalli, regardless of pattern, has the dorsal ground color extremely variable, ranging from tan, yellowish tan, yellowish, reddish, to gray. In the mottled pattern, the snout is pale and distinctly set off from the remainder of the dorsum by a dark (black to dark brown) interocular bar. There is almost always a black scapular W and some few relatively coarse black to dark brown lateral markings on the slightly yellowish sides. The remainder of the dorsum is rather finely stippled with black to dark brown. If a middorsal hairline is present, it is yellow to orange. If dorsolateral stripes are present, they overlie the mottled pattern with its scapular W, and the lateral arms of the W are sharply truncate by the yellowish to buffy dorsolateral stripes. In some specimens, the W is completely absent in the presence of dorsolateral stripes. The limb pattern is variable in adults, but in most cases the hindlimbs are sharply banded with dark brown and medium brown on the femora, with about three dark bands. When the limb is flexed, these bands are continued onto the crus and rather obscurely onto the pes. There is usually one dark brown brachial band and at least one antebrachial band below the wrist; at times there is another band further mediad on the antebrachium. The concealed surfaces of the hindlimbs are dark blackish brown, and the dorsum is warty, the warts at times reddish and in contrast to the paler dorsal ground color. The ventral color is usually some shade of yellow, although smaller individuals barely show this pigmental trait. There is often a deep orange to deep yellow suffusion in the groin. The throat pigmentation varies, but the most common condition is a finely and uniformly brown stippled throat, the stippling becoming somewhat coarser along the margins of the lower jaw. The digital discs are gray, often in sharp contrast to the dorsal brachial color. The iris is golden to greenish gold above, and brown below.

The vomerine tooth row is very long, extending at least as far laterad as the lateral margins of the choanae, and in many cases even beyond, so that the choanae lie completely above the tooth row, rather than adjacent to its lateral end. The hindlimbs are short, the heels meeting but not overlapping when the femora are held at right angles to the body axis.

Remarks: DUNN (1926) reported *E. cundalli* from the parishes of Clarendon and Portland, where he observed the frogs to be woodland dwellers seen at night sitting on bushes. He, however, collected two specimens from "wild pines". DUNN also reported specimens from Lapland (a locality with which we are unfamiliar). LYNN (1940: 43) reported *E. cundalli* from the parishes of St. Andrew, St. Ann, St. James, St. Mary, Manchester, and Portland, and therefore generalized that the species was a north coast and central mountain eleutherodactyl. GOIN & COOPER (1950) reported *E. cundalli* from St. Andrew, Portland, and St. James parishes, but did not give ecological data from their collections.

We have specimens of *E. c. cundalli* from the parishes of Westmoreland, Trelawny, and St. Catherine in addition to several of the parishes whence the species has already been recorded (Fig. 54). Our Westmoreland locality (Negril) is one of two south coast records, both of which are based on our specimens. The Negril individuals were secured at night on high shrubs, and along a limestone cliff and its talus. A long series of Windsor specimens was collected inside Windsor Cave on rocks, stalactites, debris, and walls, within the twilight zone of the cave where the entrance slopes at an angle of about 45 degrees. Other specimens collected at and near Windsor were taken on cliffs and plants up to eight feet above ground, and in rocky jumbles on forested hillsides. Burnt Hill localities in Trelawny produced two bromeliad-dwelling individuals. Our St. Catherine frogs were secured in a variety of situations, including bromeliads, at the petiole bases of banana leaves five feet above the ground, and shrubs and low plants adjacent to limestone cliffs at Lluidas Vale. One female was taken from the open end of a hollow bamboo stem four feet above the ground on Worthy Park Estate. Several more were collected in the vicinity of Lookout, with an exceptional terrestrial situation being the wall of a wet culvert. All of our Hanover specimens were secured on and about Dolphin Head Mountain. These were taken from low shrubs, a road cut, and the ground. Specimens from St. James came from low shrubs, arboreal and terrestrial bromeliads, on bare rocks in a road cut, and along a small mountain stream. Some of our St. Mary specimens from east of Ocho Rios at the mouth of the White River were secured in piles of *Cocos* trash on mud behind a low sandy beach ridge.

From the above summary, it is obvious that *E. c. cundalli* is widespread both ecologically and altitudinally; in the latter context, the subspecies occurs from sealevel at Negril and Ocho Rios to 1800 feet (549 meters) at Lookout in St. Catherine.

Specimens: *Hanover*, Bushmount, 10.5 mi. (16.8 km) SE Lucea, 22. — *Westmoreland*, 0.5 mi. (0.8 km) E, 3.5 mi. (5.6 km) S Negril, 3; 4.5 mi. (7.2 km) S Askenish, 1; 5.7 mi. (9.1 km) S Askenish, 1; 3.0 mi. (4.8 km) N Town Head, 400 feet (122 m), 1; 2.5 mi. (4.0 km) S Medley, 10; 3.6 mi. (5.8 km) S Medley, 1; 0.1 mi. (0.2 km) N Beeston Spring, 1100 feet (336 m), 1. — *St. James*, Sweetwater, Horse Guards Road, 2 (USNM 127976, USNM 117735 – holotype and paratype of *E. lynni*). 1.1 mi. (1.8 km) N Montpellier, 600 feet (183 m), 3; Glasgow, 2; 2 mi. (3.2 km) S Guilsbro, 650 feet (198 m), 9; 3.2 mi. (5.1 km) S Guilsbro, 900 feet (275 m), 2; 5.0 mi. (8.0 km) SW Spring Vale, 2; 0.3 mi. (0.5 km) SE Jericho, 1400–1500 feet (427–458 m), 3; 0.5 mi. (0.8 km) W Mocho, 31; 0.8 mi. (1.3 km) W. Mocho, 3. — *Trelawney*, 3.0 mi. (4.8 km) NW Windsor, 1; Windsor Cave, 36; Windsor, 49; Hyde, near Clark's Town, 3; 1.8 mi. (2.9 km) S Stonehenge, 1000 feet (305 m), 1; Ramgoat Cave, 2; 5.4 mi. (8.6 km) N Burnt Hill, 1000 feet (305 m), 1; 1.5 mi. (2.4 km) N Burnt Hill, 1600 feet (488 m), 1; 4.8 mi. (7.7 km) NW Troy, 10; 6 mi. (9.6 km) NW Troy, 5. — *St.n An*, 3.0 mi. (4.8 km) E. Discovery Bay, 4. — *Clarendon*, Spaldings, 1 (MCZ 11126 – holotype). — *St. Catherine*, Worthy Park Estate, 1250 feet (381 m), 1; 2.8 mi. (4.5 km) W Lluidas Vale, 1800 feet (549 m), 5; 2.4 mi. (3.8 km) W Lluidas Vale, 1600 feet (488 m), 1; 1.3 mi. (2.1 km) W Lluidas Vale, 1; 2 mi. (3.2 km) W Lookout, 1600 feet (488 m), 2; 1 mi. (1.6 km) W Lookout, 1600 feet (488 m), 3; 0.5 mi. (0.8 km) W Lookout, 1800 feet (549 m), 1. — *St. Mary*, 2.4 mi. (3.8 km) E. Ocho Rios, east side mouth White River, 13; 2.8 mi. (4.5 km) E Oracabessa, 2; 2.0 mi. (3.2 km) E Oracabessa, 1.

Eleutherodactylus cundalli glaucoreius, new subspecies

Holotype: MCZ 43320, a gravid female, from 4.5 mi. (7.2 km) S Fair Prospect, *Portland Parish*, Jamaica, one of a series collected 24 June 1961, by Ronald F. Klinikowski, David C. Leber, and Albert Schwartz. Original number ASFS 13300.

Paratypes: ASFS 13296–13299, 13301–13325, same data as holotype. — *St. Andrew*, MCZ 43284–88, 16 mi. (25.6 km) N Kingston, 14 June 1961, Klinikowski, Leber, Schwartz; ASFS 12887–88, 16 mi. (25.6 km) N Kingston, 14 June 1961, Leber; ASFS V12639, 3.3 mi. (5.3 km) N Irish Town, 2500 feet (763 m), 5 August 1967, R. Thomas; CM 52801–21, Hardwar Gap, 15 June 1961, Klinikowski, Leber, Schwartz; USNM 189164–68, Hardwar Gap, 18 June 1961, Klinikowski; ASFS V16472–81, Hardwar Gap, 12 April 1969, J. A. Rodgers, Jr., Schwartz. — *Portland*, ASFS V12626–28, Hardwar Gap, 4000 feet (1220 m), 5 August 1967, Thomas; ASFS 13048–49, Port Antonio, 18 June 1961, Schwartz; ASFS V12653–54, 2.6 mi. (4.2 km) W Port Antonio, 7 August 1967, Thomas; CM 52822, 5.5. mi. (8.8 km) S Fellowship, 20 June 1961, Schwartz; USNM 189169–82, 6.8 mi. (10.9 km) S Fellowship, 20 June 1961, Klinikowski, Leber, Schwartz; MCZ 43307–16, 8 mi. (12.8 km) S Seamans Valley, 25 June 1961, Klinikowski, Leber, Schwartz; MCZ 43317–19, 8 mi. (12.8 km) S Seamans Valley, 26 June 1961, Klinikowski, Leber, Schwartz; ASFS 13170–83, 6.8 mi. (10.9 km) S Fellowship, 20 June 1961, Klinikowski, Leber, Schwartz; MCZ 43289–306, 4.2 mi. (6.7 km) S Fair Prospect, 21 June 1961, Klinikowski, Schwartz; USNM 189183–90, 3.5 mi. (5.6 km) S Fair Prospect, 21 June 1961, Klinikowski, Schwartz; CM 52823–32, 4.5 mi. (7.2 km) S Fair Prospect, 27 June 1961, Klinikowski, Leber, Schwartz; ASFS 12706–07, 1.4 mi. (2.2 km) N Hectors River, 9 August 1967, Thomas. — *St. Thomas*, ASFS 12840–41, 14.5 mi. (23.2 km) E Kingston, 12 June 1961, Leber, Schwartz.

Definition: A subspecies of *E. cundalli* distinguished by small size (males to 28 mm, females to 32 mm snout-vent length), hindlimbs long, the heels overlapping when the femora are held at right angles to the body axis, and vomerine tooth row short, not extending to, or beyond, the lateral margins of the choanae.

Distribution: Eastern Jamaica, in Portland, St. Thomas, and St. Andrew parishes (Fig. 54), from sealevel to at least elevations of about 4250 feet (1296 meters).

Description of holotype: A gravid female with the following measurements: snout-vent length 29.6; head length 11.1; head width 11.2; tympanum 1.9; eye 3.7; naris to eye 3.5; femur 13.1; tibia 14.2; fourth toe 12.9; tibia/snout-vent length × 100, 48.0. Head as long as broad; snout acuminate but sharply truncate, with nares moderately conspicuous at anterior end of canthus rostralis; diameter of eye slightly greater than distance from naris to anterior corner of eye; diameter of tympanum much less than diameter of eye, distance from tympanum to eye slightly less than diameter of tympanum. Interorbital distance 3.0, less than diameter of eye. Digital discs present, those on digits 3 and 4 about two thirds size of tympanum. Fingers long, unwebbed, 3–4–2–1 in order of decreasing length; subarticular tubercles pale gray, distinct from palmar surface of hand. Toes long, unwebbed, 4–3–5–2–1 in order of decreasing length: subarticular tubercles prominent and gray, sharply set off from plantar surface. Heels overlap strongly when femora are held at right angles to body axis. Inguinal glands absent. Dorsum vaguely warty and with a median dorsal raised line. Throat, chest, and belly smooth. Dorsal surfaces of fore- and hindlimbs irregularly warty. Posterior and ventral faces of thighs covered with moderately sized, juxtaposed, flattened granules or warts. Tongue large, free and weakly notched behind, its greatest width equal to about two-thirds of that of floor of mouth. Vomerine teeth in two small, weakly angulate patches, extending just slightly beyond the median margins of the choanae, separated from them by a distance equal to about two-thirds the diameter of a choana, the two patches separated medially by a distance equal to the diameter of a choana.

Dorsal ground color in life tan, heavily mottled with dark brown; major dorsal markings include an interocular bar, sharp-edged anteriorly, ragged and somewhat pointed medially, and a median dorsal irregular dark rectangle, of which the anterior border is the scapular W, the rectangle expanded posterolaterally, the lateral margins of the rectangle delimited by a paler tan longitudinal spot on each side; remainder of dorsum heavily mottled and stippled with dark brown, especially prominent on the lower sides; snout mottled with dark brown on a slightly yellowish tan ground, paler than dorsal ground color; forelimbs tan, mottled dark brown, and with three more or less prominent antebrachial bars, that at mid-antebrachium most clearly defined; hindlimbs with narrow dark brown bars with paler interspaces, about four bars on femora, two on crus, and two on pes; concealed surfaces brown; venter pale yellow, throat heavily mottled with coarse dark brown spots as far posteriorly as level of forelimb insertion; venter mottled with medium brown laterally, the dotting becoming finer medially; underside of fore- and hindlimbs vaguely mottled with medium brown on a brownish ground.

Variation: A series of the 25 largest males has the following measurements: snout-vent length 20.3–27.7 (22.9); head length 8.4–10.7 (9.5); head width 7.8–11.0 (9.0); tympanum 2.0–2.9 (2.4); eye 2.7–3.9 (3.3); naris to eye 2.4–3.5 (2.8); femur 8.5–12.2 (10.1); tibia 9.4–13.2 (11.0); fourth toe 8.7–12.5 (10.3) tibia/snout-vent length × 100 44.6–53.4 (48.3). Twenty-two gravid and adult females measure: snout-vent length 26.3–31.6 (29.2); head length 10.7–13.1 (11.5); head width 9.7–12.4 (11.3); tympanum 1.8–2.5 (2.0); eye 3.4–4.4 (3.9); naris to eye 2.9–4.3 (3.7); femur 11.8–14.0 (12.9); tibia 12.9–15.0 (14.0); fourth toe 12.0–14.4 (13.2); tibia/snout-vent length × 100 45.3–50.7 (48.1).

The series of 148 *E. c. glaucoreius* shows the same patterns variants as does the nominate subspecies, but the frequencies are somewhat different. Sixty-six frogs (44.6 percent) are mottled, whereas 68 frogs (45.9 percent) have dorsolateral stripes. All other patterns are rare, with five frogs (3.4 percent) having median dorsal lines and three frogs (2.0 percent) having the picket pattern. Five frogs (3.4 percent) have a dorsal line combined with dorsolateral stripes, and one frog (0.1 percent) has picket combined with dorsolateral stripes.

Dorsal ground colors in *glaucoreius* tend toward tans and grays, although some individuals were recorded as reddish and orange-tan dorsally. The dorsolateral stripes are tan to reddish tan, and the snout anterior to the interocular bar shares the same hues. The mid-dorsal line is yellow to buffy. The venters are often heavily pigmented with black to brown; the throats are even more heavily pigmented with dark brown to black, the pigment often organized into large bold spots or blotches. The lateral dark brown body spotting is a feature which occurs commonly. The dorsum almost always has a scapular W, and this in turn is very often followed by a second W at mid-back. The more posterior W is most often encountered in those frogs with dorsolateral stripes, and, in these frogs, both the scapular and mid-back W's are truncate laterally by the stripes themselves. In the holotype, the two W's form the anterior and posterior boundaries of the dorsal brown rectangle. Fore- and hindlimb barring are usually about as described for the holotype, but femoral bars are often reduced or absent; concealed surfaces are brown. The venter, although heavily stippled or blotched with dark brown, usually shows a pale yellow cast, and occasional individuals show a brighter yellow to orange suffusion in the groin. Larger individuals show more yellow on the venter, whereas smaller frogs have the venter pale gray without yellow pigment. The short vomerine series, not extending so far laterally as the lateral margins of the choanae, and the longer legs with overlapping heels when the legs are adpressed, are characteristic of the series.

Comparisons: The most obvious difference between *c. cundalli* and *c. glaucoreius* is the much smaller size of the latter. In all measurements of both sexes, mature males and females of the two subspecies are completely separable except in tympanum diameter in males, and head length, head width, tympanum diameter, and eye in females. Although there is an easily observed difference in hindlimb length between the two subspecies, computations of tibia/snout-vent length do not reveal it, since the ranges and means of this ratio in both sexes of both subspecies are very close or identical. Nevertheless, the heels strongly overlap in *glaucoreius* and do not overlap at all in the nominate subspecies. The shorter vomerine tooth row likewise is characteristic of the smaller *glaucoreius*.

Although both subspecies have the same pattern variants, there are differences in incidence of these variants in the two subspecies. The most common condition in *cundalli* is mottled whereas in *glaucoreius*, mottled and dorsolateral stripes are almost identical in frequency. Picket and dorsal line are commoner in *cundalli* than they are in *glaucoreius*. The largest discrepancy between frequencies in the two taxa is in dorsolateral stripes, where there is a difference of 2.19 percent in this pattern between *cundalli* and *glaucoreius*.

The two subspecies are very similar in color and pattern, but there seems to be a tendency for *cundalli* to be more brightly colored than *glaucoreius*, with more often shades of yellows and reds and oranges encountered. The throats of *glaucoreius* show a distinct tendency toward very heavy mottling, the mottling taking the form of discrete dark brown to black blotches on a whitish to yellowish ground, whereas the throats in *cundalli* are regularly more finely stippled or dotted, without the coarse aspect of many *glaucoreius*. The same is true of the lateral body pattern, which in *glaucoreius* tends toward large irregular dark blotches, a condition rarely encountered in *cundalli*.

Remarks: The name *glaucoreius* is derived from the greek "glaucos" for "pale blue" and "oreios" meaning "mountain", in allusion to the occurrence of this subspecies in the Blue Mountains in eastern Jamaica. The subspecies is not, however, limited to higher elevations in this range, as its occurrence at sealevel and in the valley between the Blue Mountains and John Crow Mountains attests.

We have specimens of *E. c. glaucoreius* from the three easternmost Jamaican parishes of St. Thomas, Portland, and St. Andrew. Our St. Thomas locality east of Kingston is the first for this parish, and one of the two south coastal locations. Specimens collected here were on rocks on the ground in xeric forest. Many specimens were secured near the Hardwar Gap area in the Blue Mountains, where they were found on the ground and on the leaves of low shrubs in rain forest. Specimens from the Port Antonio, Portland, area were collected in and on a rock wall. Some of our easternmost specimens were secured south of Fair Prospect, Portland, in overgrown *Musa* groves on shrubs and trees up to seven feet above the ground, and on dog-tooth limestone cliffs in dense forest. Other Portland specimens were collected near Fellowship and Seamans Valley on the ground, on shrubs up to seven feet above the ground, on *Musa* stumps, and on the bank of a mountain stream.

DUNN (1926) never observed *E. cundalli* calling and theorized that it might be a silent form. GOIN & COOPER (1950) reported a two-note chirping call for the species, very similar to that of *E. planirostris*. We consider the call to be a staccato series of "tick"s or barks, again much like that of *E. planirostris*.

Eleutherodactylus cavernicola Lynn

Eleutherodactylus cavernicola was named from a series of 36 speciamens from Portland Cave and from two caves near Jacksons By-

(LYNN, 1954). The species, at first confounded with *E. cundalli* (Lynn & Dent, 1943), is apparently an inhabitant of caverns on the Portland Ridge (Fig. 54). This ridge, as pointed out by GRANT (1940), is a biological island where there is both some endemism (for example, *Diploglossus duquesneyi* Grant) and where some species, rare elsewhere on Jamaica, have persisted (for example, *Mabuya mabouya* Lacépède). The Portland Point area is moderately well-forested with relatively mesic situations on the ridge proper, but low-lying or coastal areas are xeric (*Acacia* scrub or mangroves) and in general seem unfit for most frogs. The possibility remains that *E. cavernicola* is not strictly a cave-dwelling frog, and that it is widely distributed in rocky but non-cavern situations on Portland Point; the limestone foundation of the ridge in which Portland Cave itself lies is eminently suitable for a petricolous frog. Nevertheless, no specimens have thus far been secured outside of the above-mentioned caves. At the time of our 1970 visit to Portland Cave, the area had been subjected to heavy rainfall, since the earthen road leading to the lighthouse had numerous rain pools in many places between Portland Cottage and the cave. A nocturnal visit to the cave and its surrounding area yielded no frogs from outside the cave, despite this heavy previous rainfall and moist external conditions.

Our four specimens are all males with the following measurements: snout-vent length 28.0–30.2; head length 11.2–12.7; head width 11.2–12.5; tympanum 2.3–2.5; eye 3.4–3.8; femur 11.3–13.8; tibia 11.9–14.1; fourth toe 8.0–12.9. LYNN (1954) did not segregate measurements for males and females, but pointed out that both males and females reach at least 38.0 mm in snout-vent length. Sexual maturity in males must occur at a slightly smaller size since three of our four specimens were taken while vocalizing.

In life, the specimens were tan above, with all markings brown to black. The iris is bronzy with red-brown areas anteriorly and posteriorly. The venter is white to flesh with the throat finely stippled purplish, and the jaws are mottled with brown. A narrow dark interior bar is regularly present, and the arrangement of the dorsal spotting is such as to delimit an inconspicuous pair of clearer tan dorsolateral stripes. The lores are dark brown to black with some paler tan mottling or marbling, and a dark supratympanic line is present. In addition, there may be a supra-axillary dark bar which helps to delimit the faint dorsolateral stripes in this region. LYNN's (1954) illustration of dorsal and lateral views shows the pattern very well, although our specimens in general have all dorsal markings somewhat darker than his drawing.

Three of our four specimens of *E. cavernicola* were collected in 1970 on a nocturnal trip to Portland Cave, whereas a diurnal trip on the previous day had yielded no frogs. Two males were collected while calling, and a third was secured at the same time without revealing itself vocally. Even though heavy rainfall had inundated the area, the inside of the cave was extremely dry, possibly explaining why no specimens were secured in situations similar to those described by LYNN (1954). All three of the 1970 frogs were collected in a steep passage leading to an overhead entrance to the cave. Rainfall had thoroughly wetted the accumulated leaves and debris deposited inside the entrance by overhead trees. The frogs were found exposed on the moist earth, and calling well hidden from solution cavities in the limestone, not over 20 feet (6 meters) within the overhead cave entrance. The fourth specimen was collected by KLINIKOWSKI in 1961. It was exposed on moist earth not over 30 feet (9 m) inside the main entrance of the cave.

