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DESCRIPTIONS OF TWO NEW SPECIES OF *PLEC-*
TROHYLA BROCCHI WITH COMMENTS ON
SEVERAL FORMS OF TADPOLES

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In a recent paper Hartweg¹ settled the generic status of *Plectrohyla* and defined two new species of that genus. While collecting in streams within the cloud forest or near the cloud-forest zone in the Alta Verapaz and El Quiché, Guatemala, in 1940, I encountered specimens of these distinctive frogs which are different from any of the known members of the genus. Recalling, with gratitude, the aid and hospitality of the Indians of those regions, I feel it is fitting that these two species should be dedicated to them. The first may be known as

Plectrohyla quecchi, new species

HOLOTYPE.—University of Michigan, Museum of Zoology (U.M.M.Z.) No. 89086. An adult male collected February 10, 1940, by L. C. Stuart.

TYPE LOCALITY.—Stream in Barranca Las Palmas about 2 km. north of Finca Los Alpes (43 km. east and slightly south of Cobán [straight line]), Alta Verapaz, Guatemala. Altitude, about 1015 meters.

¹ Norman Hartweg, "Notes on the Genus *Plectrohyla*, With Descriptions of New Species," *Occ. Papers Mus. Zool. Univ. Mich.*, 437 (1941): 1-10, Pl. I.

PARATYPES.—Although four specimens were collected with the holotype and several others elsewhere in the Alta Verapaz, for reasons to be brought out later, I do not designate these as paratypes.

DIAGNOSIS.—A *Plectrohyla* with fifty maxillary and premaxillary teeth, a simple rudimentary prepollex, tuberculate skin, and a vocal sac. Readily distinguished from *P. guatemalensis* Brocchi by its simple rudimentary prepollex, from *P. sagorum* Hartweg by greater number of maxillary and premaxillary teeth and tuberculate skin, and from *P. matudai* by its well-developed vocal sacs and enlarged forelegs.

DESCRIPTION OF HOLOTYPE.—Teeth prominent, fifty on maxilla and premaxilla; vomerines in two linear series of three each between choanae and converging slightly posterio-medially. Tongue large, subcircular, and slightly emarginate behind. Vocal sac openings large; vocal sac conspicuous. Quadratojugal absent.

Head short and broad with a conspicuous rostral keel. Canthus sharply defined. Loreal region concave. Upper jaw semicircular in outline. Tympanum indicated, but not definitely delimited. A heavy fold extending from posterior corner of eye, above tympanic region and curving downward toward axilla. Skin of upper surface of body, head, and limbs strongly tuberculate. Undersurfaces, except lower legs, granular, the belly especially so. A suggestion of a chest fold, and a well-developed supra-anal flap.

Forelegs extremely thick with heavy folds at elbow and wrist. Ventrolaterally a tubercular ridge extends from elbow to wrist. Fingers with remnants of webs and well-developed disks; comparative lengths, III-IV-II-I. A fleshy rudimentary prepollex harboring a spine at base of thumb. Well-developed tubercles at phalangeal joints. Palm tuberculate but with no conspicuously developed tubercles other than those at phalangeal joints. Pectoral girdle, arciferal.

Hind legs normally developed, slightly shorter than head-body length. Feet with webs well developed and extending from tip of last phalange on outside of each digit to penulti-

mate-antipenultimate joint on inner side of the adjacent digit except between digits IV and V, where the reverse is true. Tubercles on toe joints well developed. A large inner metatarsal tubercle. A conspicuous fold extends along the inner side of foot from heel to inner metatarsal tubercle. Terminal phalanges, claw-shaped.

In alcohol the upper surfaces are drab olive-gray heavily mottled with dark brownish gray. The sides are light brownish gray, irregularly spotted with darker shades of the same color and with a few scattered light brown specks. The undersurfaces are grayish white with no markings.

In my field notes I have noted that in life the upper surfaces were olive-brown punctated with black and dark brown. The chest was grayish, and the belly and undersurfaces of the thighs were orange-yellow.

Head-body length, 42 mm.; leg to heel, 41 mm.; head width, 15 mm.; foot, 33 mm.

VARIATION.—Collected with the holotype are four other specimens and an additional two specimens were secured at Finca Chichén (11 km. south and slightly east of Cobán). I do not designate these as paratypes because, as will be shown later, two types of tadpoles were secured in the streams inhabited by these frogs. It is, therefore, wholly possible that, when more material is made available, the series of seven adults may represent two species. Nevertheless all seven specimens are provisionally allocated to the above species.

Variation in the series is slight. The maxillary and premaxillary teeth range from 48 to 53. The color varies from the mottled pattern of the holotype to an almost uniform olive-gray dorsum in one specimen. Although there is considerable variability in the roughness of the skin, the head of even the smoothest is conspicuously tuberculate. The two specimens from Finca Chichén have slightly shorter hind legs than those from Finca Los Alpes. The series is represented by adult males only, from 40 to 44 mm. in head-body length. The following are the specimens at hand in addition to the holotype: U.M.M.Z. Nos. 89087-89, Finca Los Alpes; U.M.M.Z. Nos.

89090-91, Finca Chichén; No. 5870 (skeleton), Finca Los Alpes.

HABITS.—At Finca Los Alpes, these frogs were found at 1015 meters among the rocks in a small mountain brook whose source was in the cloud forest about five hundred meters higher. The bed indicated that this stream, though low in the dry season, reaches considerable proportions during the wet season. The specimens were found between boulders and pebbles in the water and were most difficult to discover because of their color. At night they emit a harsh quack, repeated at rather long intervals. While I was collecting in this streambed one day, a heavy mist gathered over the mountains and immediately the *Plectrohyla* began to call. At Finca Chichén I found them in the same sort of habitat, but in the dense cloud forest at about sixteen hundred meters. They were calling during the day.

RANGE.—Should this series eventually prove to represent the same species, the range may be defined as throughout the Alta Verapaz in mountain brooks at the higher altitudes. On the basis of tadpoles, the range may possibly be extended to similar habitats in the Sierra de los Cuchumatanes of El Quiché.

Plectrohyla ixil, new species

HOLOTYPE.—U.M.M.Z. No. 89092. An adult male collected July 31, 1940, by L. C. Stuart.

TYPE LOCALITY.—Small stream in a cafetal at Finca San Francisco (about 25 km. northeast of Nebaj), El Quiché, Guatemala. Altitude about 1175 meters.

PARATYPES.—U. M. M. Z. Nos. 89093-94, collected at the type locality.

DIAGNOSIS.—A *Plectrohyla* with fifty-five maxillary and premaxillary teeth, a simple prepollex, smooth skin, and a vocal sac which is only slightly developed. Differing from *P. guatemalensis* in its simple, rudimentary prepollex, from *P. matudai* and *P. quecchi* through its smooth dorsal skin, and from *P. sagorum* in possessing more maxillary and premaxillary teeth and a poorly developed vocal sac.

DESCRIPTION OF HOLOTYPE.—Teeth prominent, fifty-five on maxilla and premaxilla; vomerines