Unlike the high pitched oft-repeated chirp described by LYNN (1954) for *E. cavernicola*, our two calling males were emitting a series of two or more warm-up "cluck"'s, followed by a two-note "tick-tock", the first note higher than the second.

Specimens: *Clarendon*, Portland Cave, 5.6 mi. (9.0 km) SE Portland Cottage, 4.

Eleutherodactylus grabhami Dunn

Eleutherodactylus grabhami is widespread in western Jamaica. We have 99 specimens, of which the 25 largest males have the following measurements: snout-vent length 18.5–21.1 (19.3); head length 7.4–8.3 (7.8); head width 7.0–8.7 (7.6); tympanum 1.4–2.0 (1.7); eye 2.4–3.3 (3.0); naris to eye 1.8–2.5 (2.2); femur 7.8–9.8 (8.5); tibia 8.5–10.2 (9.0); fourth toe 8.0–9.7 (8.5). Thirty-six adult and gravid females measure: snout-vent length 23.0–29.0 (26.0); head length 8.8–11.7 (10.3); head width 9.0–11.7 (10.3); tympanum 1.5–2.3 (1.8); eye 2.6–4.4 (3.6); naris to eye 2.3–3.8 (2.9); femur

9.3–12.5 (11.1); tibia 10.8–12.9 (11.4); fourth toe 9.8–12.4 (11.1). Our smallest juvenile has a snout-vent length of 11.3.

Eleutherodactylus grabhami is basically a pale frog, with dorsal grays and tans and pinkish hindlimbs and brachia. A feature which is common to all specimens, regardless of maturity, is the spotted throat, although the degree of spotting is quite variable and the spots may be restricted to the jaw margins in extreme cases. Nevertheless, *E. grabhami* is easily identified in the field and laboratory by the spotted throat and pale dorsal color.

There are two basic dorsal patterns: mottled and broad dorsolateral stripes. The stripes, however, are often so weakly set off from the balance of the dorsal color (since they are not differently colored but rather are longitudinal areas of pale dorsal color without darker stippling or blotching) that it is often difficult, in preserved specimens, to ascertain which of the two patterns pertains in each instance. In our series, 59 individuals have mottled dorsa and 40 have dorsolateral stripes. The dorsal ground color has been recorded in life as gray (Pl. 13A2), pinkish gray, brownish gray, tan, yellowish tan, pale tan, yellowish gray, and greenish. In the mottled pattern the back is dotted and variously marked with dark brown to black; two more or less constant features are a narrow black interocular bar and a scapular W, the arms of which are usually sharply truncate laterally, so that only a pair of scapular scallops or dots remains of the W. Many frogs (ASFS 15344, for example) are almost without any sort of dorsal markings and have only a vague remnant of the dark interocular bar.

In the striped phase, the same dorsal colors occur, but the stripes are broad and represent areas of the dorsum which lack dark flecking or dotting. At their anterior ends the stripes are often outlined with dark brown or black for a short distance. The interocular bar and the scapular W are present, but the latter is usually much reduced in striped specimens and is more often absent than in the mottled condition.

Regardless of the dorsal pattern, the brachia and the hindlimbs are usually pinkish, rosy, pale orange, or reddish, and because of the otherwise pale coloration, these colored regions are especially apparent in living frogs. The throat is always covered by dark subcircular spots, although, as noted above, the number and intensity of these spots is variable. In many adult females, the spots are coalesced to give a dark gular reticulum or marbling. The sides of the body and of the venter likewise are often stippled with dark brown. The venter is white and the concealed surfaces are brownish. The iris is dull golden above and brown below. Notes on the series from Maidstone state that the limbs were not so pink as in more northern individuals.

LYNN (1940: 48) noted the presumed occurrence of *E. grabhami* at Gray's Inn, St. Mary Parish, far to the east of all previous reports for the species. The record is based upon USNM 73862–64. These specimens have been examined for us by RONALD I. CROMBIE who advised us that LYNN himself had subsequently re-identified them as *E. p. planirostris*. The frogs are presently in very poor condition but Mr. CROMBIE assured us that they are not *E. grabhami* and are indeed *E. planirostris*. *E. grabhami* is thus restricted to the western and central regions of Jamaica.

All of our material was secured west of a line dividing Trelawny and Manchester parishes from St. Ann and Clarendon parishes. LYNN's (1940) records support this eastern boundary and only DUNN's (1926) record of Spaldings, Clarendon (the type locality), is exceptional (Fig. 55). The species has not as yet been secured in St. Elizabeth, which lies west of the north-south limiting line. In Hanover, we have localities near Town Head and Bushmont on or in the vicinity of Dolphin Head Mountain, at elevations ranging from 500 feet (153 m) to 1000 feet (305 m). Specimens from three localities were collected calling on rocks and low shrubs along a trail leading through a cleared hillside. Individuals from Beeston Spring, Westmoreland, were collected calling from the leaves of low herbaceous vegetation at an elevation of approximately 1100 feet (336 m). St. James specimens from near Mocho were taken on rocks on a road cut and in woods, and from terrestrial bromeliads, at elevations approximating 2200 feet (672 m). Frogs from Cambridge, Maroon Town, and Jericho were all taken from terrestrial bromeliads at elevations ranging from 800 feet (244 m) to 1500 feet (458 m). All of our Manchester specimens, from east of Maidstone, were taken on a rock wall between an open road and an exposed pasture. Frogs from Windsor, Trelawny, were collected on the ground and on the leaves of low shrubs along a forest path, and associated with dog-tooth limestone on a steep hillside. Frogs from south of Stonehenge were found among bromeliad cuttings. Specimens from these two localities indicate an eastern and northern encroachment by the species into the Cockpit Country. Frogs from northwest of Troy in Trelawny, collected on rocks and herbs in forest, and specimens from Quick Step, Trelawny, taken from terrestrial bromeliads, indicate that *E. grabhami* is also common along the southern Cockpit edge. These data suggest that *E. grabhami* is probably found throughout the ecologically suitable Cockpit Country.

Males we observed and collected while calling were emitting a single slight "peep" or a series of "peep"s, much like the lisping calls of *E. luteolus* and *E. planirostris*.

Specimens: *Hanover*, Bushmont, 10.5 mi. (16.8 km) SE Lucea, 6; 4.4 mi. (7.0 km) N Town Head, 800 feet (244 m), 2. — *Westmoreland*, 3.6 mi. (5.8 km) S Medley.

3; 2.5 mi. (4.0 km) S Medley, 8; 0.1 mi. (0.2 km) N Beeston Spring, 1100 feet (336 m), 3. — *St. James*, 3.0 mi. (4.8 km) NE Cambridge, 900 feet (275 m), 1; 3.1 mi. (5.0 km) NE Maroon Town, 800 feet (244 m), 1; 0.3 mi. (0.5 km) SE Jericho, 1400–1500 feet (427–458 m), 2; 0.5 mi. (0.8 km) W Mocho, 12; 0.8 mi. (1.3 km) W Mocho, 5. — *Trelawny*, Windsor, 30; 1.7 mi. (2.7 km) S Stonehenge, 1200 feet (366 m), 1; Ramgoat Cave, 1; 4.8 mi. (7.7 km) NW Troy, 1; 6 mi. (9.6 km) NW Troy, 4; 3.3 mi. (5.3 km) N Quick Step, 1300 feet (395 m), 1; 0.9 mi. (1.4 km) N Quick Step, 1300 feet (395 m), 1. — *Manchester*, 3 mi. (4.8 km) E Maidstone, 15.

Eleutherodactylus planirostris planirostris Cope

Eleutherodactylus p. planirostris is one of two introduced species of anurans in Jamaica. The twenty-five largest males in our series of 185 specimens have the following measurements: snout-vent length 17.3–20.2 (18.5); head length 6.5–7.9 (7.1); head width 6.2–7.7 (6.8); tympanum 1.3–1.9 (1.7); eye 2.2–3.1 (2.6); naris to eye 1.7–2.2 (2.0); femur 6.7–9.5 (7.7); tibia 7.9–10.5 (8.6); fourth toe 7.1–9.8 (8.2); tibia/snout-vent length × 100 43.0–52.0 (46.3). The twenty-five largest females measure: snout-vent length 23.0–25.4 (24.4); head length 8.2–9.5 (8.8); head width 7.5–9.8 (8.5); tympanum 1.5–2.2 (1.9); eye 2.7–3.5 (3.2); naris to eye 2.3–3.0 (2.6); femur 9.2–10.7 (9.8); tibia 9.9–11.5 (10.6); fourth toe 9.2–10.6 (10.1); tibia/snout-vent length × 100 40.0–46.9 (43.4). There are many other gravid females with lesser snout-vent lengths than the minimum measurement (23.0) noted above. The smallest gravid female (ASFS 15628) has a snout-vent length of 19.8 and a tibia length of 8.5.

Eleutherodactylus p. planirostris is dichromatic in dorsal pattern. Goin (1947) analysed the inheritance of these two patterns (mottled and dorsolateral stripes) in the introduced population at Gainesville, Florida, and concluded that the inheritance is a simple Mendelian 3: 1 ratio, with the mottled pattern being the homozygous recessive condition and the dorsolateral striped condition being either the homozygous dominant or the heterozygous condition. At the time of Goin's review, he examined Jamaican specimens of *E. planirostris* from two general areas (eastern: Chapelton, Kingston, Windsor, Highgate; and western: near Sandy Bay, Montego Bay, 5 mi. W Montego Bay). These two regions are more or less diagonally opposite each other and suggest that there were two (rather than one) introduction of *E. planirostris* in Jamaica: one in the Kingston region and the other in the Montego Bay area. GOIN (1947: 34–35) also noted that eastern specimens were all mottled and that the northwestern (Montego Bay area) population showed both dorsal patterns. Such a situation strongly suggests two introductions, and that the eastern introduction fortuitously included only specimens which were mottled and thus homozygous recessives, whereas the northwestern introduction contained specimens with both recessive and dominant genes.

Eleutherodactylus p. planirostris is now known from many more localities (Fig. 56) and specimens than were available to GOIN. It also seems likely that the gap (which appeared to exist between these two introductions in 1947) has now been bridged; *E. planirostris* is notorious in its ability to be transported and colonize new areas – often areas which are completely unsuitable to other eleutherodactylus. Additionally, in Jamaica, there seems not to occur naturally any serious niche-competitor with *E. planirostris*. The species occurs syntopically with *E. johnstonei* (which is also introduced) and *E. gossei*, but the latter is by far the larger frog and in addition calls from above the ground surface, whereas *E. planirostris* regularly uses terrestrial calling sites.

Our specimens from eastern Jamaica (southeastern Manchester, southwestern Clarendon, St. Catherine, and Portland parishes – 15 specimens) are all mottled and thus confirm GOIN's contention that all eastern specimens are homozygous recessives. Combining GOIN's (1947: 31) data for various eastern localities with ours, mottled individuals occupy eastern Jamaica west to a line from southeastern Manchester (4.0 mi. N Milk River), central Clarendon (Chapelton), and central St. Mary (Highgate); these conclusions are based upon a total of 37 specimens.

Specimens from central and western Jamaica (*i.e.*, west of the above eastern boundary of the mottled morph) are puzzling. Both striped and mottled morphs occur in all marginal localities in Westmoreland (vicinity of Whitehouse), St. Elizabeth (Magotty), northern Manchester (Troy), northern Clarendon (Aenon Town), and north coastal St. Ann (Ocho Rios). The major exception to this statement is the occurrence in the region near Negril in extreme western Westmoreland of only mottled individuals (five specimens). Combining data for all of our recent specimens (with the exception of the long series from Troy, we find that there are 49 mottled individuals and 36 striped frogs, or an approximate ratio of the two morphs of 1 : 1.

The long series from Troy, collected under especially unusual circumstances (see below), contains 85 frogs, and is the longest series of *E. planirostris* from Jamaica. Of this series, 81 are mottled and four are striped; thus there is a very strong preponderance of homozygous recessive individuals in the series. We interpret these facts to indicate that the region about Troy is very likely the area where eastern mottled frogs have come into genetic and geographic contact with western individuals. A short series of seven frogs from Aenon Town to the east of Troy has four mottled and three striped individuals, and thus does not show a strong tendency toward mottled as does the more western Troy series.

If we combine data from all central and western specimens in our collection, we have 130 mottled individuals and 40 striped frogs, or a 1:3 ratio, with the mottled condition being more prevalent. All the above data suggest that the mottled pattern is the more common in Jamaica than the striped pattern, despite the fact that the striped pattern is the homozygous dominant and heterozygous condition. GOIN (1947: 32) suggested several possibilities for this situation. It seems likely that his possibility (3) – selection of one pattern over another because of some direct effect or because one pattern is associated with some unknown physiological effect – is the most acceptable explanation for the situation in western Jamaica, although the remaining three possibilities should not be entirely eliminated. GOIN (1947: 31) recorded that, upon examination of 163 specimens from Cuba (where the subspecies is native and whence the Jamaican populations were presumably derived), he found 85 striped and 71 mottled individuals (six were indeterminate), or roughly a 1 : 1 ratio of the two morphs in this "parent" population. SCHWARTZ (1960: 21 *et seq.*) pointed out that in *E. r.*

goini from western Cuba, the expected 3: 1 ratio pertains, but that in Isla de Pinos and New Providence *E. p. planirostris* the ratios were, respectively, about 1: 1 and 9: 1. Obviously, different factors must affect the gene pools on the various islands occupied by the species. It is remarkable that in the samples from the populations from the two "parent" islands (Cuba and Isla de Pinos) the two morphs occur with about equal frequency, despite experimental genetic evidence to the contrary.

As GOIN proposed, there is little reason to doubt that Jamaican *E. planirostris* were introduced from Cuba. Comparison of our data from Jamaican frogs with those presented by SCHWARTZ (1960: 23) for Cuban specimens, shows that both sexes reach about the same size (largest Cuban male 19.9, largest Jamaican male 20.2; largest Cuban female 26.9, largest Jamaican female 25.4). The tibia/snout-vent length × 100 ratio in Jamaican males has a mean of 46.3 (43.0–52.0) whereas this ratio in Cuban males has a mean of 46.6 (45.7–48.9). This ratio in Jamaican females averages 43.4 (40.0–46.9), whereas the female Cuban average is 45.4 (40.6–48.8). These data suggest that Jamaican *E. p. planirostris* have relatively shorter tibiae than do their Cuban relatives; the difference is more striking in females than in males.

LYNN (1937) reported the first specimens of *E. p. planirostris* from a collection of nine made by him at Montego Bay, St. James Parish. Later, LYNN (1940) reported 15 specimens collected (also in 1937) at Kingston, St. Andrew. LYNN's Montego Bay specimens were secured at night perched on low blades of grass by the roadside, the frogs never more than six inches above the ground. LYNN & DENT (1943) collected *E. p. planirostris* at: Sandy Bay, Hanover; Highgate, St. Mary; Port Antonio, Portland; Chapelton, Clarendon; and at the mouth of Hectors River, Portland. GOIN (1947) reported specimens from Windsor, Portland, and west of Montego Bay. GOIN & COOPER (1950) took 16 specimens under dead banana leaves at Sweetwater, St. James. These later localities, starting with LYNN & DENT (1943), seem to indicate movement of *E. p. planirostris* from the two original localities rather than subsequent introductions, although the latter is a possibility, in that the frogs may have been moved about Jamaica itself through the accidental efforts of man.

Our collections, made twenty tears later, further indicate that *E. planirostris* has been successful in inhabiting a terrestrial niche from low to moderate elevations (to 2000 feet – 610 m) throughout most of the island. We have specimens from St. James, one of the parishes from which the original specimens were collected and reported by LYNN. These specimens, from south of Vaughansfield, were taken in an open pasture under rocks, and under banana trash. We have several specimens from Trelawny, whence *E. p. planirostris* has not been previously known. One specimen from Windsor was taken in an arboreal bromeliad about seven feet (2 m) above the ground in a pasture tree. Five specimens from near Negril, Westmoreland Parish, were collected in the grass at the edge of a pasture and under palm trash along the coast. Our other Westmoreland specimens came from the Whitehouse area, where they were collected in xeric palmetto pasture land near the coast, under moist rotten wood, and on the grounds of a small hotel after a heavy rain. All 25 of our Hanover specimens came from the earthen bank of a culvert in a field southwest of Lucea.

One of our Manchester localities, which yielded 85 frogs, is east of Troy, where a remarkable number of frogs (including also *H. wilderi*, *E. gossei*, *E. luteolus*, and *E. pantoni*) was collected from debris and drift caught up against a bridge across Hectors River, which here forms the Trelawny-Manchester boundary. The river had risen in flood at about 16.00 hours after a heavy prolonged afternoon rain. The jam, which was composed of masses of cane, grass, coconut fronds, shrubs, and bushes (all dead), was alive with frogs, insects, and spiders. The frogs were obviously exhausted and easy to secure. Many of the *E. planirostris* sought refuge under a pile of rocks on the river bank.

In the parish of St. Ann we collected seven specimens east of Aenon Town on the ground in a *Musa* grove. Another 18 were taken northwest of Ocho Rios under *Cocos* trash in a grassy coconut grove, and three were from other palm trash in an open park east of Runaway Bay. From south of Gregory Park, St. Catherine, we collected one specimen under a large log in moist, rich, lowland forest.

Specimens: *Hanover*, 7 mi. (11.2 km) SW Lucea, 25. — *Westmoreland*, 2.7 mi. (4.3 km) S Negril P.O., 4; 1 mi. (1.6 km) E Negril, 1; 0.3 mi. (0.5 km) NW Whitehouse, 4; 0.5 mi. (0.8 km) SW Whitehouse, 12. — *St. James*, 1.4 mi. (2.2 km) S Vaughansfield, 6. — *Trelawny*, 1.2 mi. (1.9 km) E Falmouth, 1; Windsor, 3; Hyde, nr. Clark's Town, 1. — *St. Elisabeth*, 1.8 mi. (2.9 km) NE Magotty, 400 feet (122 m), 2. — *St. Ann*, 1.0 mi. (1.6 km) E Runaway Bay P.O., 3; 4.4 mi. (7.0 km) NW Ocho Rios, 15; 1.5 mi. (2.4 km) E Aenon Town, 7. — *Manchester*, 0.7 mi. (1.1 km) E Troy, 85; 4.0 mi. (6.4 km) N Milk River, 4. — *Clarendon*, 7.6 mi. (12.2 km) N Milk River, 1. — *St. Catherine*, 1.6 mi. (2.6 km) S Gregory Park, 1. — *Portland*, Folly Estate, east of Port Antonio, 3; 1.0 mi. (1.6 km) SE Boston Bay, 1; Fair Prospect, 3; 5.3 mi. (8.5 km) N Manchioneal, 3.

Eleutherodactylus gossei Dunn

Eleutherodactylus gossei Dunn was based upon a series of specimens from Spaldings Clarendon (the type locality); Mandeville, Manchester; Cumberland, Clarendon; and Balaclava, St. Elizabeth. DUNN contrasted *gossei* with "*luteolus*": the latter name was incorrectly used by DUNN, since he applied it to a population of what today is considered *E. gossei* (specimens, *fide* Dunn, from Bluefields, Westmoreland; Kingston, St. Andrew; Port Antonio, Portland; and Montego Bay, St. James). LYNN (1940: 32–34) reported *E. gossei* (as *E. luteolus*) from many localities throughout Jamaica and showed that the species is virtually islandwide in distribution. The only parish whence *E. gossei* remained unknown was Westmoreland (DUNN's "Bluefields" record is apparently that of the type of *E. luteolus* Gosse; however, GOIN, 1953: 1, gave "Content, Parish of Westmoreland" as the type locality of *E. luteolus*).

Our initial impression, after studying 297 specimens of *E. gossei*, was that there are four distinct populations which are nameworthy. However, although we remain convinced that such will ultimately prove to be the situation, we have refrained from naming two of these and have given formal designation to only one from the extreme eastern portion of the island. Our rationale for this action follows.

Measurements and proportions are based upon the following series of 19 to 31 adult and gravid females and the 22 to 26 largest males from four regions: A) extreme eastern Hanover and Westmoreland parishes east through St. James, St. Elizabeth, south-central Trelawny, Manchester and Clarendon, central St. Catherine, central and eastern St. Mary, western Portland, and western St. Andrew (see lists of specimens examined by regions in the present account); B) central and western Trelawny, St. Ann, northwestern St. Mary, and extreme northeastern Clarendon and northwestern St. Catherine; C) southern coast from southwestern Clarendon, through southern St. Catherine, southern St. Andrew, to southern St. Thomas; D) Portland Parish in association with the northern slopes of the Blue Mountains and the interior valley between the Blue Mountains and the John Crow Mountains (see Fig. 57).

At first glance, the most obvious difference between these four populations is one of size (see Table 1), most clearly shown in adult females. Females from the south coast (C) reach snout-vent lengths much greater (34.2) than do females from any other sample) 29.8, 31.2, 26.2) and are distinctly stockier frogs. On the other hand, the Portland females (D) are much the smallest (maximally 26.2) in snout-vent length (other samples with high extremes of 29.8, 31.3, 34.2). These differences in size between the various samples are shown also in all other measurements in females, with sample C females consistently larger in all measurements and sample D females consistently smaller. However, if we use the criterion of gravid females (including adult but non-gravid specimens), the large size of sample C females is obscured; minimally sized gravid females of samples A, B, and D are 23.5, 23.5, and 19.7, and the means of the snout-vent lengths of females of these three samples are, respectively, 25.5, 27.6, and 22.0. Sample C females have a mean snout-vent length of 27.1, which is less than that of sample B, despite the much greater size reached by sample C females! However, note that sample D females are consistently smaller, both in adult size and in mean snout-vent length, than all other females; the upper extreme of snout-vent length in sample D (26.2) barely overlaps the lower extremes of snout-vent length measurements in samples A, B, and C (23.5, 23.5 and 23.2).

Turning to males, we find that sample C males likewise reach a greater snout-vent length (28.2) than do males from the other three samples (upper extremes in each case 26.5, 26.4, and 23.2), although the differences are less striking. Sample D males are smaller in maximum snout-vent length than males of samples A, B, and C (26.5, 26.4, and 28.2), and in fact, in snout-vent length alone, males from samples C and D are virtually separable with an overlap of only 0.1 mm. Sample D males also have consistently lower means in all measurements with the exception of tympanum (all male samples have a tympanum mean of 1.8) and eye (sample A has a mean of 3.1 as does sample D).

We were originally convinced that there was a series of subspecies, graded by size, from the smallest (D), through A and B to the largest (C). This series is not to be interpreted as clinal; the various populations are not sequentraily arranged and can be correlated with geographic features. We still harbor the conviction that this is the true situation, but the amount of overlap in all measurements in most cases renders diagnoses of these populations nomenclatorially very difficult indeed. We have not attempted to borrow all extant specimens of *E. gossei* for our analysis; we feel that much more freshly collected and precisely documented specimens are necessary before further action can be taken. Most important may be apparent differences in vocalization. Our notes, admittedly incomplete, suggest that, as in *E. pantoni*, the various populations may well differ in tonality or timbre of call. The tibia/snout-vent length ratio × 100 has likewise been employed in an attempt to show differences between these samples. In males, the means for this ratio (from A to D) are 43.3, 45.0, 45.5, and 43.7, with sample D low but slightly greater than sample A. In females, the means (from A to D) are 43.9, 44.5, 45.6, and 45.2. Thus, in females, the ratio in sample D is relatively high, second only to that of sample C, despite the very strong differences in female adult size of these two populations.

Goin (1954: 192–193) noted that *E. gossei* showed the greatest variation in dorsal pattern morphs of any Jamaican species; in fact, Goin considered *gossei* the basic or ancestral stock for all other members of the *gossei* group (which, in adddition to *gossei*, includes *pantoni*, *fuscus*, *junori*, *andrewsi*, *nubicola*, and *alticola*). The eight morphs of *E. gossei* include: mottled, dorsolateral stripes, picket (?), middorsal hairline, broad middorsal stripe, pelvic spots, (pale) interocular bar, and purple (a pattern consisting of a series of three dorsal stripes). Our examination of 297 *gossei* shows the following.

In all samples *except C and D*, mottled is the dominant dorsal pattern (percentages, by sample, are: A, 36.8: B, 35.4: C, 24.4: and D, 9.2). We have added another category (unicolor) to Goin's series of eight morphs, and this is the dominant pattern in sample C (46.5 percent), whereas middorsal hairline is the dominant morph in sample D (29.9 percent) with unicolor having a similar incidence (28.7). In our preserved material, no specimen obviously has pelvic spots: this feature may be somewhat fugitive since Thomas's notes on a series (ASFS 13193–207) from 3.5 mi. S Fair Prospect, state that "two have *andrewsi*-like inguinal spots." We are unable to acertain the presence of these or other pelvic spots in any of our specimens, although on occasion there are groups of dark and (at times) vague dots, spots, or blotches in the inguinal region which might be so interpreted.

Sample A has the widest variety of dorsal pattern morphs in addition to the modal mottled condition: there is one specimen (ASFS 15682) which is distinctly picket, a morph which Goin was not certain occurred in *E. gossei*; this is the only picket example in our entire series. Broad middorsal stripe likewise occurs only in sample A (three specimens, 3.9 percent), and pale interocular bar (in contrast to entire snout pale, which we do not consider as pale interocular bar) occurs in one frog in sample A. In addition, one frog (ASFS 16027) has the dorsum darkly bi- (rather than tri-) lineate. Dorsolateral stripes occur in four frogs (5.3 percent), middorsal hairline in 15 frogs (19.7 percent), purple in seven frogs (9.2 percent), unicolor in

TABLE 1

MEANS AND EXTREMES OF EIGHT MEASUREMENTS AND ONE RATIO OF

Sample D is distinguished nomenclatorially (as *E. g.*

SAMPLE	*Sex*	N	*Snout-vent*	*Head length*	*Head width*	*Tympanum*
A	M	26	23.9 (22.0–26.5)	9.1 (8.2–10.3)	9.4 (8.2–10.5)	1.8 (1.5–2.0)
B	M	22	24.2 (21.5–26.4)	9.5 (8.4–10.2)	9.8 (8.8–10.6)	1.8 (1.6–2.2)
C	M	24	24.6 (23.1–28.2)	9.7 (8.4–11.0)	9.9 (8.0–11.3)	1.8 (1.5–2.3)
D	M	25	21.7 (20.8–23.2)	8.6 (8.1–9.3)	8.9 (8.3–9.5)	1.8 (1.5–2.0)
A	F	31	25.5 (23.5–29.8)	9.9 (8.7–11.7)	10.1 (8.8–12.2)	1.8 (1.5–2.2)
B	F	19	27.6 (23.5–31.3)	10.8 (9.2–12.9)	11.2 (9.3–12.9)	1.9 (1.6–2.5)
C	F	36	27.1 (23.2–34.2)	10.6 (9.3–13.0)	11.1 (9.2–13.8)	1.9 (1.6–2.5)
D	F	21	22.0 (19.7–26.2)	8.9 (7.8–10.7)	9.1 (7.8–11.8)	1.7 (1.4–2.2)

15 frogs (19.7 percent), and mottled plus hairline in one frog. Thus, in sample A, there are 10 pattern morphs or combinations thereof.

Sample B, in addition to the modal mottled condition, has three frogs (6.3 percent) with dorsolateral stripes, six with middorsal hairline (12.5 percent), six purple, 13 (27.1 percent) hairline, two (4.2 percent) mottled plus hairline, and one dorsolateral stripes plus hairline – a total of seven morphs and combinations.

Sample C, in addition to the modal unicolor condition, has 21 frogs mottled (24.4 percent), two frogs with dorsolateral stripes (2.3 percent), 15 frogs with middorsal hairline (17.4 percent), six frogs purple (7.0 percent), and two frogs mottled plus hairline (2.3 percent).

Sample D is the most distinctive in dorsal patterns. There are seven morphs involved, with more than half the specimens being either unicolor or with a middorsal hairline. The mottled dorsum is of very low frequency in sample D (eight frogs, 9.2 percent), and dorsolateral stripes have a high frequency (13 frogs, 14.9 percent) relative to other samples. Purple (eight frogs, 9.2 percent), dorsolateral stripes plus hairline (three frogs, 3.4 percent), and mottled plus hairline (four frogs, 4.6 percent) also occur. In summary, sample D is very low in mottled morphs, and very high in dorsolateral stripes, middorsal hairline, dorsolateral stripes plus hairline, and mottled plus hairline. The last two categories are not significantly higher in frequency in sample D than in other samples wherein they occur, but at least dorsolateral srtipes plus hairline do not occur in samples A and C.

MALES AND FEMALES OF FOUR SAMPLES OF *Eleutherodactylus gossei.*

oligaulax) from samples A, B, and C (see text and Fig. 57).

Naris-eye	*Femur*	*Tibia*	*Fourth toe*	*Tibia/s-v × 100*
2.8	9.8	10.3	9.8	43.3
(2.1–3.6)	(8.6–11.7)	(9.0–11.6)	(8.7–11.4)	(37.7–52.1)
2.8	10.3	10.9	10.3	45.0
(2.5–3.0)	(9.2–11.2)	(10.0–12.0)	(9.3–11.8)	(40.8–50.7)
2.8	10.6	11.2	10.9	45.5
(2.5–3.2)	(8.8–11.9)	(10.0–12.0)	(9.7–12.0)	(41.1–50.4)
2.4	9.1	9.5	9.5	43.7
(2.1–2.6)	(8.2–9.7)	(8.7–10.0)	(8.7–10.0)	(40.5–45.8)
2.8	10.5	11.2	10.9	43.9
(2.2–3.4)	(8.8–13.1)	(9.4–13.1)	(9.8–12.7)	(39.9–47.9)
3.2	11.5	12.3	11.7	44.5
(2.4–3.8)	(9.8–12.9)	(10.6–13.8)	(9.4–13.4)	(41.1–49.6)
2.9	11.8	12.3	12.0	45.6
(2.4–3.8)	(9.8–14.8)	(10.9–14.4)	(10.0–15.5)	(39.4–53.6)
2.4	9.5	9.9	9.6	45.2
(1.8–2.9)	(8.8–12.0)	(9.1–11.6)	(8.6–11.5)	(42.0–50.6)

Analysis of the above data suggests strongly that Sample D is distinctive in its size and in its incidences of dorsal pattern morphs. In addition, it occupies that region of Jamaica which is becoming increasingly well known as a center of endemism in amphibians, reptiles, and birds (see discussion in the present paper). Accordingly, we distinguish sample D nomenclatorially below.

Eleutherodactylus gossei gossei Dunn

Eleutherodactylus gossei DUNN, 1926. Proc. Boston Soc. Nat. Hist., *38*(4): 118, type locality Spaldings, Clarendon Parish, Jamaica (altitude 2900 feet); holotype MCZ 11125.

Definition: A subspecies of *E. gossei* characterized by variable (moderate to large) size (females, by region, reaching maximum snout-vent lengths of 30 to 34 mm, males to 26 to 28 mm), dorsum modally mottled in two regions, modally unicolor in the third region, and with dorsolateral stripes, middorsal hairline, and purple as more or less minor variants (by percentage); the previous discussion, in reference to samples A, B, and C, applies to the nominate subspecies.

Variation: See Table 1 for variation in *E. g. gossei* by regions (samples A, B, and C). As noted above, sample A reaches the smallest adult size in both sexes, whereas sample C reaches the largest adult size in both sexes, and sample B is intermediate. Other measurements adhere to the trends shown in the snout-vent lengths.

Dorsal patterns are variable, but within the subspecies as a whole, unicolor (32.4 percent) and mottled (31.4 percent) are the most prevalent, of about equal frequency, and account for more than 50 percent of the specimens. (It should be recalled that sample C contributes most strongly to the frequency of unicolor individuals and sample A most strongly to the mottled individuals). In order of decreasing frequency, the other pattern morphs are: middorsal hairline (17.1 percent), purple (9.0 percent), dorsolateral stripes (4.3 percent), mottled plus hairline (2.4 percent), middorsal stripe (1.4 percent), and picket, interocular bar, dorsolateral stripes plus hairline, and bilineate each with 0.5 percent.

Dorsally, *E. g. gossei* is some shade of brown, ranging from rich reddish brown to tan; in the mottled condition the dorsum is irregularly marked with darker brown or has a scapular W. There is often a faint and not very distinct pale tan interocular bar, and the dorsolateral stripes are pale tan. The middorsal hairline is pale tan to buffy. The venter is usually creamy to faintly yellowish, and the throat is extremely variable, unicolor with the belly, grayish, or with dark (brown) and light (white to creamy) flecks or mottling; these variants are neither correlated with size nor sex. Most distinctive is the red (or pink) to orange in the groin and on the concealed surfaces. This feature is often enough to distinguish *E. gossei* from other syntopic or sympatric species. In some areas (Milk River) there is a tendency for the groin and concealed surfaces to be orange rather than red, and in this same region, the brachia and sides of abdomen are likewise suffused with reddish to orange.

Our notes on vocalization of *E. g. gossei* are interesting and perhaps pertinent (it should be noted, however, that verbalizations of frog calls by different persons will of course vary as to the interpretation of each listener and his transliteration of a sound which is at its best difficult to verbalize). Near Troy, the call was stated (SCHWARTZ) to be a "simple repetitive whistle"; near Shooters Hill, a calling male in captivity vocalized (THOMAS) "a fairly loud 'wink' followed by two descending pairs of 'ticks'; e.g., 'wink...tick...tick......tick...tick'". East of Kingston, the call was reported (SCHWARTZ) as "tuck...tuck...tuck...", often somewhat higher and faster as the call progressed. At least calls from frogs in the field seem to be a successive and repetitive series of single notes. LYNN (1940: 32) quoting DUNN's (1926: 117) notes on the call of E. "*luteolus*", stated that the call is "a repeated 'whuk-whuk-whuk-whuk'. These syllables are usually given quite rapidly and may be continued for a long time without pause." We heartily agree with LYNN's comments upon the duration of the call.

Remarks: *E. g. gossei* is widely distributed over the entire island of Jamaica with one notable exception – the extreme western portion in Hanover and Westmoreland parishes (Fig. 57). Considering that we and others have collected extensively in the region about Dolphin Head and its associated lowlands, it seems more than chance that no specimens have been taken from this region. The species is known, in Westmoreland Parish, only from as far west as Beeston Spring in extreme southeastern Westmoreland, and in Hanover from Shettlewood (LYNN, 1940) in the extreme southeastern portion of the parish. Elsewhere, *E. g. gossei* occupies habitats which are essentially xeric (as at Milk River, Clarendon, where specimens were taken in locally mesic areas associated with springs and spring seepages) to those which are very mesic (as on the southern slopes of the Blue Mountain above Kingston, Hardwar Gap, near Lluidas Vale, and elsewhere). Altitudinally, the subspecies occurs from sealevel (mouth of the White River in St. Mary) to elevations of 4250 feet (1297 m) at Hardwar Gap. GOIN & COOPER (1950: 2) reported taking a clutch of *E. gossei* eggs between Cinchona and Morce's Gap, St. Andrew; this locality is presumably in excess of 5000 feet (1525 m) and is thus above our own high specimen from Hardwar Gap.

With the exception of LYNN (1940), little information has been published on the habits and habitat of *E. gossei*. LYNN stated that *E. gossei* was taken frequently beneath stones during the day, and calling at night from the ground or low bushes. He generalized that the species is primarily a woods dweller, even though he noted collecting it often in quite open situations.

Of the two subspecies, *E. g. gossei* has by far the broadest distribution and diversity of habitat. Its range includes not only several northern coastal but also montane localities with elevations in excess of 4000 feet (1220 m). Between these extremes, *E. g. gossei* seems to have established itself in a great number of ecological niches.

In Westmoreland, specimens were collected near Beeston Spring under a rotting log in a pasture. In St. James, frogs were collected on rocks of a road cut near Mt.

Horeb and under banana trash southeast of Plum Park. Trelawny yielded good series from Windsor on a path through woods near a clearing and on shrubs in a *Musa* grove. Northwest of Troy, males were taken calling from leaves of low shrubs, and at Ramgoat Cave, *E. g. gossei* was secured from leaves of low shrubs in forest. In St. Ann, specimens collected east of Aenon Town were in grass in a *Musa* grove. Northwest of Ocho Rios specimens were secured under *Cocos* trash in a grassy grove, and south of Moneague, frogs were taken under roadside rocks and under trash in woods.

In St. Mary, a series was collected at the mouth of the White River in *Cocos* trash on mud behind the beach ridge. Other frogs were collected calling from among dead leaves and rocks on the ground and up to 5 feet (1.5 m) above the ground in a viney tangle east of Kingston in St. Thomas. Specimens were taken under rocks in a somewhat moist ravine-like situation north of Shooters Hill, Manchester. *E. g. gossei* was encountered in a variety of situations in St. Catherine: in logger's chips at the base of a stump in moist woods; calling from shrubs 3 to 4 feet (1 to 1.2. m) high; from a tree limb 5 feet (1.5 m) above the ground east of Worthy Park; and on the road through deciduous woods at night west of Ewarton.

Specimens: Sample A. *Westmoreland,* 0.2 mi. (0.3 km) W Beeston Spring, 1000 feet (305 m), 2; 0.1 mi. (0.2 km) N Beeston Spring, 1100 feet (366 m), 1. — *St. James,* 0.4 mi. (0.6 km) NE Mt. Horeb, 800 feet (244 m), 3; 1.7 mi. (2.7 km) SW Plum Park, 1100 feet (336 m), 1; 1.8 mi. (2.9 km) SE Plum Park, 1200 feet (366 m), 1; 5 mi. (8.0 km) W Montego Bay, 2 (MCZ 23635–36). — *Trelawny,* 4.8 mi (7.7 km) NW Troy, 10; 6 mi. (9.6 km) NW Troy, 3. — *St. Elisabeth,* Balaclava, 3 (MCZ 10167–69); Malvern, 1 (MCZ 28700); nr. Black River, 1 (UMMZ 83336). — *St. Ann,* 1.5 mi. (2.4 km) E Aenon Town, 3. — *Manchester,* 0.7 mi. (1.1 km) NW Troy, 5; 3 mi. (4.8 km) E. Maidstone, 2; Mandeville, 2; 0.4 mi. (0.6 km) N shooters Hill, 1500 feet (458 m), 2. — *Clarendon,* Spaldings, 7 (MCZ 11125, MCZ 11326–31 – holotype and paratypes). — *St. Catherine,* Bog Walk (?), 2 (MCZ 23630–31). — *St. Mary,* Highgate, 7 (MCZ 28701–05, MCZ 81605–06); 3.0 mi. (4.8 km) E Annotto Bay, 1. — *St. Andrew,* Stony Hill, 6 (MCZ 28991–95, MCZ 81604). — *Portland,* nr. Buff Bay, 2 (USNM 106536–37).

Sample B. *Trelawny,* Windsor, 8 (incl. USNM 83721–22); 4.0 mi. (6.4 km) S Stonehenge, 1400 feet (427 m), 1; 2.8 mi. (4.5 km) S Stonehenge, 1400 feet (427 m), 1; Ramgoat Cave, 4; 6.4 mi. (10.2 km) N Burnt Hill, 1200 feet (367 m), 1. — *St. Ann,* 2.2 mi. (3.5 km) E St. Ann's Bay, 2; 3.0 mi. (4.8 km) S Moneague, 1900 feet (580 m), 1; 4.2 mi. (6.7 km) S Moneague, 2200 feet (671 m), 1; Mount Diablo, 1 (MCZ 23634); 4.4 mi. (7.0 km) NW Ocho Rios, 2. — *St. Catherine,* 3.6 mi. (5.8 km) NE Lluidas Vale, 1500 feet (458 m), 1; 1.3 mi. (2.1 km) W Lluidas Vale, 2; 2.8 mi. (4.5 km) W Lluidas Vale, 1800 feet (549 m), 8; Worthy Park Estate, 1250 feet (381 m), 3; 5 mi. (8.0 km) E Worthy Park, 1200 feet (366 m), 1; 4 mi. (6.4 km) E Worthy Park, 1200 feet (366 m), 3; 5 mi. (8.0 km) W Ewarton, 1. — *St. Mary,* 0.6 mi. (1.0 km) S Spring Valley, 1; 2.5 mi. (4.0 km) N. Port Maria, 2; 2.4 mi. (3.8 km) E Ocho Rios, east side, mouth of White River, 9; 4.3 mi. (6.9 km) W, 1.0 mi. (1.6 km) S Oracabessa, 1.

Sample C. *Clarendon,* 4.0 mi. 6.4 km) N Milk River, 10; 7.6 mi. (12.2 km) N Milk River, 4. — *St. Catherine,* 10 mi. (16.0 km) W Kingston, 4 (USNM 108099–102). — *St. Andrew,* Kingston (incl. Hope Gardens), 57 (MCZ 81567–91, MCZ 81595–99, MCZ 11401–09, MCZ 11420, MCZ 23620–24, MCZ 23643–50, MCZ 81600–03); 16 mi. (25.6 km) N Kingston, 15; Hardwar Gap, 1. — *St. Thomas,* 14.5 mi. (23.2 km) E

Kingston, 4; Sunning Hill, on road to Trinityville, 1 (USNM 102660); nr. Bath, 6 (UMMZ 83337–40, UMMZ 83313, UMMZ 83346); Lysson's Beach, 2 (MCZ 26936–37).

Eleutherodactylus gossei oligaulax, new subspecies

Holotype: MCZ 43321, a gravid female, from 3.5 mi. (5.6 km) S Fair Prospect, *Portland Parish*, Jamaica, one of a series collected 21 June 1961 by Ronald F. Klinikowski and Albert Schwartz. Original number ASFS 13197.

Paratypes: *Portland*, ASFS 13193–96, ASFS 13198–207, same data as holotype; CM 52839–56, 4.5 mi. (7.2 km) S Fair Prospect, 27 June 1961, Klinikowski, D. C. Leber, Schwartz; USNM 189191–211, 4.5 mi. (7.2 km) S Fair Prospect, 24 June 1961, Klinikowski, Leber, Schwartz; CM 52833–38, 4.2 mi. (6.7 km) S Fair Prospect, 21 June 1961, Klinikowski, Schwartz; ASFS V12821–22, 6.0 mi. (9.6 km) SSW Fair Prospect, 12 August 1967, R. Thomas; ASFS 13377–84, 8 mi. (12.8 km) S Seamans Valley, 25 June 1961, Klinikowski, Leber, Schwartz; MCZ 43322–32, 8 mi. (12.8 km) S Seamans Valley, 26 June 1961, Klinikowski, Leber, Schwartz; ASFS V12769–73, 1.0 mi. (1.6 km) SE Boston Bay, Thomas, 11 August 1967.

Definition: A subspecies of *E. gossei* characterized by small size (females to 26 mm, males to 23 mm snout-vent length), dorsum modally with a middorsal hairline or unicolor and with a high incidence of individuals with dorsolateral stripes and a very low incidence of mottled individuals.

Distribution: Extreme eastern Jamaica in Portland Parish, in the valley between the Blue and John Crow Mountains and on the northern slopes of the former range (Fig. 57); see details beyond.

Description of holotype: A gravid female with the following measurements: snout-vent length 20.6, head length 8.3, head width 8.2, tympanum 1.4, eye 2.8, naris to eye 2.3, femur 9.2, tibia 9.6, fourth toe 9.1; tibia/snout-vent length × 100 46.6. Head as long as broad; snout acuminate but sharply truncate with naris very conspicuous at anterior end of canthus rostralis; diameter of eye greater than distance from naris to anterior corner of eye; diameter of tympanum half that of diameter of eye, distance from tympanum to eye slightly less than diameter of tympanum. Interorbital distance 2.4, less than diameter of eye. Digital discs absent. Fingers relatively long, unwebbed, 3–4–2–1 in order of decreasing length; subarticular tubercles indistinct and not set off chromatically from palmar surface of hand. Toes relatively long, unwebbed, 4–3–5–2–1 in order of decreasing length; subarticular tubercles indistinct and not set off chromatically from plantar surface. Heels overlap slightly when femora are held at right angles to body axis. Inguinal glands present. Dorsum finely shagreened with one large wart in the center of each upper eyelid, and a pair of enlarged scapular warts; a raised middorsal line. Throat, chest, and belly smooth. Dorsal surfaces of fore- and hindlimbs warty, especially so on the crura. Posterior and ventral faces of thighs covered with moderately sized, juxtaposed, flattened granules or warts. Tongue small, free and entire behind, its greatest width equal to about one-half that of floor of mouth. Vomerine teeth in two small almost straight patches, extending to about the middle of the choanae laterally, separated from them by a distance equal to about three times the diameter of a choana, the two patches separated medially by a distance equal to four or five times the diameter of choana.

Dorsal ground color medium brown with a faint middorsal tan hairline and a pair of very dark brown scapular dots on the scapular warts; sides of head from canthus rostralis ventrally very dark brown, this pigment extending posteriorly as a well defined dark brown stripe above the tympanum to about one-third of the distance along the body and with a short ventral extension behind the tympanum toward the forelimb insertion; limbs concolor with dorsum, the antebrachium with a prominent dark brown crossbar, the hindlimbs prominently crossbarred with three bars on the thigh and crus and two on the pes, the median of the three crural bars the broadest and most complete, those on the thigh the narrowest and most incomplete; venter creamy, much mottled with black in life, the throat heavily and regularly stippled with black, and the sides of the belly stippled with dark brown to black; undersides of hindlimbs stippled with dark brown; groin and concealed surfaces of hindlimbs orange with the exception of a very distinct dark brown postanal triangle whose anterior edge is outlined by an almost black inverted U.

Variation: A series of the 25 largest males has the following measurements: snout-vent length 20.8–23.3 (21.7); head length 8.1–9.3 (8.6); head width 8.3–9.5 (8.9); tympanum 1.5–2.0 (1.8); eye 2.7–3.5 (3.1); naris to eye 2.1–2.6 (2.4); femur 8.2–9.7 (9.1); tibia 8.7–10.0 (9.5); fourth toe 8.7–10.4 (9.5); tibia/snout-vent length × 100 40.5–45.8 (43.7). Twenty-one gravid and adult females measure: snout-vent length 19.7–26.2 (22.0); head length 7.8–10.7 (8.9); head width 7.8–11.8 (9.1); tympanum 1.4–2.2 (1.7); eye 2.7–3.5 (3.1); naris to eye 1.8–2.9 (2.4); femur 8.8–12.0 (9.5); tibia 9.1–11.6 (9.9); fourth toe 8.6–11.5 (9.6); tibia/snout-vent length × 100 42.0–50.6 (45.2).

The dorsa of *E. g. oligaulax* are regularly some shade of brown, rarely tending toward reddish brown and rarely toward dark brown. The snout in some specimens is distinctly paler (tan) than the remainder of the back and is set off sharply at the level of the eyes. A dark brown to almost black interocular bar is also present in many frogs, varying in width from fine and narrow (USNM 189200) to very broad (USNM 189193). The ventral color is generally whitish to creamy (no specimens were recorded as having a yellow or yellowish venter) and is very often heavily stippled with black to dark brown, the stippling most concentrated on the throat but very often extending over the entire ventral surface (CM 52845). The loreal region is regularly very dark brown and the posterior dark extension of the loreal pigment onto the sides of the body is as conspicuous as it is in the holotype; this posterior extension often borders dorsally a very dark brown area on the anterior sides. The dark brown postanal triangle is a common feature. The groin is red to reddish, and this pigment is continued onto the concealed surfaces of the hindlimbs. The dorsal hairline and dorsolateral stripes, when present, are buffy, and the stripes are extremely broad and very boldly distinct from the brown dorsal color.

Dorsal pattern morphs, in order of decreasing frequency, are: middorsal hairline (29.9 percent), unicolor (28.7), dorsolateral stripes (14.9), mottled and purple (9.2), mottled and hairline (4.6), and dorsolateral stripes and hairline (3.4).

Comparisons: *E. g. oligaulax* differs from *E. g. gossei* principally in size and in frequency of dorsal pattern morphs. Maximally sized male *oligaulax* are 23.3 in snout-vent length whereas minimally sized *gossei* males measure 21.5 (sample B). The mean snout-vent length in male *oligaulax* is 21.7, whereas in the three samples of male *gossei*, the means are distinctly greater (23.9, 24.2, and 24.6). The most critical difference between male *gossei* and male *oligaulax* is length of tibia; maximum tibia length in *oligaulax* is 10.0, whereas 10.0 is the minimal tibia length in two samples of *gossei* (B, C), and the minimum in sample A is 9.0. Means of all other measurements taken (except tympanum and eye) are distinctly lower in male *oligaulax* than in male *gossei* (see Table 1).

We have already commented in some detail on the smaller size of female *oligaulax* (as sample D) in comparison to female *gossei*, and these remarks need not be repeated here. Likewise, means of all measurements are lower in female *oligaulax* than in female *gossei*, even tympanum and eye, measurements which show no differences in males of the two subspecies. Tibia length in female *oligaulax* does not show the striking difference in mean and extremes as it does in male *oligaulax* (in comparison with the same sexes in *gossei*), but the female *gossei* means in tibia length (10.9, 11.7, 12.0) are all much higher than that of female *oligaulax* (8.6). There is no question that *oligaulax* is a much smaller frog in all dimensions than is *gossei*.

As far as dorsal patterns are concerned, 64 percent of *E. g. gossei* are mottled or unicolor; in *oligaulax*, 59 percent of the specimens are unicolor or middorsal hairline. Both taxa have high values for unicolor, but the incidence of middorsal hairline is much greater (29.9 percent) in *oligaulax* than in *gossei* (17.1 percent). Even more importantly, mottled, which in *gossei* occurs in 31 percent of the frogs, has a very low incidence (9 percent) in *oligaulax*. Likewise, dorsolateral stripes are relatively frequent (15 percent) in *oligaulax* but relatively infrequent (4 percent) in *gossei*.

Finally, there is a strong tendency for the venter in *oligaulax* to be heavily stippled or marked with darker, whereas in *gossei* the venter may have some dark marbling or mottling on the throat (rarely uniform stippling), but elsewhere on the belly there is rarely any dark mottling or marking of any sort.

Remarks: The name *oligaulax* is from the Greek for "having but little land foı plowing", in allusion to the compact range of the subspecies.

E. g. oligaulax has a very circumscribed distribution, being confined to the valley between the Blue Mountains and the John Crow Mountains, the lower (western) slopes of the latter and the northern slope of the former. Presumably it will be found at higher elevations in the John Crow Mountains, since it seems very likely that *oligaulax* evolved in that range. We include the series from 1.0 mi. E Boston Bay with *oligaulax* rather provisionally, since these specimens are on the whole larger and stockier, and the upper limit for female snout-vent length (26.2), as well as all other measurements except head length and tibia are set by a female (ASFS V12796) from this series. The only adult male in the Boston Bay series lies near the upper extreme in snout-vent length (22.3) for male *oligaulax*. It may well be that these Boston Bay frogs demonstrate influence of large sample C *gossei* from the south.

In this regard, we consider four frogs from near Manchioneal and Hectors River as intermediate between *gossei* and *oligaulax* (see detailed localities beyond). The series is small but the frogs are generally larger than *oligaulax* and more like large sample C *gossei*. The localities are all coastal. To the west, we consider material from the Port Antonio area as intergradient between *gossei* and *oligaulax*; these localities are also coastal, and in size the frogs are larger (and thus like sample A *gossei*) than typical *oligaulax*. We have examined no material from the upper slopes of the Blue Mountains except from Hardwar Gap. A single specimen from there is clearly *E. g. gossei*, and shows no influence of *oligaulax* which occurs farther to the east.

Altitudinally, *E. g. oligaulax* is known from sealevel (assuming that the Boston Bay frogs are *oligaulax* and not intergradient) to elevations of about 750 feet (229 meters) south of Seaman's Valley.

Specimens of *E. g. oligaulax* were collected at Fair Prospect in an overgrown *Musa* grove and on leaves of shrubs and trees up to 5 feet (1.5 meters) above the ground. At Seamans Valley, frogs were secured on shrubs and on the ground. One intergrade between *oligaulax* and *gossei* was taken on the ground in a *Musa* grove at Port Antonio.

Intergrades between *E. g. gossei* and *E. g. oligaulax:*
Portland, Port Antonio, 2; 2.5 mi. (4.0 km) W Port Antonio, 1; 7.2 mi. (11.5 km) E Port Antonio, 1; Mona, nr. Port Antonio, 8 (MCZ 37113–20); 1.9 mi. (3.3 km) N Manchioneal, 1; 3.2 mi. (5.1 km) N Manchioneal, 1; 1.4 mi. (2.2 km) N Hectors River, 1; 0.8 mi. (1.3 km) N Hectors River, 1.

Eleutherodactylus junori Dunn

The least known of the Jamaican *Eleutherodactylus* is *E. junori.* The species was described by DUNN (1926) on the basis of seven frogs from Spaldings, Clarendon Parish. LYNN did not collect additional specimens, and the only further reference to *E. junori* in the literature is that of GOIN (1954), who discussed the dorsal pattern variation in the seven original specimens. GOIN suggested that *E. junori* might be closely related to *E. andrewsi*, since both are small frogs whose ranges are allopatric. He also suggested (p. 193) that *junori* and *andrewsi* might be independent derivatives of *E. pantoni*. In 1961, at a locality 4.8 miles northwest of Troy, Trelawny, some 15 miles northwest of the type locality of *E. junori*, the senior author with KLINIKOWSKI and LEBER heard a very distinctive call like the rapping together of two stones. The locale was along the southern border of the Cockpit Country. Four calling males were secured from superficial cavities in limestone blocks, one was taken calling on the exposed earth of the banana grove, and another from a crack in a cut-bank. The call was a series of seven falling notes, like the rapping of stones together, and was very loud. Nevertheless, calling males were extremely difficult to locate because of the calling sites. In addition to the calling males, four other males, nine females, and two juveniles – a total of 19 frogs – were secured. These have been compared with the holotype and four paratypes of *E. junori*, and we have no doubt that at least the males collected by us are identical with the typical series. In addition to pattern and morphological similarity between the original material and our own, note that DUNN (1926: 120) stated that *junori* calls "exclusively from holes in rocks" and that the call is "like a child's wooden ratchet. It is a long call, very deceptive and hard to trace, rising to a high pitch and falling again to silence." In some ways, the call of *junori* resembles that of *Hyla wilderi*, but the call of the former lacks the repetitive "ticky" quality of that of the latter.

DUNN (1926: 120) diagnosed *E. junori* as "a tiny, short-legged, short-snouted species" with sharply pointed toes, dorsolateral stripes fairly well developed, and with an unmarked white belly. This diagnosis leaves a very great deal to be desired, since the frogs are so close to *E. gossei* in both pattern and structure that were it not for the fact that we collected calling males, it is almost certain that we would have dismissed the specimens of *E. junori* as being merely immature or subadult *E. gossei*. More careful study does not reveal a single morphological character which will infallibly distinguish the two taxa. Certainly *E. junori* is much the smaller of the two (see data on sympatric sample A *E. g. gossei*), and its digital tips seem slightly less expanded than those of comparably sized *E. gossei*, but these are both qualitative characteristics. The vomerine tooth series in *junori* seems more arched and to extend less far laterally than it does in *gossei*, but this too is qualitative. Rather than being closely related to *E. pantoni* as GOIN suggested, it seems far more reasonable to interpret *junori* as a *gossei* derivative (or sibling). Finally, we have no assurance that all specimens we here regard as *junori* are indeed that species; this is especially true of the females, but we consider them *junori* because of similarities in pattern and color between them and known male *junori* and because of the small size at which they are gravid. *E. gossei* occurs with *E. junori* at the Troy locality, but female *gossei* are larger at maturity and have other pigmental traits which separate them from both male and female *junori*. We confess that there may well be more than one specimen of *junori* included within our long series of *E. gossei*; without foreknowledge of habitat and call, the two species, as preserved specimens, would be very difficult to distinguish.

A series of 13 males (including data from the holotype and paratypes) has the following measurements: snout-vent length 19.4–24.0 (20.8); head length 7.6–9.1 (8.3); head width 7.6–9.0 (8.1); tympanum 1.2–1.9 (1.6); eye 2.5–3.5 (2.9); naris to eye 1.9–2.7 (2.3); femur 7.0–9.3 (8.2); tibia 7.9–9.5 (8.8); fourth toe 7.0–9.3 (8.4); tibia/snout-vent length × 100 39.1–46.7 (42.3). Eight gravid females measure: snout-vent length 22.9–26.7 (24.8); head length 8.3–10.0 (9.2); head width 8.6–10.1 (9.4); tympanum 1.4–1.8 (1.6); eye 2.7–3.4 (3.1); naris to eye 2.4–3.0 (2.7); femur 9.0–11.0 (9.8); tibia 9.5–10.9 (10.2); fourth toe 8.9–10.1 (9.5); tibia/snout-vent length × 100 36.8–43.2 (41.1). The two juveniles have snout-vent lengths of 13.4 and 17.0. Of the nineteen fresh specimens, 14 have mottled dorsa, typically with a dark brown scapular W, three have pale dorsolateral stripes, and two are mottled with a dorsal hairline. In life, the dorsal coloration was some shade of brown, ranging from light, to dark or reddish brown. A distinctive dorsal pattern element is the presence of a pair of longitudinal rows of yellow blotches slightly median to the position of the dorsolateral lines. The venter is usually pale yellow, even in the smallest juvenile, but some adult frogs had the venters creamy white in life. The dorsolateral lines, when present, are yellowish tan and may contrast very strongly with the very dark brown back. In one juvenile individual (ASFS 16025) both dorsolateral stripes and the more median row of yellow blotches or dots were both present. The groin and the hindlimbs are washed with orange (Pl. 3E11), which is especially prominent on the concealed surfaces of the femora; the underside of the hindlimbs may be yellowish buff. The throats are usually marked with some brown stippling or marbling, but this is not invariable. None of the fresh specimens demonstrates a pale interocular bar which GOIN (1954) reported from the type series.

Comparison of the above description with that of *E. gossei* shows that, aside from the apparent absence of some dorsal pattern variants in *junori*, the two species are quite comparable in pigmentation and pattern. Both share in the orange in the groin and on the hindlimbs and concealed surfaces, and in general body proportions and shape. There is no doubt, however, that they represent two distinct species. As pointed out above, we do not feel that *junori* is very closely related to *andrewsi*, which is a much smaller species (snout-vent lengths in females to 23, in males to 21) and which always has a pair of suprainguinal dark spots. The known ranges of the two species are separated by about 50 miles (80 kilometers) and *andrewsi* occurs only at high elevations (2500 to 5000 feet; 763 to 1525 m) in the Blue Mountains in eastern Jamaica. The two stations for *E. junori* have elevations of 2750 feet (839 m) at Spaldings and about 2000 feet (610 m) northwest of Troy (Fig. 58).

The precise habitat at the Troy locality is within the southern margin of the Cockpit Country. The road from Troy passes northwestward through Crown Lands and (in 1961) terminated at a lone house with its clearing and cultivated land within the Cockpit itself. The frogs were taken in a banana plantation near the end of the road, and calling males were secured from holes in limestone blocks in the banana plantation, exposed on the muddy earth, and from a crevice in an earthen cut-bank. Females were taken on the ground in the banana grove and in an adjacent pasture. Associated species were *E. cundalli*, *E. gossei*, *E. grabhami*, and *E. pantoni*.

Specimens: *Trelawny*, 4.8 mi. (7.7 km) NW Troy, 19. — *Clarendon*, Spaldings, 5 (MCZ 11124, MCZ 11347–50 — holotype and paratypes).

Eleutherodactylus nubicola Dunn

Our series of *E. nubicola* is composed primarily of subadult and juvenile specimens. However, the 21 largest males have the following measurements: snout-vent length 26.0–29.6 (27.2); head length 9.5–11.7 (10.3); head width 9.9–11.8 (10.9); tympanum 1.6–2.3 (2.0); eye 3.3–4.7 (4.0); naris to eye 2.3–3.4 (2.8); femur 10.0–13.3 (11.9); tibia 12.0–14.2 (12.9); fourth toe 12.0–13.4 (12.7). Nine adult and gravid females measure: snout-vent length 29.3–37.1 (32.3); head length 11.4–14.4 (12.5); head width 11.6–14.8 (12.8); tympanum 1.8–2.4 (2.1); eye 2.9–5.4 (4.2); naris to eye 2.9–4.0 (3.3); femur 11.9–16.8 (14.2); tibia 14.0–16.8 (14.2); fourth toe 13.4–16.2 (14.9). GOIN (1960) discussed the pattern variation and its genetics, and we can add nothing further to his comments. All specimens are dorsally some shade of brown to tan. If dorsolateral stripes are present, they are orange or yellow, and the brachia are often somewhat more orange or yellow than the back itself.

All of our collections of *E. nubicola* were taken at or near Hardwar Gap (Fig. 58) at an elevation of approximately 4250 feet (1296 m), well within the limits set by LYNN (1940) of 3500 to 6000 feet (1068 to 2100 m). (By modern topographic methods, LYNN's elevations should be emended, based upon his localities, to 3200 to 7400 feet). We have specimens taken on the ground, on monocot leaves (two to three feet above the ground), under rocks during the day, and under leaves adjacent to a drainage ditch. A series of ten specimens was taken, along with 22 *E. pantoni*, ten *E. cundalli*, and one *E. gossei*), from a wet roadside stack (approx. 3.5 × 2.5 × 1.2 m) of short logs in wet deciduous forest.

Specimens: *St. Andrew*, Hardwar Gap, 105. — *Portland*, 0.5 mi. (0.8 km) N Hardwar Gap, 1.

Eleutherodactylus pantoni Dunn

Eleutherodactylus pantoni was named (DUNN, 1926: 119) from a suite of specimens from Spaldings, Clarendon (the type locality); Cumberland, Clarendon; Hollymount, St. Catherine; and Mandeville, Manchester. The species had been figured previously (Barbour, 1910: pl. 2) as "*E. luteolus*". Dunn's diagnosis stated that the species is very large, with males to about 34 mm, females to 48 mm, and with a yellow belly in life. The legs are long with the heels overlapping when the legs are flexed vertically to the axis of the body, the snout is long with the eye as long as its distance from the naris, and the back is smooth.

Lynn (1940: 34–37) reaffirmed the yellow ventral coloration and large size of the species and recorded *E. pantoni* from near Troy, Manchester; Chester Vale, St. Andrew; near Bath, St. Thomas; Arntully, St. Thomas; Newton, St. Andrew; and Green Hill, Portland. The species was thus known from central and eastern Jamaica, from the lowlands (Bath) to high elevations (about 3000 feet – 915 m) in the Blue Mountains in St. Andrew and Portland parishes.

Dunn (1926: 120) reported the call as a single or double "took" or "tlock", and Lynn agreed with Dunn's verbalization of the call. Lynn & Dent (1943: 237–238) first reported *E. pantoni* from western Jamaica at Dolphin Head, as well as at John's Hall, St. James, and in the Cockpit Country. These authors also reported the species from Corn Puss Gap, St. Thomas, and Windsor, Portland (between Port Antonio and Millbank). They also noted that the call of *E. pantoni* varied geographically. At Clydesdale at the western end of the Blue Mountains, the call was "almost invariably given in two syllables, 'took-took' rather than as a single note". They did not hear the double "took" call at Corn Puss Gap, farther east in the Blue Mountains; in this region *E. pantoni* gives a six-"took" call. Additional six-"took" males were secured at Windsor, Portland, and the same call was heard in the region of Portland Gap and near Abbey Green on the trail to Blue Mountain Peak. Lynn & Dent "never heard the typical double call of the Clydesdale *pantoni* in these regions and the six-times repeated variant was common in all. It thus appears that there is a local race of *pantoni* which inhabits the mountains from the region of Blue Mountain Peak eastward and which is characterized by a distinct call." Their examination of specimens of males with these two call-types revealed no morphological differences except that the eastern specimens seem to have relatively shorter legs. Lynn & Dent also noted that eastern specimens tended to have less yellow on the belly in life than did those from further west.

Still farther west, in the hills above Montego Bay and at Dolphin Head, Lynn & Dent reported that *E. pantoni* has a single "took" call; this call differs from the two-"took" call of geographically central specimens. Thus, there seems to be a series of populations which, from west to east, have calls varying from one note to two notes to six notes. Central specimens (Mandeville, Spaldings, Cockpit Country) generally have a two-note call, but single calls likewise are heard at these stations (Lynn & Dent, 1943: 238).

Goin & Cooper (1950: 3–4) reported *E. pantoni* from Clydesdale, St. Andrew; Sweetwater, St. James; and Cascade, Murdoch's Gap, Green River Trail on north slope of Sir John Peak, and Spanish River Bridge, all the latter in or associated with the Blue Mountains. These authors confirmed Lynn & Dent's comments on vocal variation in the species. Specimens from Clydesdale had a two-"took" call, both one- and two-"took" calls were heard at Sweetwater (with the one-"took" the more common), and all Cascade, Murdoch's Gap, and Spanish River Bridge males gave the six-"took" call.

Goin (1950) commented on pattern variation in *E. pantoni*. He recognized three pattern morphs in the species: dorsolateral stripes, middorsal stripe, and picket. In addition, he recorded mottled and picket + middorsal stripe. Goin & Cooper (1950) noted that there seemed to be some geographic variation in color pattern ratios within the species. To the above dorsal patterns, they added sacral spots. Thus, of their 51 Clydesdale specimens (two-"took" call), 39 were mottled, 11 had sacral spots, and one had dorsolateral stripes. In 24 Sweetwater (one- and two-"took" calls) *E. pantoni*, none had sacral spots, two had middorsal stripes, one had picket + middorsal stripe, and 17 were mottled. In their 18 specimens from Cascade-Murdoch's Gap-Green River Trail-Spanish River Bridge, 13 were mottled, one had a middorsal stripe, three had sacral spots, and one had picket + sacral spots. They especially noted that their Spanish River Bridge specimens differed from all others in having "dark vermiculations encroaching on the uniform yellow venter."

Finally, Goin (1954), in discussing the *gossei* group, suggested that *pantoni* was a derivative of *E. gossei*, and that the former showed five basic pattern morphs: mottled, dorsolateral stripes, picket, middorsal stripe, and pelvic spots (= sacral spots).

We have examined 512 specimens of *E. pantoni* from throughout the range of the species, from Westmoreland and Hanover parishes in the west to Portland Parish in the east. We have borrowed the holotype and paratypes and a few other specimens which we considered pertinent to our discussion. We have been unable to locate the specimens from Bath, St. Thomas, which were said (Lynn, 1940: 36) to be in both the United States National Museum and the Museum of Zoology, University of Michigan: thus we are unable to make any comments on this far-southeastern population.

Examination of our series shows that *E. pantoni* demonstrates distinctive geographic differences in size, voice, and coloration (especially ventrally and on the throat). The species seems to be absent from north-central Jamaica (northern Trelawny, St. Catherine, St. Mary, and western Portland parishes) and from southern Jamaica south of a line between Beeston Spring-Mandeville-Kingston; both these presumably unoccupied areas may well be artifacts of collecting. Although *E. pantoni* seems to shun coastal situations and is primarily a forest-dwelling species, nevertheless it occurs on the coast at Port Antonio (which is in an extremely mesic and well-wooded area), and near the coast in extreme western Hanover Parish (Logwood, Salt Spring), also in mesic forested situations. The absence of *E. pantoni* in northern and southern Jamaica may be due to unsuitably drier, or less mesic, or less well-forested, habitats. However, we suspect that the species remains to be collected in such areas as Fern Gully, for instance, or in the Santa Cruz Mountains in St. Elizabeth. The majority of our specimens have come from the Cockpit Country, where the species is extremely abundant near Windsor and northwest of Troy. We view the specimens reportedly from Kingston with some suspicion since we know of no recent specimens of *E. pantoni* from what is essentially a xeric coast.

Our analysis of variation in *E. pantoni* shows that there are three populations which are nameworthy; in one case, we have extensive series of intergrades between two of these subspecies, and in the other, we can deduce from some of our specimens, as well as comments by previous authors, where the area of intergradation probably occurs. Of the three subspecies, the nominate subspecies occupies the broadest geographic range and is discussed first.

Eleutherodactylus pantoni pantoni Dunn

Eleutherodactylus pantoni DUNN, 1926. Proc. Boston Soc. Nat. Hist, *38*(4): 119; type locality - Spaldings, Clarendon Parish, Jamaica (altitude 2900 feet); holotype - MCZ 11123.

Definition. A subspecies of *E. pantoni* distinguished by moderate size (males to 33 mm, females to 43 mm snout-vent length), heels touch when femora held at right angles to body axis, throat variable but most often coarsely (but not uniformly) stippled and with a large clear area on each side, venter usually bright orange, and call of either one or two notes.

Variation: The series of the 25 largest male *E. p. pantoni* has the following measurements: snout-vent length 29.0–33.1 (30.9); head length 11.0–14.8 (12.5); head width 11.5–13.8 (12.7); tympanum 1.6–2.8 (2.1); eye 2.9–4.7 (4.0); naris to eye 3.1–4.4 (3.5); femur 11.8 15.5 (13.6); tibia 12.7–16.8 (14.4); fourth toe 12.8–15.0 (13.9); tibia/

snout-vent length × 100 42.3–51.3 (46.6). Twenty-eight adult and gravid females measure: snout-vent length 29.8–43.2 (36.4); head length 11.9–17.5 (14.2); head width 12.5–17.7 (14.9); tympanum 1.9–2.8 (2.4); eye 4.0–6.0 (4.6); naris to eye 3.3–5.5 (4.1); femur 14.2–20.3 (16.3); tibia 14.8–20.1 (17.2); fourth toe 15.4–18.4 (16.7); tibia/snout-vent length × 100 43.0–52.7 (47.3).

The series of 106 *E. p. pantoni* shows four of the five pattern types reported by GOIN (1954); the only pattern morph not represented is sacral spots, a condition which GOIN & COOPER (1950) recorded from Clydesdale (11 of 51 specimens) and Cascade-Murdoch's Gap-Green River Trail-Spanish River Bridge (three of 17). All these localities are slightly peripheral to the range of *E. p. pantoni* as we delimit it, and it seems likely that sacral spots do not occur in the nominate subspecies.

Of the four morphs represented in our series, the commonest (91 of 106 specimens) is mottled; we include in this category those longer preserved specimens which are presently uniformly colored above and at best may show a dark scapular W. Six individuals have pale dorsolateral stripes, three have a middorsal hairline, five are picket, and one has picket + dorsal hairline.

The dorsal color in life is variable, from dark gray to rich chocolate brown, with tones generally tending toward the latter extreme. In the mottled phase, the dorsa are marbled or more or less randomly blotched with paler hues, but a scapular and a sacral W are usually present and fairly well delineated. In some specimens, the paler brown snout is set off rather sharply from the balance of the dorsal color. The forelimbs are prominently banded with dark and pale brown, and the hindlimbs are even more contrastingly marked with these same colors, with the dark crossbands often very narrow and distinct (especially in very young individuals) from the hindlimb ground color. The ventral ground color is somewhat variable, but in full adults, it is most often very bright orange; bright hues are Pl. 3D12 and Pl. 3J12 to Pl. 3F11. In younger specimens, the ventral color is less intense, centering about Pl. 3C11. The orange ventral color is often apparent in the groin, where the tint may be even more intense and almost a red-orange hue.

The most distinctive chromatic feature of *E. p. pantoni* is the throat. In contradistinction to the condition in the other subspecies, the throat in the nominate form is coarsely stippled in most instances, but the stippling is seldom uniform; rather, there are two paler and much less intensely stippled areas on each side of the throat. In some extreme individuals, these clear areas are somewhat confluent medially, giving a weakly stippled throat centrally, with some coarse peripheral spotting or dotting. The throat markings stop abruptly at the level of the forelimb insertions.

Remarks: The distribution of *E. p. pantoni* extends from Beeston Spring and Darliston in the west, east through Manchester, Clarendon, St. Catherine, and St. Andrew parishes (Fig. 59). As noted above, we have been unable to locate the specimens reported by LYNN from Bath, St. Thomas, and these may well pertain to the nominate subspecies also. Altitudinally, *E. p. pantoni* occurs from sea level (UMMZ specimens from Kingston, although we have mentioned previously our doubts about the provenance of these specimens) to elevations of 4250 feet (1296 m) at Hardwar Gap, where the species is exceptionally common. The lowest altitudinal record from our own specimens is 1000 feet (305 m) near Darliston. The species seems to be absent from most of south-central Jamaica, where the forested habitat frequented by this frog was either originally absent or has been now so modified by cultivation and deforestation that the species no longer occurs there.

The areas of intergradation between *E. p. pantoni* and the two subspecies yet to be described will be discuseed in each case in detail under those subspecies. In one case (western subspecies) the area of intergradation is apparently over a fairly broad area (the Cockpit Country), whereas in the other (eastern subspecies), we are uncertain if intergradation occurs and about the precise area involved, but the region appears to be in the uplands of the Blue Mountains between Hardwar Gap on one hand and the St. Thomas-Portland parish region of these mountains on the other (see below).

The only significant habitat data previously published on *E. pantoni* are by DUNN (1926) and LYNN (1940), both of whom stated that this species is a woodland dweller. DUNN generalized that the habitat is the ground, or holes in limestone rocks, the two situations producing slight variations in the quality of the call. LYNN stated that *E. pantoni* lived beneath stones and in holes in the ground. Our experience warrants agreement with the original proposition that this species prefers wooded habitats. We, however, encountered *E. pantoni* in a great variety of situations not noted by DUNN or LYNN.

We observed *E. p. pantoni* to be generally restricted to low-to-the-ground situations. We collected specimens from the mossy bank of, and mossy rocks in, a stream north of Kingston, St. Andrew; calling from a small tree stub two feet (0.6 m) above the ground at Hardwar Gap, St. Andrew; from a very wet roadside stack of logs, along a trail through rain forest, and on road cuts at Hardwar Gap. Specimens were also secured on an open and bare road cut west of Ewarton, St. Catherine, and under rocks in an open field south of Darliston, Westmoreland.

Specimens: *Westmoreland*, 0.1 mi. (0.2 km) N Beeston Spring, 1100 feet (336 m), 8; 6.9 mi. (11.0 km) SSE Darliston, ca. 1000 feet (305 m), 1. — *Manchester* 3 mi. (4.8 km) E Maidstone, 2; Mandeville, 2 - UMMZ 85842. — *Clarendon*, Spaldings, 26 - MCZ 11123, MCZ 11376–11400, (holotype and paratypes). — *St. Catherine*, 4 mi. (6.4 km) W Ewarton, 1600 feet (488 m), 1. — *St. Andrew*, Kingston, 5 - UMMZ 85843; 16 mi. (25.6 km) N Kingston, 4; Hardwar Gap, 46. — *Portland*, Hardwar Gap, 8.

Eleutherodactylus pantoni amiantus, new subspecies

Holotype: MCZ 43360, an adult female, from 0.4 mi. (0.6 km) NE Mt. Horeb, 800 feet (244 m), *St. James Parish*, Jamaica, taken on 12 August 1970 by Danny C. Fowler. Original number ASFS V19818.

Paratypes: *Hanover*, CM 52299, 0.5 mi. (0.8 km) S Salt Spring, 27 July 1961, R. F. Klinikowski; ASFS V12126, 0.7 mi. (1.1 km) E Logwood, 3 July 1967, R. Thomas; ASFS V12106–08, 2.4 mi. (3.8 km) NW Moreland Hill, 400 feet (122 m), 2 July 1967, Thomas; CM 52882–99, Bushmount, 10.5 mi. (16.8 km) SE Lucea, 19 July 1961, Klinikowski, D. C. Leber, A. Schwartz. — *Westmoreland*, ASFS V12124–25, 2.0 mi. (3.2 km) NW Moreland Hill, 400 feet (122 m), 3 July 1967, Thomas; USNM 167337–41, 2.5 mi. (4.0 km) S Medley, 19 July 1961, Klinikowsky, Leber, Schwartz; MCZ 43361–69, 3.6 mi. (5.8 km) S Medley, 20 July 1961, Klinikowski, Leber, Schwartz; USNM 167342–50, 3.6 mi. (5.8 km) S Medley, 26 July 1961, Klinikowski, Leber, Schwartz; ASFS V12195–99, 3.0 mi. (4.8 km) N Town Head, 400 feet (122 m), 8 July 1967, Thomas. — *St. James*, ASFS 14565–603, 0.5 mi. (0.8 km) W Mocho, 16 July 1961, Klinikowski, Leber, Schwartz; MCZ 43370–85, CM 52863–75, 0.8 mi. (1.3 km) W Mocho, 22 July 1961, Klinikowski, Leber, Schwartz; CM 52900, 0.5 mi. (0.8 km) W Mocho, 16 July 1961, Klinikowski; ASFS V20125–26, Glasgow, 23 August 1970, Fowler; ASFS V19840–58, 2 mi. (3.2 km) S Guilsbro, 650 feet (198 m), 13 August 1970, M. T. Felix, Fowler, Schwartz; ASFS V19862–65, 3.6 mi. (5.8 km) S Guilsbro, 900 feet (275 m), 13 August 1970, Fowler; ASFS V13073, 1.3 mi. (2.1 km) S Mt. Horeb, 1000 feet (305 m), 31 August 1967, Thomas; ASFS V20136, 1.4 mi. (3.2 km) S Vaughansfield, 24 August 1970, Fowler.

DEFINITION: A subspecies of *E. pantoni* distinguished by large size (males to 38 mm, females to 44 mm snout-vent length), heels overlap slightly when femora held at right angles to body axis, throat rarely coarsely stippled and with clear areas but rather, in adults, completely patternless orange to yellow and with only some coarse peripheral mottling or blotching along the lower jaw margin, venter yellow to orange, less bright than in *E. p. pantoni*, and call usually of one (occasionally two) notes.

DISTRIBUTION: Western Jamaica, in Hanover and extreme northern and western Westmoreland parishes, and throughout St. James Parish; intergrades with *E. p. pantoni* throughout Trelawny Parish in the Cockpit Country and in extreme southwestern St. Ann and extreme northern Clarendon parishes (Fig. 59).

Description of holotype: An adult female with the following measurements: snout-vent length 42.9, head length 16.6, head width 17.5, tympanum 2.9, eye 5.1, naris to eye 5.0, femur 19.3, tibia 20.4, fourth toe 18.5; tibia/snout-vent length × 100 47.6. Head broader than long; snout sharply truncate with nares conspicuous at anterior end of canthus rostralis; diameter of eye equal to distance from naris to anterior corner of eye; diameter of tympanum much less than diameter of eye, distance from tympanum to eye slightly more than diameter of tympanum. Interorbital distance 4.8, slightly less than diameter of eye. Digital discs very small, those on digits 3 and 4 about one-quarter diameter of tympanum, those on digits 1 and 2 even smaller. Fingers moderate, unwebbed, 3–4–2–1 in order of decreasing length; subarticular tubercles pale gray, moderately distinct from palmar surface of hand. Toes long, unwebbed, 4–3–5–2–1 in order of decreasing length; subarticular tubercles gray and prominent, sharply distinct from plantar surface. Heels overlap slightly when femora are held at right angles to body axis. Inguinal glands absent. Dorsum smooth except for a few warts on the upper eyelids. Throat, chest, and belly smooth. Dorsal surfaces of fore- and hindlimbs weakly warty. Posterior and ventral faces of thighs covered by moderately sized, juxtaposed, flattened granules. Tongue large, free, and weakly notched behind, its greatest width equal to about one-half that of floor of mouth. Vomerine teeth in two very long, strongly angulate series, extending far laterad beyond the lateral margins of the choanae, separated from them by a distance equal to about one-third the diameter of a choana, the two series separated medially by a distance equal to slightly less than the diameter of a choana.

Dorsal ground color in life rich chocolate brown and without pattern except for a few scattered paler brown flecks; head concolor with dorsum; a bright orange bar from the posterior corner of the eye over the lower half of the tympanum to before the forelimb insertion; fore- and hindlimbs concolor with dorsum, both weakly crossbarred in darker blackish brown; all ventral surfaces orange and immaculate except for a row of chocolate spots along the margins of the lower jaw; dorsal brown and ventral orange colors sharply delimited laterally; fingers, toes, and upper surfaces of hands orange.

Variation: A series of the 24 largest males has the following measurements: snout-vent length 31.3–38.0 (33.3); head length 12.4–15.2 (13.6); head width 12.6–15.2 (14.1); tympanum 2.0–2.8 (2.2); eye 4.1–5.2 (4.6); naris to eye 3.6–4.9 (4.0); femur 13.3–16.7 (14.5); tibia 14.3–16.8 (15.5); fourth toe 13.3–17.2 (14.7); tibia/snout-vent length × 100 43.0–50.3 (46.6). Twenty-two gravid and adult females (including the holotype) measure: snout-vent length 29.5–43.6 (37.7); head length 12.0–17.0 (14.9); head width 12.0–18.5 (15.7); tympanum 1.4–3.6 (2.5); eye 4.0–6.0 (5.0); naris to eye 2.4–5.3 (4.4); femur 12.9–19.7 (16.8); tibia 14.8–21.0 (18.4); fourth toe 12.7–20.4 (17.3); tibia/snout-vent length × 100 43.1–52.5 (48.8).

The series of 149 *E. p. amiantus* demonstrates four dorsal pattern morphs: mottled, dorsolateral stripes, middorsal hairline, and dorsal zone. The last of these, dorsal zone, has not been previously reported in *E. pantoni*; it consists of a broad middorsal dark band (usually reddish brown in life), set off sharply from the paler dorsolateral brown coloration. Of the four patterns, mottled is overwhelmingly the most common, with 135 of 149 individuals showing it. Five frogs have dorsolateral stripes (which are buffy and distinct in life), six have middorsal hairline, and three have dorsal zone. Neither picket nor sacral spots occur in our series; GOIN & COOPER (1950) recorded no sacral spots and one picket + middorsal stripe in their series of 24 frogs from Sweetwater, St. James – a locality within the range of *E. p. amiantus*.

The most characteristic feature of *E. p. amiantus* is the immaculate throat. This condition is best expressed in adults of both sexes and least well expressed in juveniles which often have some dark throat stippling or mottling. Even a few adults have the throat pattern somewhat like that of the nominate subspecies – a coarsely stippled throat with two lateral clearer areas. Taken in series, however, adults of *amiantus* and *pantoni* are easily distinguished by the presence of an immaculate throat in the former and a stippled or mottled throat in the latter.

Comparisons: Of the three subspecies of *E. pantoni*, *amiantus* has the highest means in all measurements in both sexes. Male *amiantus* reach a larger size than do male *pantoni*, but females of the two subspecies are about equal in snout-vent length. The throat pattern will serve to distinguish most adult specimens of the two taxa, although some *amiantus* occasionally have throats as dark as do adult *pantoni*. There are no striking differences in incidence of the various dorsal pattern morphs between *amiantus* and *pantoni*; in both forms, mottled is by far the most common condition. Although the hindlimbs of *amiantus* overlap slightly when the femora are held at right angles to the body, the heels touch in *pantoni*, and the difference is slight. This is reflected in the almost identical tibia/snout-vent length ratios in the two subspecies; both *amiantus* and *pantoni* have identical means in males (46.6), and the mean in female *amiantus* (48.8) is only slightly higher than in female *pantoni* (47.3). Extremes in both sexes of both taxa are very comparable. The ventral colors of *amiantus* tend toward paler oranges and yellow than the vivid orange color of the venter in the nominate subspecies. We have no color-coded data for *amiantus* venters, but our notations on ventral color in *amiantus* include "venters bright yellow" (2.4 mi. NW Moreland Hill), "venters yellow" (2.0 mi. NW Moreland Hill), "venter yellow" (1.4 mi. S Vaughansfield), "yellow venters" (3.6 mi. S Guilsbro), "ventral ground color yellow-orange" (2 mi. S Guilsbro), and "venter orange" in the holotype (and at 1.3 mi. S Mt. Horeb). There may be local demes of *E. p. amiantus* which tend more to orange than to yellow ventrally, but the general situation seems to be that the ventral coloration of *amiantus* is paler and less bright than in *pantoni*.

Remarks: Intergradation between *E. p. pantoni* and *E. p. amiantus* occurs throughout Trelawny Parish in the Cockpit Country. We have long series from this region (and from extreme southwestern St. Ann and extreme northern Clarendon parishes) which combine the characteristics of *amiantus* and *pantoni*. Throats are extremely variable throughout this geographic area, and at Windsor, for instance, adults have the typical dark throat of *pantoni* and the typical immaculate throat of *amiantus*, plus all degrees of intermediacy between these two extremes. The ventral color at Windsor was recorded as yellow (not orange) with hues ranging from Pl. 10L2 to Pl. 10I1, and with the undersides of the hindlimbs orange (Pl. 11L12 to Pl. 11F10). At Troy, the ventral color was recorded as dark yellow (Pl. 9L4) with the groins brighter orange (Pl. 9C12). Since the type locality of *E. p. pantoni* (Spaldings, Clarendon) is very close to this region of intergradation, it is quite possible that living topotypes of *E. p. pantoni* will show yellow rather than orange venters. We have elected to follow the nomenclatorial course taken here (i.e., to associate the nominate form with the brightly colored frogs), since there seems no other choice.

The above comments on intergradation between *amiantus* and *pantoni* are based upon the following specimens: *Trelawny*, Windsor, 110; 1.2 mi. (1.9 km) N Quick Step, 1000 feet (305 m), 1; 4.8 mi. (7.7 km) NW Troy, 17; 6 mi. (9.6 km) NW Troy, 9; 0.4 mi. (0.6 km) N Burnt Hill, 1800 feet (549 m), 3; 3.8 mi. (6.1 km) N Burnt Hill, 1400 feet (427 m), 1; Ramgoat Cave, 6. — *St. Ann*, 1.5 mi. (2.3 km) E Aenon Town, 2; 2.1 mi. (3.4 km) ENE Aenon Town, 1800 feet (549 m), 5. — *Manchester*, 0.7 mi. (1.1 km) E Troy, 14.

The name *amiantus* is from the Greek meaning "pure, undefiled" in allusion to the immaculate throat in this subspecies.

E. p. amiantus seems to exhibit the same habitat preference as the nominate subspecies and the more eastern form named beyond, except perhaps for a slight tendency toward less wooded areas. One specimen was secured from a terrestrial bromeliad, a situation not previously encountered for the species. Specimens were collected on a cut bank and in a pasture west of Mocho, St. James; on rocks and ground on a cleared hillside southeast of Lucea, Hanover; on a hillside in an abandoned pasture, and in woods along the road south of Medley, Westmoreland; calling from limestone rock surfaces around the edge of a mesic doline north of Town Head, Westmoreland; on the ground in brush northeast of Mt. Horeb, St. James; on a mesic road cut bank and along a small mountain stream south of Guilsbro, St. James; on tree trunks at Glasgow, St. James; and in a terrestrial bromeliad in a limestone area south of Vaughansfield, St. James.

In Trelawny Parish, specimens which we regard as intergrades between *pantoni* and *amiantus* show the same habitat preferences as other *E. pantoni*. At Windsor, Trelawny, we collected specimens on the forest floor, calling from rocks, in low terrestrial bromeliads, on cliff faces, calling from small depressions in limestone rock (where the males were well hidden and almost ubiquitous), and under fallen and wet bark at the entrance to Windsor Great Cave. We also took specimens from the ground in a banana grove east of Aenon Town, St. Ann, and on the forest floor, in a pasture, and on a trail into the Cockpit Country northwest of Troy, Trelawny.

Eleutherodactylus pantoni pentasyringos, new subspecies

Holotype: MCZ 43333, a gravid female, from 4.5 mi. (7.2 km) S Fair Prospect, *Portland Parish*, Jamaica, one of a series collected on 27 June 1961 by Ronald F. Klinikowski, David C. Leber, and Albert Schwartz. Original number ASFS 13485.

Paratypes: *Portland*, ASFS 13486–93, ASFS 13495–96, same data as holotype; CM 52298, 6.0 mi. (9.6 km) SSW Fair Prospect, 11 August 1967, R. Thomas; CM 52876–81, 6.0 mi. (9.6 km) SW Fair Prospect, 12 August 1967, Thomas; MCZ 43334–40, 3.5 mi. (5.6 km) S Fair Prospect, 21 June 1961, Klinikowski, Schwartz; CM 52297, 4.2 mi. (6.7 km) S Fair Prospect, 21 June 1961, Schwartz; MCZ 43341–59, same locality as holotype, 24 June 1961, Klinikowski, Leber, Schwartz; ASFS 13456–62, 8 mi. (12.8 km) S Seamans Valley, 26 June 1961, Klinikowski, Leber, Schwartz; USNM 167327–36, 8 mi. (12.8 km) S Seamans Valley, 25 June 1961, Klinikowski, Leber, Schwartz; ASFS 13118–20, 5.5 mi. (8.8 km) S Fellowship, 20 June 1961, Klinikowski, Leber; CM 52857–62, 5.8 mi. (9.3 km) S Fellowship, 20 June 1961, Klinikowski, Leber, Schwartz; USNM 167319–24, 6.8 mi. (10.9 km) S Fellowship, 20 June 1961, Klinikowski, Leber, Schwartz; ASFS 13581, Port Antonio, 29 June 1961, native collector; USNM 167325–26, Port Antonio, 22 June 1961, native collector; ASFS 13269, Port Antonio, 24 June 1961, native collector.

Definition: A subspecies of *E. pantoni* distinguished by small size (males to 32 mm, females to 39 mm snout-vent length), heels overlap slightly or just fail to meet when femora held at right angles to body axis, throat finely and uniformly stippled, the stippling often covering the entire ventral surface, venter pale yellow, pale orange, or white, never bright orange, and call of five or six notes.

Distribution: Known only from Portland Parish to the north of the Blue Mountains and the John Crow Mountains, from sealevel (Port Antonio) to moderate elevations (about 1100 feet – 336 m), but presumed to occur at much higher elevations in the Blue Mountains to the east of Hardwar Gap; see remarks below (Fig. 59).

Description of holotype: A gravid female with the following measurements: snout-vent length 36.1, head length 15.4, head width 16.6, tympanum 2.6, eye 4.8, naris to eye 4.8, femur 15.1, tibia 17.2, fourth toe 16.6; tibia/snout-vent length × 100 47.6. Head broader than long; snout sharply truncate with nares conspicuous at anterior end of canthus rostralis; diameter of eye equal to distance from naris to anterior corner of eye; diameter of tympanum much less than diameter of eye, distance from tympanum to eye slightly less than diameter of tympanum. Interorbital distance 4.5, slightly less than diameter of eye. Digital discs very small, those on digits 3 and 4 about one-third diameter of tympanum, those on digits 1 and 2 even smaller. Fingers moderate, unwebbed, 3–4–2–1 in order of decreasing length; subarticular tubercles pale gray, distinct from palmar surface of hand. Toes long, unwebbed, 4–3–5–2–1 in order of decreasing length; subarticular tubercles gray and prominent, moderately distinct from plantar surface. Heels overlap when femora are held at right angles to body axis. Inguinal glands absent. Dorsum smooth except for a few warts on upper eyelid and in a fairly prominent scapular W. Throat, chest, and belly smooth. Dorsal surfaces of fore- and hindlimbs very weakly warty. Posterior and ventral faces of thighs covered by moderately sized, juxtaposed, flattened granules. Tongue large, free and weakly notched behind, its greatest width equal to about one-half that of floor of mouth. Vomerine teeth in two very long angulate series, extending far laterad beyond the lateral margins of the choanae, separated from them by a distance equal to about one-quarter the diameter of a choana, the two series separated medially by a distance equal to about one-third the diameter of a choana. Dorsal ground color (as preserved) medium brown with a prominent but somewhat fragmented black scapular W and a narrow black interocular bar, preceded by an irregular narrow whitish interocular bar, but snout not distinctly paler or darker than dorsum; irregularly scattered black or dark brown spots above the axilla and in the region of the groin, with a single rounded black spot on the left side above the groin, its mate on the right side much smaller; upper surfaces of limbs concolor with dorsum, the forelimbs with one dark brown antebracial bar, the hindlimbs with three prominent narrow dark brown bars on the femora and three wider and more irregular dark brown bars on the crura; concealed surfaces distinctly paler (more orange) than dorsal surfaces of hindlimbs; toes and fingers not pale; a prominent dark brown supratympanic bar from the posterior corner of the eye to above the tympanum and thence ventrad to the insertion of the forelimb, the post-tympanic section of the bar separated from the more dorsal section by a narrow strip of brown ground color; lores and subocular region heavily marbled with very dark and medium brown; throat densely and uniformly stippled with dark brown which continues onto the entire venter as a less dense stippled wash; undersides of fore- and hindlimbs stippled, darkest on the antebrachium and hand, and on the distal portions of the thighs and crura.

Variation: A series of the 12 largest males has the following measurements: snout-vent length 27.4–32.3 (28.9); head length 11.4–13.4 (12.2); head width 11.7–14.9 (12.7); tympanum 1.6–2.3 (2.0); eye 3.9–4.7 (4.2); naris to eye 3.1–3.9 (3.4); femur 11.5–14.9 (12.5); tibia 11.6–16.1 (13.3); fourth toe 11.6–16.3 (13.1); tibia/snout-vent length × 100 42.3–49.8 (45.9). Twenty-two adult and gravid females (including the holotype) measure: snout-vent length 31.0–39.3 (34.7); head length 12.2–15.8 (14.0); head width 13.1–16.9 (15.1); tympanum 1.7–2.6 (2.2); eye 4.3–5.5 (4.7); naris to eye 3.9–5.0 (4.3); femur 12.8–17.3 (15.1); tibia 14.5–17.4 (15.9); fourth toe 14.0–17.4 (15.6); tibia/snout-vent length × 100 42.7–49.1 (45.9).

The series of 80 *E. p. pentasyringos* shows four basic dorsal patterns. Fifty-three individuals are mottled and thus this morph is the most common in the series. Eleven frogs have pale dorsolateral stripes and 11 have middorsal hairline. In addition, three specimens have broad pale middorsal lines, a condition found in no other population. Finally, two specimens are picket, and one is dorsal hairline + dorsolateral stripes. No specimens have sacral spots as far as we are concerned, but presumably the holotype might be so considered (see description above). Occasional other individuals which have some dark dorsal spotting or dotting have a more or less (usually less) distinct pair of dark dots in the inguinal region, but these are never bold and sharply delimited as are comparable sacral spots in *E. andrewsi*, for instance.

Dorsal ground colors vary about a medium brown, and the dark scapular W is a prominent and common feature of the series; in many frogs, the pre-W area is paler and sharply set off from the balance of the dorsal color. A dark interocular bar likewise is common, and a few specimens also show a narrow to moderately broad pale interocular bar. The ventral coloration varies from pale orange to pale yellow or white, the brightest orange hues occurring in mature or gravid females. One female was recorded as having the dorsum heavily blotched with orange. The dorsal hairline is cream to light tan, and the dorsolateral stripes are buffy and not particularly contrasting with the dorsal ground which itself is medium brown in most instances. In full adults, the throat is heavily and uniformly stippled with dark brown and often with a fine pale midventral line. Many older specimens seem to have the throat dusky rather than discretely stippled, but closer examination shows that the dusky condition is due to extremely fine stippling. Rarely is the throat coarsely stippled with two pale lateral areas as in *E. p. pantoni*, and, if this condition is present, the stippling is much finer and more uniform than on the throats of the nominate subspecies. In many adult *pentasyringos*, the dark throat stippling extends far posteriorly over the entire venter (as in ASFS 13493) so that the belly is irregularly marbled with dark pigment.

Comparisons: *E. p. pentasyringos* is the smallest of the three subspecies of *E. pantoni*. Females rank lowest in means of all measurements taken except head width and eye, and males rank lowest in all measurements except head width, eye, and naris to eye. The tibia/snout-vent length ratios are likewise low in *pentasyringos*, most strikingly so in females (45.9 versus 47.3 and 48.8 in *pantoni* and *amiantus*).

All subspecies modally have mottled dorsa, but *pentasyringos* shows the highest incidence of other pattern morphs: 28 of 80 *pentasyringos* (35 percent) are other than mottled dorsally, whereas 15 of 106 *pantoni* (14 percent) and 14 of 149 *amiantus* (9 percent) are not mottled. No other population shows a combination of middorsal hairline + dorsolateral stripes except *pentasyringos*. Dorsally, *pentasyringos* is basically a medium brown frog, whereas *amiantus* tends strongly toward rich dark brown dorsal hues, and *pantoni* is variably gray to rich chocolate brown. The ventral color in *pentasyringos* is most like that of *amiantus* far to the west, with distinctly paler hues (yellows and oranges and even white) in contrast to the vivid orange venters of adjacent *pantoni*. Finally, the uniformly and finely stippled throat (with in many instances the stippling continued across the entire venter) immediately distinguishes *pentasyringos* from immaculate-throated *amiantus* and *pantoni* with the throat coarsely stippled with two clear lateral areas.

Remarks: The name *pentasyringos* is derived from the Greek meaning "calling five times", an allusion to the multiple-"took" call of this northeastern population. Although in our experience five notes is the rule in *pentasyringos*, we have heard some males giving a six-"took" call upon occasion, but never a call with one or two notes as in *pantoni* and *amiantus*. LYNN & DENT (1943) and GOIN & COOPER (1950) both considered that these Portland frogs gave a six-"took" call, however, and made no mention of five notes; there may well be areas included in the range of *pentasyringos* where either five- or six-note calls predominate. In any event, multiple-calling is the rule in *pentasyringos*, rather than single- or double-note calling as in *pantoni* and *amiantus*.

We have seen no specimens which we consider intergradient between *pantoni* and *pentasyringos*. However, assuming that six-"took" calling males pertain to *pentasyringos* rather than *pantoni*, there seems to be a sharp geographical break between these two taxa. LYNN & DENT (1943) reported two-note calls from Clydesdale, St. Andrew, and six-note calls from Abbey Green and Portland Gap, St. Thomas. The distance separating Clydesdale and Abbey Green is about 5 miles (8 kilometers). GOIN & COOPER's (1950) records for six-note males include Spanish River Bridge, Murdoch's Gap, and Cascade (all in Portland Parish); we have been unable to locate these three sites with accuracy, but any of them may be closer to Clydesdale than is Abbey Green. Certainly GOIN & COOPER's comments upon their Spanish River Bridge frogs (dark vermiculations encroaching on the uniform yellow venter) leave no doubt that *E. pantoni* at that locality are *pentasyringos*, since this condition occurs only in that subspecies. The southernmost and easternmost record for *E. p. pentasyringos* is that of LYNN & DENT (1943) at Corn Puss Gap on the parish boundary between Portland and St. Thomas parishes, north of Bath.

When all of the above are considered, we are unable to state categorically precisely where (or even if) *pantoni* intergrades with *pentasyringos*. The 5 mile gap between Clydesdale and Abbey Green is indeed narrow, and it seems unlikely that intergradation, either morphologically or vocally, occurs in such a short distance. It is possible, of course, that vocal and morphological intergradation does not occur simultaneously, and that, despite the occurrence of six-note calling males in the central Blue Mountain region, in this area a six-note eastern call is retained while morphologically and chromatically the frogs are closer to *pantoni* than to *pentasyringos*. Certainly additional detailed collecting in this region should be most revealing. It is not at all impossible that *pentasyringos* is not conspecific with *pantoni*, and that their ranges overlap somewhere in the Blue Mountain uplands.

As in several other forms (see final discussion of the present paper), *E. pantoni* has differentiated in eastern Jamaica. The John Crow Mountains appear to have been a local center of amphibian, reptilian and avian endemism; most locality records of *pentasyringos* are associated with this range or its lower foothills. However, the subspecies has apparently also invaded the Blue Mountains uplands from about Sir Johns Peak eastward to Portland Gap (and presumably beyond, since the subspecies occurs also at Corn Puss Gap, a locality more properly associated with the John Crow Mountains but part of the central ridge dividing Portland and St. Thomas parishes).

E. p. pentasyringos displays the same general habitat preferences as does *E. p. pantoni*; namely, it is ground-oriented. We collected specimens on and under rocks adjacent to a stream south of Fellowship, Portland; on the ground in an overgrown *Musa* grove, on rocks in a forest on a limestone mountainside, and calling from the axil of a palm south of Fair Prospect, Portland; and on a tree-fern base 1.5 feet (0.5 m) above the ground south of Seamans Valley, Portland.

Eleutherodactylus fuscus Lynn & Dent

Eleutherodactylus fuscus was named on the basis of three male specimens from Dolphin Head, Westmoreland Parish, and Quick Step, St. Elizabeth Parish (= Trelawny Parish). Except for comments upon its presumed relationship to *E. pantoni* by GOIN (1954), nothing further has been published about *E. fuscus* since its description in 1943. It is a very distinctive species, not easily confused with *E. pantoni* which the preserved specimens somewhat resemble; the original description was apparently based upon preserved material, since the frog in life is especially colorful.

Our series consists of 47 specimens, of which 10 are gravid or adult females, 29 are adult males, and the remainder are juveniles and subadults with snout-vent lengths between 15.2 and 24.2. The 29 males have the following measurements: snout-vent length 25.5–33.7 (30.4); head length 10.5–13.6 (12.5); head width 11.4–14.6 (13.1); tympanum 1.7–2.5 (2.1); eye 3.0–4.6 (4.0); naris to eye 3.0–4.1 (3.6); femur 10.3–14.5 (13.0); tibia 11.2–14.2 (13.2); fourth toe 10.5–13.8 (12.7). The 10 females measure: snout-vent length 31.2–37.3 (34.1); head length 12.8–19.5 (14.3); head width 13.8–16.0 (14.9); tympanum 2.0–2.3 (2.2); eye 4.2–5.0 (4.6); naris to eye 3.7–4.4 (4.0); femur 13.3–16.4 (14.7); tibia 13.5–16.1 (15.0); fourth toe 12.8–15.3 (14.3). There is slight sexual dimorphism in size, with females the larger. Tympanum diameter is not strongly sexually dimorphic, however.

The general body tones of *E. fuscus* are tans and browns, usually with a reddish or orange tint. In a series of 11 frogs from Medley, eight specimens were reddish or orangish brown dorsally (from Pl. 16E6 to Pl. 14I7 to Pl. 13C10), with venters creamy (Pl. 10B1) to yellow (Pl. 10B12). The groin, concealed surfaces of the hindlimbs, and sides were orange (Pl. 10B12 to Pl. 2E12). In these specimens, which are uniformly colored and patternless dorsally, a raised scapular W is conspicuous, and its posterior points are often marked by some restricted black to dark brown pigment. In addition, many specimens have a pair of black inguinal dots, variable in extent, much as in *E. andrewsi* (which is of course a much smaller species). In the Medley series, two were dusky brown dorsally, with the pre-W area and a sacral blotch more reddish than the balance of the dorsum and thus set off from it rather conspicuously. The remaining member of the Medley series had a mottled tan dorsum with a clear tan middorsal line. In many specimens the throat was white, and the belly color had variable shades of yellow (Pl. 17G1); the groin and concealed surfaces were regularly recorded as some shade of orange (Pl. 9G8 to Pl. 9H12) in another series from Medley.

Taking the entire series as whole, most specimens agree with the first two pattern types noted above; the completely or virtually completely unicolor and patternless dorsum is the more common condition of these two. Three frogs show a middorsal pale hairline from the snout to above the vent, and thence along the posterior faces of the thighs, where the line disappears in the popliteal area and reappears once more on the distal quarter of the crura and extends along the dark sole of the foot near its outer margin to end at the base of the fourth toe. Two frogs have a picket pattern, with a darker middorsal zone and lighter sides, and one frog has a few scattered longitudinal pale spots along the dorsolateral line region between the scapula and the groin.

The most constant pattern feature is the presence of a semicircular dark brown to black mark above and including the upper third of the tympanum. This is an obvious feature in both sexes and at all ages and acts as a ready hallmark of *E. fuscus*. Occasional individuals in addition have a few scattered dark flecks below the tympanum or posterior to the bend in the semicircular mark. The throat is either unmarked or has some vague stippling or even a poorly defined pale brown reticulum on a white to yellow ground. One small juvenile had orange preocular and postocular spots, but all other specimens had the loreal region unicolor with the dorsum except for the presence of a dark loreal line which is the anteriad extension of the dark semicircular postocular-tympanic mark.

Goin (1954), on the basis of very limited material, suggested that *fuscus* was most closely related to and a derivative of *pantoni* (1954: 193). We have no doubt that he was perfectly correct in this assumption: the two species resemble each other in general habitus and habitat (although *pantoni* seems to be more tolerant of somewhat less mesic situations than *fuscus*) and in ventral coloration. At the time of Goin's paper, the three specimens of *fuscus* were all assigned to the mottled type of dorsal pattern. Our collection shows that both picket and dorsal line pattern types occur in the species, and that inguinal dots likewise are present in some specimens. Thus, of the five pattern types shown by Goin (1954: 193) for *pantoni*, only dorsolateral lines has not as yet been reported in *E. fuscus*.

If *pantoni* and *fuscus* are closely related, it would seem likely that the derived species (*fuscus*) would outnumber the more widespread member of the pair (*pantoni*) where the two species are sympatric and syntopic. This does not seem to be the case, since we have collected considerable numbers of *pantoni* within the known range of *fuscus*, and in fact *pantoni* seems to outnumber *fuscus* in their region of geographic overlap. *E. fuscus* has a peculiarly circumscribed distribution, since it does not appear to enter the Cockpit Country proper but does slightly invade its western margin. *E. pantoni* occurs, on the other hand, at most Cockpit localities and is one of the three dominant terrestrial frogs in this region (with *E. cundalli* and *E. grabhami*). We interpret *E. fuscus* as a *pantoni* derivative which has evolved in the uplands of the Dolphin Head region in extreme western Jamaica. This area of karst topography seems especially suitable as a site for the differentiation of a distinctive species.

All of our *E. fuscus* came from the parishes of Westmoreland and St. James, although LYNN & DENT (1943) described the species from specimens from Westmoreland and St. Elizabeth (Fig. 60). Two of our Westmoreland specimens from south of Medley were collected along the road shoulder and along a path through a hillside clearing. Ten others, also collected in the Medley region, were taken calling in woods along a trail (calling males were on bare earth and leaves and not upon rocks), under a *Musa* leaf, under a banana shelter, and from red earth mounds heaped around yam or sweet potato plants adjacent to, and shaded by, *Musa*. Still another locality south of Medley yielded three specimens calling from exposed rocks at the edge of the road.

Eleven specimens were taken west of Mocho on a cleared hillside in grass, shrubs, ferns, and trees; at this locality one frog was secured seven inches (0.18 m) above the ground, the only instance we have of securing *E. fuscus* in other than a purely terrestrial situation. Three individuals from north of Town Head were collected calling from the ground in a mesic doline pasture in a banana patch.

Altitudinally, *E. fuscus* is known to range from 400 feet (122 m) near Medley to 2250 feet (686 m) at Mocho. We heard the species calling approximately one mile south of Medley and at Town Head, where the males seemed to be localized in pockets. LYNN & DENT (1943) reported the call of *E. fuscus* to be a clear whistling "wick-wick". We heard the same oft-repeated call, interspersed with scattered single notes; the call is extremely ventriloqual. As noted above, all calling males were strictly terrestrial, and none showed any tendency to call from shrubs, herbs, or bushes above the ground surface.

Specimens: *Westmoreland*, 2.5 mi. (4.0 km) S Medley, 6; 3.6 mi. (5.8 km) S Medley, 23; 3.0 mi. (4.8 km) N Town Head, 400 feet (122 m), 5; 4.7 mi. (7.5 km) S Askenish, 1. — *St. James*, 0.8 mi. (1.3 km) W Mocho, 12.

Eleutherodactylus luteolus Gosse

GOIN (1953) showed that the name *luteolus* Gosse had been improperly applied to the frog which had been called *E. gossei* Dunn. The previous nomenclatural confusion led LYNN & DENT (1942) to name *E. lewisi*, which, as COCHRAN (1961: 45) pointed out, is a synonym of *E. luteolus*. There is of course no doubt that *E. luteolus* and *E. gossei* are quite distinct species, with the former much the smaller of the two.

Of our series of 94 *E. luteolus*, the 27 largest males have the following measurements: snout-vent length 14.8–17.3 (16.4); head length 5.3–7.1 (6.6); head width 5.7–7.0 (6.4); tympanum 1.2–2.0 (1.7); eye 1.9–2.6 (2.4); naris to eye 1.5–2.0 (1.9); femur 6.3–8.0

(7.3); tibia 7.1–8.3 (7.9); fourth toe 6.2–7.7 (7.1). Twenty-one gravid and adult females measure: 18.5–25.2 (22.2); head length 7.1–9.4 (8.4); head width 7.1–9.5 (8.4); tympanum 1.3–2.1 (1.7); eye 2.2–3.1 (2.7); naris to eye 2.0–2.9 (2.5); femur 8.8–11.4 (9.8); tibia 8.8–11.5 (10.3); fourth toe 8.2–10.3 (9.5).

In contrast to most species of *Eleutherodactylus* which possess the feature, *E. luteolus* shows a high percentage (60.6 percent) of individuals with a middorsal hairline. The line, however, varies from complete to restricted to the posterior half or one-third of the trunk. The second most frequent category of dorsal pattern is mottled (25.6 percent), whereas only 8.5 percent of the frogs have dorsolateral stripes. A pattern of dorsal hairline + dorsolateral stripes occurs in 5.3 percent of the specimens.

Preserved *E. luteolus* are almost always easily recognized not only by their small size but by the presence of conspicuous dark orange to brown glandular areas, one supra-axillary and the other inguinal. These areas are less conspicuous and yellowish in living frogs, but they become increasingly obvious with the length of time in preservative and the fading of the browns and tans which make up the dorsal and lateral colors. One specimen (ASFS 15683) was noted in life to have prominent yellow glands on the femora, but these glands are no longer conspicuous on this specimen, whereas both groin and supra-axillary glandular areas are presently easily ascertained. A few preserved individuals, both immature and adult, do not show the glandular areas so clearly, but we have no hesitancy in regarding these specimens as *luteolus* because of other chromatic and morphological characteristics.

The dorsal ground color varies from pale tan, straw, brown, and metallic brown to rich chocolate, often with a reddish tinge posteriorly and on the femora, and even at times in the groin, although the latter condition is uncommon. The snout, in darker frogs, is somewhat paler and set off by a narrow, and often vague, dark interocular bar. The dorsal pattern is basically a dark brown scapular W, but the entire figure may be so reduced that all that remains is a pair of black dots which represent the posterior angles of the letter. If a middorsal hairline is present, it varies from faintly orange to cream, and the dorsolateral stripes are tan, in contrast to the darker middorsal region. In some specimens, the dorsolateral stripes in life are difficult to determine, since there is little contrast between them and the balance of the dorsal pigmentation. There is always a conspicuous black to dark brown mask which extends posteriorly down the flank, often about half of the way to the groin, becoming more attenuate and finer posteriorly. The ventral ground color varies from very pale yellow in those frogs which are dark dorsally, to white or pale grayish in paler frogs. The brachia at times have a reddish tinge.

We have included a male (ASFS V13033) from 1.8 mi. SW Ewarton, St. Catherine, with *E. luteolus*, although we are not absolutely certain that the specimen is properly identified as that species. Its snout-vent length (17.3) is greater by 0.1 mm than those of any other male *E. luteolus*, and its isolated geographic position, some 65 miles (104 km) east of all other *E. luteolus* records, as well as its general aspect and absence of glandular areas, all combine to make us somewhat doubtful as to its identification. However, it has a well-developed black mask and in other pattern details it agrees best with our concept of *E. luteolus* and we so consider it *pro tem.*

With a few exceptions, the ecological data from our collection of *E. luteolus* agree with those of LYNN & DENT (1942) and GOIN (1953). Specimens from southwest of Old Hope, Westmoreland, confirm GOIN's coastal situations for *luteolus* at Negril Point, Westmoreland. One of our specimens was collected under moist sea-grape litter, back of the coast; GOIN's material was secured under palm trash interior to the coast. We also have specimens from Bushmount, Hanover, which verify LYNN & DENT's Bushmount locality (for *E. "lewisi"*). Our Askenish specimen was secured in a terrestrial bromeliad; whether an accidental occurrence or not, it is noteworthy in that bromeliad habitats are virtually unused by Antillean *Eleutherodactylus*.

Our collection, besides filling in many gaps between the previously reported localities, extends the northern and eastern limits of the range for the species (Fig. 58). Whereas *E. luteolus* has been known only from Westmoreland Parish, we have specimens from four other parishes; Hanover, St. James, Manchester, and St. Catherine. Four stations in St. James Parish yielded five specimens, and there is one individual from Manchester. The high altitudinal record for *E. luteolus* is 2250 feet (686 m) at localities west of Mocho, St. James. Even though LYNN & DENT stated that the elevation at which their Dolphin Head specimens were taken was approximately 2000 feet at the base of the mountain, modern topographical maps show that the summit of Dolphin Head rises only 1789 feet.

As described by GOIN (1953), the situations in which we took calling male *E. luteolus* were low shrubs, herbs, on rocks, and on bare earth and grass, never over three feet above the ground. The call, which GOIN likened to that of *E. planirostris*, we found to be a single, slight, rising whistle, or "peep".

Specimens: *Hanover*, Bushmount, 10.5 mi. (16.8 km) SE Lucea, 29; 4.4 mi. (7.0 km) N Town Head, 800 feet (244 m), 1; 2.9 mi. (4.6 km) S Askenish, 800 feet (244 m), 1. — *Westmoreland*, 2.5 mi. (4.0 km) S Medley, 32; 3.6 mi. (5.8 km) S Medley, 14; 3.0 mi. (4.8 km) N Town Head, 400 feet (122 m), 1; 4.5 mi. (7.2 km) S Askenish, 2; 4.4 mi. (7.0 km) SW Old Hope, 2; 2.0 mi. (3.2 km) NW Moreland Hill, 400 feet (122 m), 1; 3.2 mi. (5.1 km) SW Whithorn, 1. — *St. James*, Glasgow, 400 feet (122 m), 3; 2 mi. (3.2 km) S Guilsbro, 650 feet (198 m), 1; 2.7 mi. (4.3 km) SE Plum Park, 1200 feet (366 m), 1; 0.5 mi. (0.8 km) W Mocho, 1; 0.8 mi. (1.3 km) W Mocho, 3. — *Manchester*, 0.7 mi. (1.1 km) E Troy, 1. — *St. Catherine*, 1.8 mi. (2.9 km) SW Ewarton, 800 feet (244 m), 1.

Eleutherodactylus andrewsi Lynn

As GOIN (1954) pointed out, *E. andrewsi* has a very limited repertory of pattern variation. The species is easily recognized by its small size and by the pair of suprainguinal dark brown to black spots. All of our 12 specimens were some shade of brown dorsally and, aside from a faint dark interocular bar, were otherwise unpatterned. There may be a vague indication of a scapular W, and there is always a dark brown postorbital line which proceeds above the forelimb insertion, dipping ventrally to end on the side at about mid-flank. The groin and the concealed surfaces of the hindlimbs were recorded as reddish (Pl. 3F11) in life.

Eight adult males have the following measurements: snout-vent length 18.2–20.5 (19.1); head length 7.2–8.0 (7.5); head width 7.0–8.0 (7.4); tympanum 1.4–1.7 (1.6); eye 2.4–2.9 (2.6); naris to eye 1.5–2.9 (2.6); femur 7.6–8.1 (7.8); tibia 7.9–8.7 (8.2); fourth toe 7.5–8.3 (7.9). The single gravid female measures: snout-vent length 23.2, head length 8.9, head width 8.7, tympanum 1.6, eye 3.0, naris to eye 2.2, femur 8.6, tibia 9.1, fourth toe 8.8. This female exceeds the largest recorded measurement of 21 mm (LYNN, 1940: 43) for the species. Our smallest juvenile has a snout-vent length of 15.1.

E. andrewsi is known only from a very limited region in the Blue Mountains, its distribution centered about the Portland-St. Andrew Parish line (Fig. 55). Based upon nine specimens collected calling at Chester Vale, St. Andrew Parish, at an elevation of 3200 feet (976 m), LYNN (1937) considered *E. andrewsi* an inhabitant of deep woods in the higher mountains. Lynn recorded a maximum elevation of 5000 feet (1525 m) for the species, based upon his having heard the frog vocalizing.

GOIN (1954) reported *E. andrewsi* calling from an open rocky region as well as from beneath bushes along a trail. We collected this species on rocks at the side of a stream north of Irish Town, St. Andrew, and beneath trash, litter, and rocks on the ground at Hardwar Gap, St. Andrew. Calling males were secured from the ground under raised rocks on a road cut and from other ground sites, all more or less concealed, at Hardwar Gap. The elevations from which our collections were made ranged from 2500 feet (763 m) north of Irish Town to 4250 feet (1296 m) at Hardwar Gap. The high-pitched, oft-repeated, highly ventriloqual whistle or squeak described by Lynn for *E. andrewsi* we interpreted as a somewhat reedy whistle or "weep", irregularly repeated.

Specimens: *St. Andrew,* Hardwar Gap, 7; 3.3 mi. (5.3 km) N Irish Town, 2500 feet (763 m), 1. — *Portland,* Hardwar Gap, 4000 feet (1220 m), 2; 2 mi. (3.2 km) N Hardwar Gap, 3000 feet (915 m), 2.

Eleutherodactylus orcutti Dunn

Eleutherodactylus orcutti is the only Jamaican *Eleutherodactylus* whose habits are aquatic. SHREVE & WILLIAMS (1963: 326) suggested that the aquatic habitat allied *orcutti, semipalmatus* Shreve from Hispaniola, *karlschmidti* Grant from Puerto Rico, and the Cuban *cuneatus* Cope and *brevipalmatus* Schmidt (all of which are aquatic or assumed to be so). However, SCHWARTZ (1967: 55) suggested that the aquatic habitat of these species (including *sierramaestrae* Schmidt and *turquinensis* Barbour & Shreve, rather than *brevipalmatus* as SHREVE & WILLIAMS had done) was convergent, and that they represent local aquatic species which are derived from more widespread assemblages on each of the islands on which they occur. We find no present reason to revise the latter interpretation.

Our series is composed of 67 specimens, of which 12 are gravid or adult females. The twenty largest males were also measured. Data on the males are: snout-vent length 25.3–33.7 (28.3); head length 10.4–14.5 (11.8); head width 10.5–14.8 (11.9); tympanum 2.7–4.2 (3.2); diameter of eye 3.5–5.0 (4.2); naris to eye 2.6–5.0 (3.1); femur 11.9–16.0 (13.6); tibia 12.2–15.2 (13.6); fourth toe 11.0–15.4 (13.1). Adult females have the following measurements: snout-vent length 29.0–38.4 (32.5); head length 10.2–15.1 (11.6); head width 11.1–15.6 (13.1); tympanum 2.0–2.9 (2.4); eye 3.9–5.4 (4.6); naris to eye 2.9–4.3 (4.6); femur 12.8–17.9 (15.6); tibia 13.4–17.2 (15.5); fourth toe 14.0–17.5 (15.6).

As LYNN (1940:57) pointed out, females reach a greater size than males. Maximum sizes cited by LYNN (37 mm in females and 30 mm in males) are exceeded by our measurements of a much shorter series than was available to him. He also pointed out (1940: 58) that males have a much larger tympanum than do females, a fact amply confirmed by our series; the sex of even immature specimens is easily determined by examination of the tympanum.

LYNN (1940: 57) discriminated between three patterns in *E. orcutti*: plain dorsum, mottled dorsum, and dorsolateral stripes. Our series lacks representatives of the latter morph. By percentages, LYNN's series of 73 specimens were 53.5 percent mottled, 26.0 percent plain, and 20.6 percent dorsolateral stripes; in contrast, our series of 67 specimens has 62.9 percent mottled and 37.1 percent plain. It is possible that the discrepancy between the data on pattern from the two collections is due to the fact that all of LYNN's material was from higher elevations in the Blue Mountains (Arntully and Chester Vale, at elevations of 3000 and 3300 feet – 915 and 1007 m), whereas most of our specimens are from Portland Parish(see below) and from much lower elevations. There may well be deme differences in pattern frequency in *E. orcutti.*

Although the majority of our *E. orcutti* were taken in ecological situations similar to those described by LYNN (1940: 56) and GOIN & COOPER (1950), several were collected in situations which are noteworthy and which extend both the geographical and altitudinal distributions from which the species has been known. Three frogs were taken from large boulders in the Rio Grande south of Seamans Valley at an elevation of approximately 750 feet (229 m); this valley lies between the Blue and John Crow mountains (Fig. 60). All previous specimens have been taken from small mountain streams in the Blue Mountains. The lowest previously recorded location, discounting GOIN & COOPER's Spanish River Bridge and Murdoch's Gap localities which we are unable to locate, is Arntully, St. Thomas, at an elevation of 3000 feet (915 m).

Thirty-three specimens were collected south of Fellowship, Portland, on rocks in a mountain stream, also at approximately 750 feet. These two Portland localities extend the eastern boundary of the known range of *E. orcutti.* It is also remarkable that no specimens have previously been collected at Hardwar Gap (on the St. Andrew-Portland parish boundary), since this pass is easily accessible by road from the Kingston area. Here we secured one male calling from a seepage in the forest.

In general, calling male *E. orcutti* have been taken from moist rocks in streams or from rocky faces over which water ran slowly. The above-noted specimen from Hardwar Gap is noteworthy in that it is the only reported instance of *E. orcutti* calling from a situation other than a stream. As noted by LYNN (1940: 58), calling *E. orcutti* emit a sound like a leaky faucet, although the sound is louder than that made by the mechanical device.

Specimens: *St. Andrew*, 16 mi. (25.6 km) N Kingston, 19; 3.3 mi. (5.3 km) N Irish Town, 2500 feet (763 m), 7; 3.4 mi. (5.4 km) NE Irish Town, 2; Hardwar Gap, 1. — *Portland*, 6.8 mi. (10.9 km) S Fellowship, 33; 8 mi. (12.8 km) S Seamans Valley, 3.

DISCUSSION

The seventeen species of native Jamaican frogs show a series of distributional patterns, which, when correlated with the island's geography and with data from other vertebrate groups, suggest that the faunal history of Jamaica has been far from simple. One tends to think that such relatively structurally "simple" Antillean islands as Jamaica and Puerto Rico have faunal patterns which are likewise uncomplicated. Both of these islands are of about the same general size, and both are composed mainly of a central montane massif with a surrounding lowland plain. But detailed analysis of the fauna of Puerto Rico has shown that very few amphibians and reptiles are more or less uniformly distributed over the entire island; various peculiarities of distribution gradually have emerged as material has accumulated. Studies on the Jamaican herpetofauna have just within the past decade been reaching such a point.

We can segregate the Jamaica frogs into three major and one minor group: *1*) those species which are islandwide in distribution; *2*) those which are restricted to the eastern portion of the island, centering in the Blue Mountains-John Crow Mountains area; *3*) those species whose distribution is western and central; and *4*) that species which occurs on Portland Point. In addition, some species in group *1* have western-central and eastern subspecies and thus bridge the gap between groups *1* and *2*.

In group *1* occur all the hylids and *Eleutherodactylus jamaicensis*. These five species are widely distributed geographically and altitudinally and appear to occur from one end of the island to the other without subspecific differentiation. It should be pointed out, however, that *E. jamaicensis* shows geographic variants in pattern which suggest strongly that the species is not genetically uniform over its broad range. There is presently no evidence that any of the hylids show subspecific variation. We should point out that our relegation of *Hyla marianae* (and perhaps *H. crucialis*) to this group of frogs is open to question. Certainly *marianae* is known from so few localities, all of which are more or less grouped in the central portion of Jamaica, that it may well be premature to assume that it is islandwide. However, we see little reason to doubt that it will ultimately be collected in the Dolphin Head region in the west and in the Blue Mountains-John Crow Mountains in the east. As we have noted in the text, *H. crucialis* may be absent in extreme western Jamaica; there is only a voice record from extreme eastern Jamaica. *H. wilderi* is known only as far east as St. Andrew Parish, but it too seems a likely candidate for occurrence in the eastern montane masses.

Eleutherodactylus cundalli, E. gossei, and *E. pantoni* also are widespread throughout Jamaica and thus belong in group *1*. In each of these species, however, there has been nomenclatorially recognizable variation, and each has a subspecies in the eastern portion of the island, although the ranges of the three subspecies do not coincide (nor do we expect that they necessarily should). In addition, *E. pantoni* has a distinctive western subspecies. The absence of *E. gossei* from extreme western Jamaica has already been noted in the text.

These three species offer a transition between groups *1* and *2*, the latter those frogs which are restricted to eastern Jamaica. Included in this category are three species which are limited to the uplands of the Blue Mountains: *Eleutherodactylus alticola, E. nubicola,* and *E. andrewsi. Eleutherodactylus orcutti* occurs not only in the Blue Mountains but also in the valley between the Blue and John Crow mountains and likely occurs in streams in the latter range as well. Thus, in eastern Jamaica, there are four species which are limited to this region, and three species which have local subspecies there (*E. c. glaucoreius, E. p. pentasyringos, E. g. oligaulax*).

The western-central taxa in group *3* include three (possibly four) species. *Eleutherodactylus fuscus, E. grabhami* and *E. luteolus* are all limited to the western and central portions of Jamaica. The fourth species, *E. junori*, is so little known that we include it here only provisionally. Certainly the two localities whence *junori* is known suggest that it is a portion of this western-central anuran fauna. The western-central species occur as far east as about the eastern margin of Trelawny and Manchester parishes (although there is a questionable specimen of *luteolus* from farther east in St. Catherine).

There is but a single frog, *Eleutherodactylus cavernicola*, in group *4*. This species is restricted to Portland Point. That it is an *E. cundalli* relative (and perhaps derivative) as Lynn pointed out seems certain. Its habitat is apparently so specialized, and the area where it occurs is so remote and harsh, that it is likely that *E. cavernicola* has been adapted for this particular situation and occurs nowhere else.

From the above summary, it becomes apparent that there are two main areas of differentiation of Jamaica frogs – western-central and eastern. Of the two regions, certainly the eastern is the more interesting, since it includes the highest Jamaican peaks in the Blue Mountains.

Remarkably, this eastern section is inhabited by several other vertebrates which have differentiated specifically or subspecifically from their Jamaican relatives. Among the reptiles, *Dromicus polylepis* Buden is a distinct species known from eastern Jamaica in Portland and St. Andrew parishes and presumably occurs elsewhere throughout the eastern end of the island. *Anolis reconditus* Underwood & Williams likewise is an endemic species of lizard from this region, whose range (LAZELL, 1966: 12, fig. 3) is limited to the uplands of St. Thomas and St. Andrew-Portland parishes. *D. polylepis* has a western-central cognate in *D. funereus* Cope (Buden, 1966) and *A. reconditus* is related to the widespread *A. lineatopus* Gray. LAZELL (1966) presented an interesting and plausible hypothetical history of divergences from the basic *Anolis* stock in Jamaica and considered *A. reconditus* as a very early derivative of an ancestral anoline stock which has been restricted to its present range with increasing diversity of other species of anoles.

Two other anoles (*A. grahami* Gray and *A. lineatopus* Gray) also have eastern subspecies (*A. g. aquarum* and *A. l. ahenobarbus*) whose distributions are confined to extreme eastern Jamaica (UNDERWOOD & WILLIAMS, 1959). These two subspecies center in the Blue-John Crow ranges but in neither case are they restricted to these massifs.

Sphaerodactylus dacnicolor Barbour, although considered by GRANT (1940) as a synonym of *S. oxyrhinus* Gosse, appears to be a taxon distinct from *oxyrhinus* (whether species or subspecies is presently debatable) and is also limited to eastern

Jamaica. Perhaps *Diploglossus microblepharis* Underwood should also be included as an eastern endemic, but the species is known from only a single specimen and too little is known of the distribution of the species to treat it with any degree of certainty.

Among birds, there is one interesting example of subspecific differentiation in eastern Jamaica. *Trochilus polytmus scitulus* Brewster & Bangs is a hummingbird whose range is limited to eastern Jamaica (BOND, 1956: 95) from Port Antonio on the north to Bath in the south; the species *T. polytmus* is island-wide with no known differentiation elsewhere.

Western-central vertebrates are not so abundant as eastern forms. Aside from the three or four frogs mentioned herein as being from this section of Jamaica, it should be recalled that *Eleutherodactylus pantoni amiantus* is also limited to western Jamaica. Among reptiles, *Sphaerodactylus oxyrhinus* Cope occurs only in this region (and appears to be the western cognate of *S. dacnicolor*). There is also an undescribed species of bromeliad-dwelling *Sphaerodactylus* from this same western-central region. It is possible that *Diploglossus fowleri* Schwartz should also be considered a (western-) central species, but, like *D. microblepharis*, the species is too poorly known to be certain.

Aside from *Eleutherodactylus cavernicola* on Portland Point, this region supports an endemic galliwasp (*Diploglossus duquesneyi* Grant) and an endemic subspecies of dwarf boa (*Tropidophis haetianus stullae* Grant).

From the above discussion, it is apparent that eastern Jamaica has been a striking center of differentiation, both specific and subspecific, for several groups of vertebrates. The high interior uplands of the Blue Mountains and the John Crow Mountains have almost certainly been areas which, during the relatively recent past, have been isolated by encroaching seas and have allowed various forms to evolve there in isolation from their relatives elsewhere in island refugia which today are portions of the island of Jamaica.

There have been two pertinent discussions of Antillean hylids. DUNN (1926: 123–124) suggested that all Jamaican hylids represent but a single hylid invasion onto that island. SHREVE & WILLIAMS (1963: 307–310) presented other hypotheses but in the end returned to that of DUNN. The problem is not easily resolved on the basis of data presently available, both biological and structural, for these frogs. The facts that both Jamaica and Hispaniola each have four species of *Hyla*, and that the four Jamaican species are strictly bromeliad-dwellers as far as egg deposition and larval development is concerned, and that the four Hispaniolan species (*dominicensis* Tschudi, *heilprini* Noble, *pulchrilineata* Cope, *vasta* Cope) are predominantly stream-breeders (the exception being *dominicensis* which deposits its eggs in standing water), tend to becloud the problem at its outset. Only one hylid (*septentrionalis* Duméril & Bibron) occurs in Cuba and has reached the Bahama Islands and southern Florida (and has been presumably introduced in Puerto Rico; see DUELLMAN & CROMBIE, 1970, for details). The only clear fact emerging from a comparison of these frogs is that three species (*brunnea, septentrionalis, dominicensis*) are closely related to each other; they have at times been variously regarded as subspecies of one species. Although *septentrionalis* and *dominicensis* are quite similar (DUELLMAN & CROMBIE, 1970: 92.3), they do differ in some details, and it seems appropriate to continue to consider them as distinct species. *H. brunnea*, on the other hand, has such a distinctive bromeliad-adapted tadpole that its specific status seems assured, despite adult resemblances to *septentrionalis* and *dominicensis*.

TRUEB (1970), in her excellent analysis and discussion of the casque-headed tree frogs, suggested that *septentrionalis, vasta, brunnea, crucialis*, and *dominicensis* comprise a natural group on the basis of cranial morphology. She suggested that the South American *Hyla boans* group might well be the progenitor of these Antillean hylids. Her phyletic sequence for the larger Antillean species is that *vasta* is the primitive West Indian stock from which *dominicensis* and *septentrionalis* have diverged on one hand, and *brunnea* and *crucialis* on the other. Her schema suggests that *brunnea* is not especially closely related to *septentrionalis-dominicensis* and that it (along with *crucialis*) represents a separate and derived line of hylid evolution on Jamaica. There is little to contradict her ideas of relationships and phylogeny; the fact that presumably primitive *vasta* is known to deposit eggs both in streams and in bromeliads lends biological and ethological support to the contention that *vasta* is primitive and gave rise to the Jamaican bromeliad-dwelling species on one hand and to the terrestrial breeders in Hispaniola and Cuba on the other.

As to the two smaller Jamaican species (*marianae, wilderi*), their relationships to the two large Jamaican species (*brunnea, crucialis*) or the two small Hispaniolan species (*heilprini, pulchrilineata*) are not at all clear. DUNN's (1926: 123–124) suggestion that *marianae* and *wilderi* may be "neotenic" in response to strong niche competition may seem far-fetched (as DUNN himself pointed out) but the suggestion has some merit. SHREVE & WILLIAMS (1963: 310) have summed up the situation very succinctly: "Thus, even if Dunn's hypothesis of separate radiations on the two islands is rejected, we dot not have, except for the *brunnea-septentrionalis-dominicensis* triad, any clear case of inter-island relationship. If we reject Dunn's hypothesis we may be compelled to postulate as many as seven independent incursions of *Hyla* into the Greater Antilles, only one of which reached more than one island. Remarkable as Dunn's suggestion is, and despite the convergence it implies in the case of *Hyla vasta* and *Hyla heilprini* with certain mainland stocks, it seems very definitely the simplest available hypothesis."

GOIN (1954) discussed at some length the relationships of those Jamaican *Eleutherodactylus* which he assigned to the *gossei* group. The included species are: *gossei* (as the basal member), with *pantoni*, *fuscus*, *junori*, and *andrewsi* as one line and *nubicola* and *alticola* as another. We have no doubt that these species form a natural Jamaican group, perhaps without close relatives elsewhere in the Antilles (however, see beyond); we do feel that, contrary to GOIN's interpretation, *junori* is a direct derivative of *gossei* (rather than an indirect *gossei* derivative via *pantoni*; see GOIN's fig. 2, p. 193), and that *andrewsi* and *junori* are not especially closely related despite some similarity of size and widely disjunct distributions, both geographically and altitudinally. The group is characterized by small to absent digital discs, smooth venter, absence of an external vocal sac, and vomerine teeth in long arched or bowed series (although *alticola* usually has the vomerine teeth in small patches). In color, there is a tendency for yellow to orange (*pantoni*, *fuscus*) on the venter, and red to orange in the groin or on the hindlimbs (*gossei*, *andrewsi*; *luteolus* uncommonly). Inguinal glands occur in *gossei*, *fuscus*, *junori*, and *luteolus*, and are absent in *pantoni*, *nubicola*, and *andrewsi*. In addition, *luteolus* has prominent supra-axillary glands. We include *luteolus* in the *gossei* group because of its similarities in morphology, calling sites, and voice; we suggest that it is a western derivative of a proto-*gossei* stock which has evolved in the western Jamaican mountains. All included species are vocal, the calls varying from a weak ascending "peep" in *luteolus* to the loud and ventriloqual whistled "wick-wick" of *fuscus*. Calling sites are predominantly terrestrial, with some individuals of most species at times calling from herbs, shrubs, or even the lower trunks or branches of trees.

Three species (*cundalli, cavernicola, grabhami*) we associate with the wide-spread Antillean *ricordi* group. Members have moderate to large digital discs, smooth to rugose bellies, long vomerine series, no external vocal sacs, and at times a rugose dorsum. Inguinal glands may be present or absent, and of the Jamaican members, they are present only in *grabhami*. Members of the group, which occurs on Cuba, Hispaniola, and Puerto Rico (including the Virgin Islands), have weak and insect-like voices and ill-organized calls; calling sites are regularly terrestrial and very rarely from above the ground.

There remain two native species whose affinities remain uncertain: *jamaicensis* and *orcutti*. SCHWARTZ (1969: 114) suggested that *jamaicensis* might be an aberrant member of the *auriculatus* group; the species agrees with other *auriculatus* group members in its arboreal habits and calling sites, its enlarged digital discs, and granular belly. But, on the other hand, males lack an external vocal sac (present in other *auriculatus* group members) and have long vomerine tooth rows (short and patch-like in almost all *auriculatus* group members). Our own experience with *E. jamaicensis* shows that it is not restricted to arboreal situations (although it is an obligate bromeliadicole). In having both supra-axillary and inguinal glands, *jamaicensis* resembles *luteolus* (of other Jamaican species), and it is possible, as we suggested earlier, that it is a very aberrant member of the *gossei* group, whose enlarged discs enable it to live in and about slick-leaved bromeliads. Its granular belly, however, is unique among Jamaican eleutherodactyls; even this feature might also be an adaptation for increased frictional contact with bromeliad leaves. It is possible that ventral granulation is correlated with arboreal activities, since the granular-bellied *auriculatus* group members are regularly non-terrestrial in habits and calling sites. If this is the case, then a relationship between *jamaicensis* and the *gossei* group seems more likely than presuming that the species is a relict *auriculatus* group species on Jamaica.

Eleutherodactylus orcutti has been discussed by SCHWARTZ (1967: 55–56) and considered as an aquatic species not closely related to other Antillean aquatic *Eleutherodactylus* but rather a local ecological derivative from some resident group. SCHWARTZ suggested that *orcutti* might be related either to Jamaican *ricordi* or *gossei* assemblages, but its short tooth row seems to eliminate it from these two groups. Its webbed feet (obviously an aquatic adaptation) likewise differentiate it from members of these assemblages. Vocally, it is very like *ricordi* group members; for example, its call is very like that of the Cuban *ricordi*-group *E. atkinsi* Dunn (GARRIDO & SCHWARTZ, 1968: 8), although these two species are of course morphologically very different. As far as calling sites are concerned, *orcutti* resembles members of both the *ricordi* and *gossei* groups, although we have the impression that it is more strictly terrestrial than most *gossei* group members. Everything considered, we suggest that *E. orcutti* should be assigned to the *gossei* group of *Eleutherodactylus*.

In summary, of the 13 native Jamaican *Eleutherodactylus*, we consider all but three as members of the *gossei* group, or at least peripheral members thereof (*jamaicensis, orcutti*). The remaining three species (*cundalli, cavernicola, grabhami*) on the other hand we consider as members of the *ricordi* group, an assemblage of frogs whose center is Cuban and Hispaniolan. Thus the native Jamaican eleutherodactylus seem to have had a double origin, with one group (*gossei*) evolving *in situ* from some unknown ancestor (but see beyond) and the other of Cuban (or Hispaniolan) origin.

As far as non-Jamaican affinities of the *gossei* group, it seems most closely related to *Eleutherodactylus dimidiatus* Cope in Cuba. The *dimidiatus* group is characterized by having feebly developed discs, smooth (or at times granular as in *E. jugans* Cochran) venters, long (or short in two species) vomerine tooth row, no external vocal sac, generally squatty habitus, and absent inguinal glands. There is evidence that the seven species now included in the *dimidiatus* group (*dimidiatus, emiliae* Dunn, *intermedius* Barbour & Shreve, *albipes* Barbour & Shreve, *jugans, ventrilineatus* Shreve, *parabates* Schwartz; see SCHWARTZ, 1964 for details) are themselves a polyphyletic assemblage, since *E. dimidiatus* is a very different frog than the remainder of the group. It is possible, therefore, that *dimidiatus* might more properly be considered a Cuban member of the *gossei* group, and that the other stocky and squatty members of the *dimidiatus* group be considered as members of still another and more compact group of Antillean eleutherodactyls, for which the name (for its first-named member) might appropriately be the *emiliae* group. If such action is taken, then the *emiliae* group is limited to the uplands of Hispaniola and Cuba, whereas the *gossei* group is diverse and widespread geographically in Jamaica and has one widespread (both geographically and altitudinally) species in Cuba.

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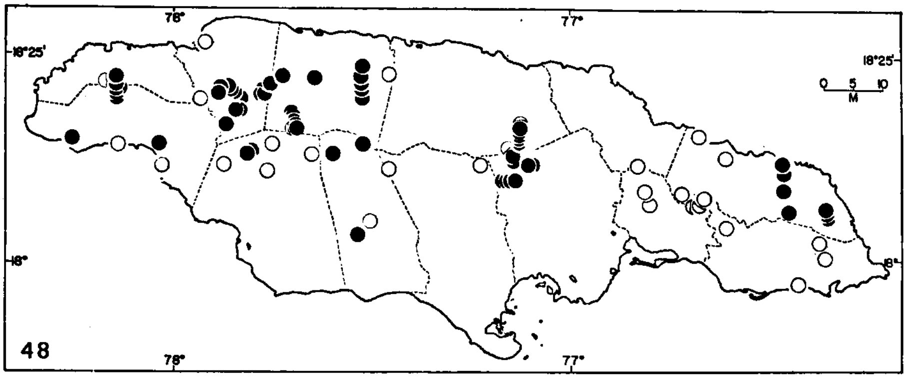
DISTRIBUTION MAPS

Our distribution maps attempt to present the known ranges of the various species and subspecies of Jamaican frogs. Solid symbols indicate specimens examined by the authors (primarily in the ASFS); open symbols represent literature records and voice records. Borrowed material is also shown by solid symbols.



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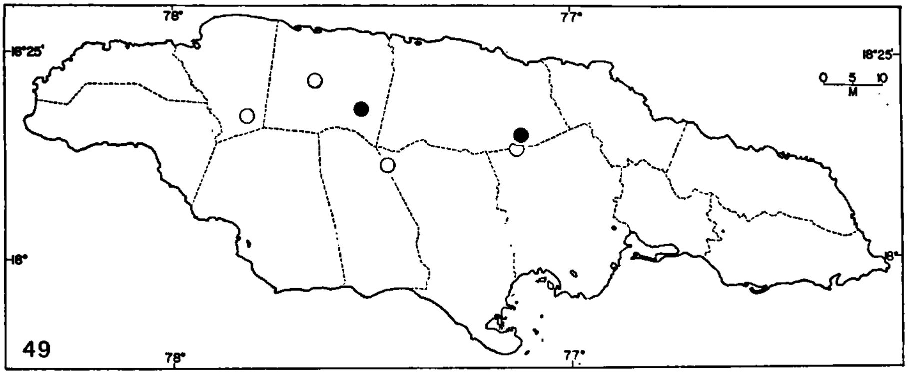

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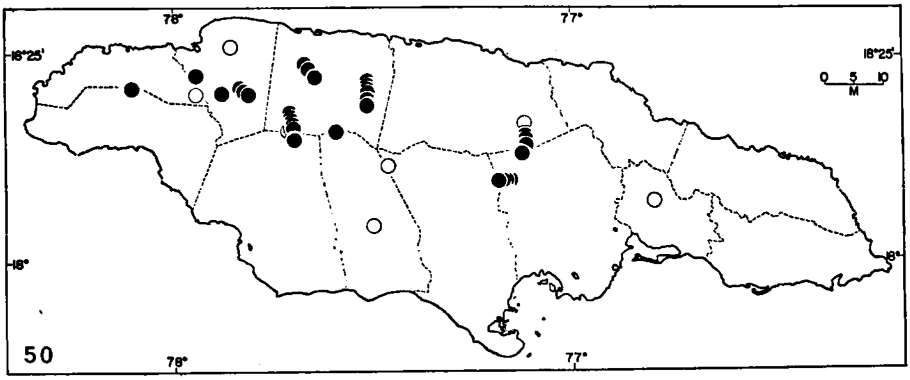

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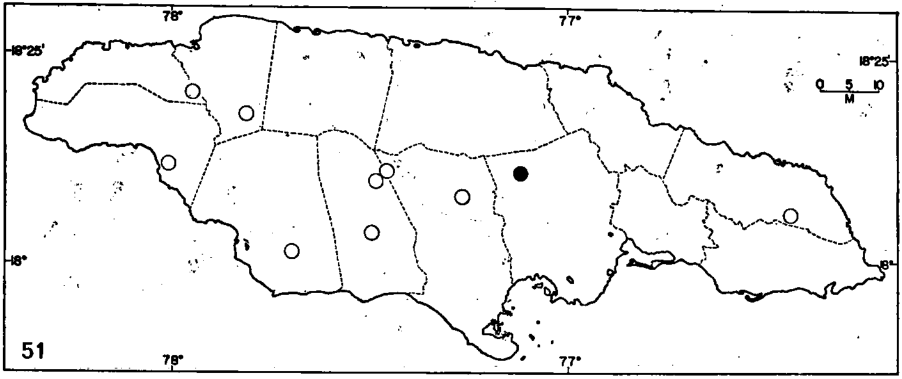
Fig. 48. Distribution of *Hyla brunnea*. — Fig. 49. Distribution of *Hyla marianae*. — Fig. 50. Distribution of *Hyla wilderi*.

51



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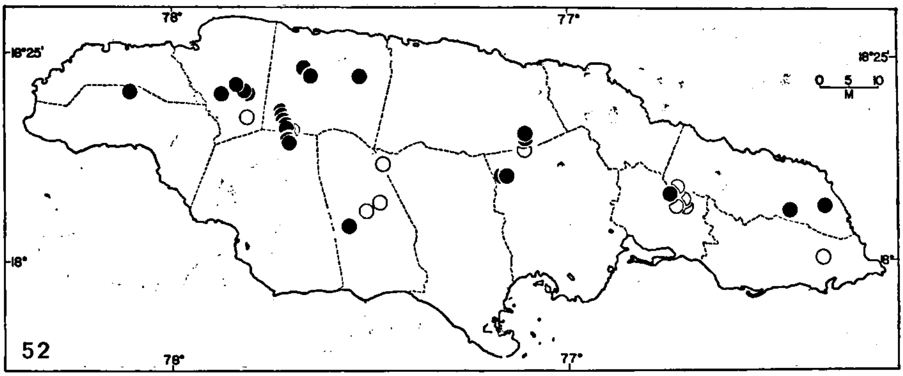

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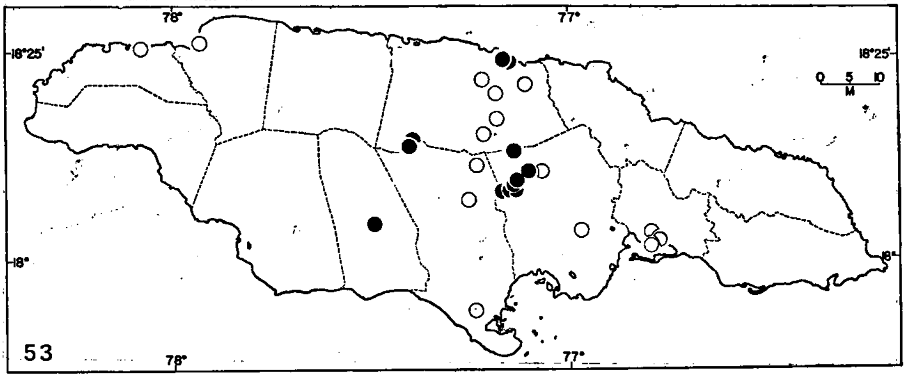
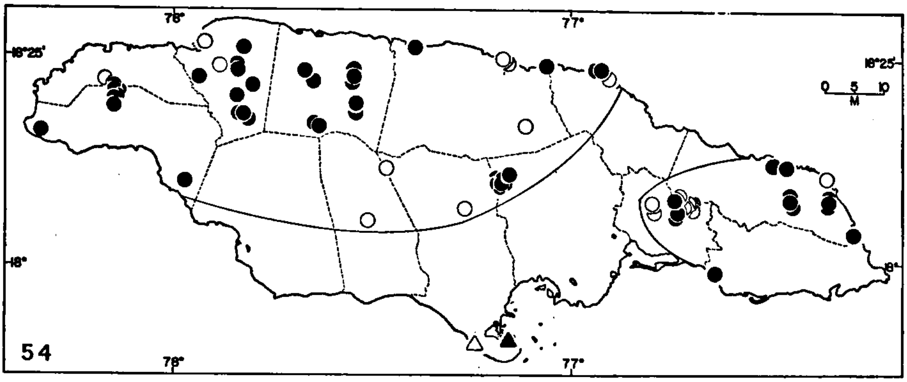
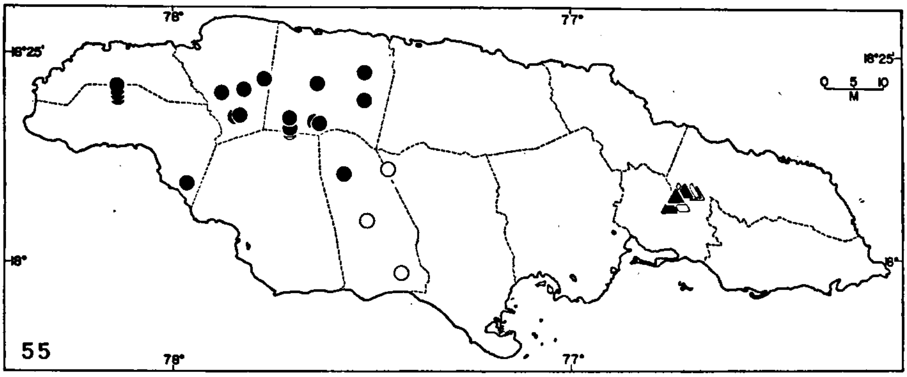


Fig. 51. Distribution of *Hyla crucialis.* — Fig. 52. Distribution of *Eleutherodactylus jamaicensis.* — Fig. 53. Distribution of *Eleutherodactylus johnstonei.*





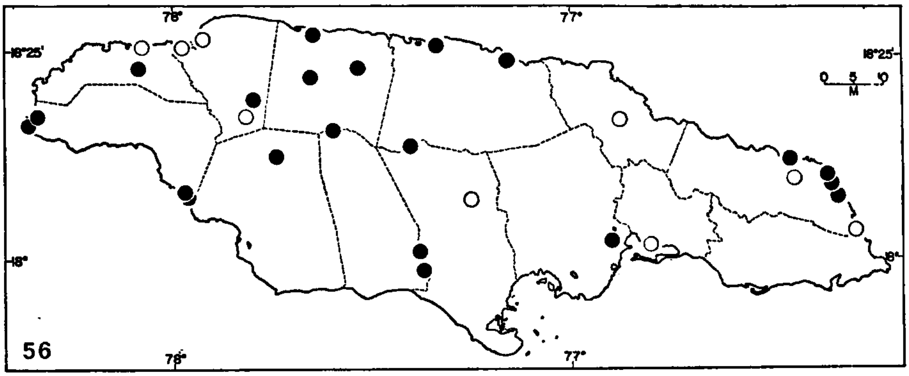
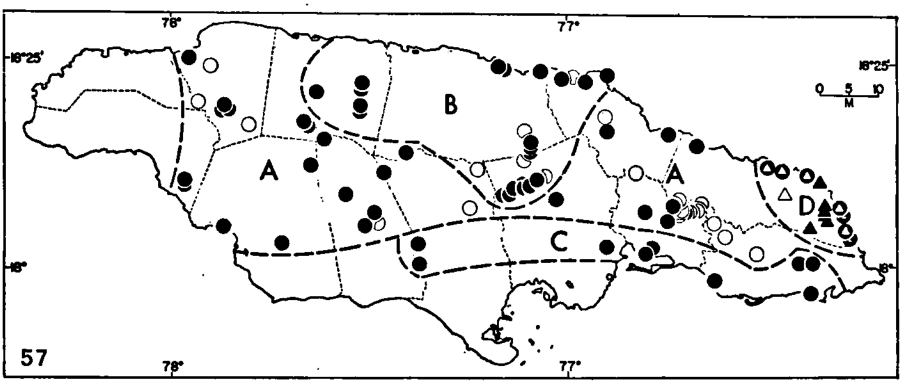


Fig. 54. Distribution of two species of *Eleutherodactylus*. Circles, *E. cundalli*; solid line in the west includes known range of *E. c. cundalli*; solid line in the east includes the known range of *E. c. glaucoreius*. Triangles, *E. cavernivola*. — Fig. 55. Distributions of *Eleutherodactylus grabhami* (circles) and *Eleutherodactylus andrewsi* (triangles). — Fig. 56. Distribution of *Eleutherodactylus planirostris*.



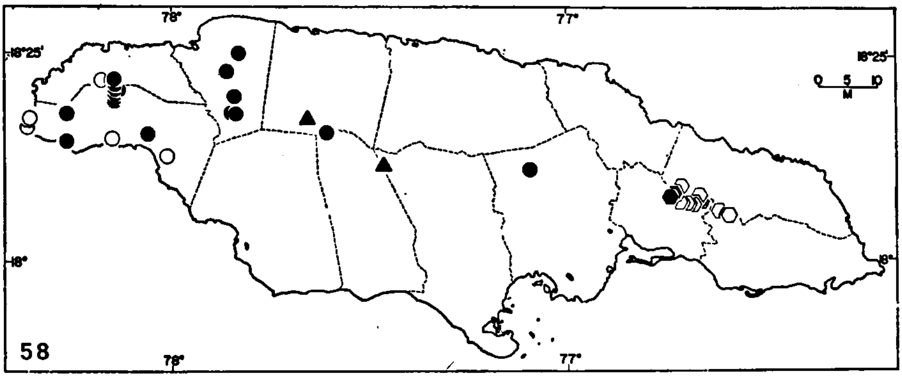
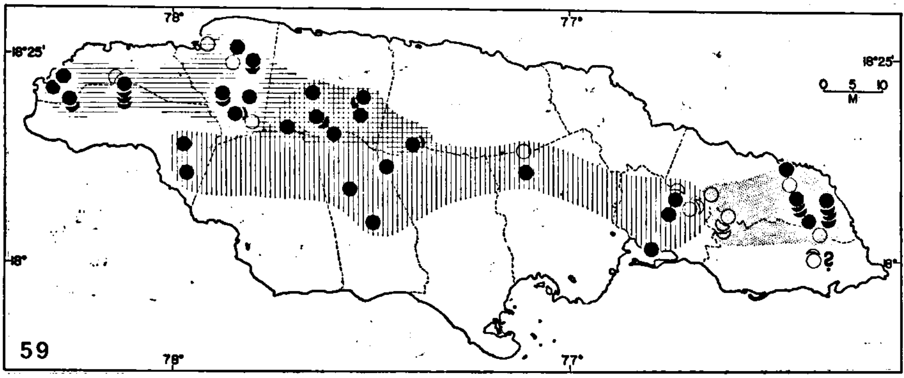


Fig. 57. Distribution of *Eleutherodactylus gossei*. Geographic limits of samples A, B, C, and D are outlined by dashed lines; A, B, and C are included in *E. g. gossei*; D is *E. g. oligaulax*. Triangles represent stations for *E. g. oligaulax*; circles, stations for *E. g. gossei*; triangles-within-circles are intergrades between *oligaulax* and *gossei*. — Fig. 58. Distributions of *Eleutherodactylus luteolus* (circles), *Eleutherodactylus junori* (triangles), and *Eleutherodactylus nubicola* (hexagons).



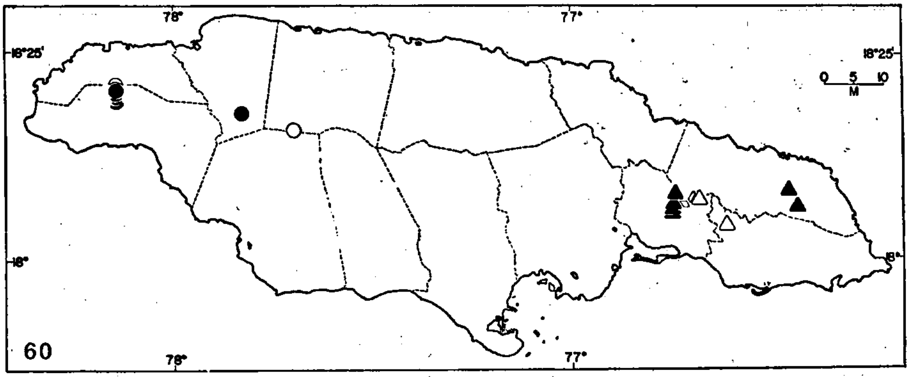


Fig. 59. Distribution of subspecies of *Eleutherodactylus pantoni*, as follows: *pantoni*, vertical lines; *amiantus*, horizontal lines; *pentasyringos*, stippling. Area of intergradation between *amiantus* and *pantoni* shown by overlap of vertical and horizontal lines. — Fig. 60. Distributions of *Eleutherodactylus fuscus* (circles) and *Eleutherodactylus orcutti* (triangles).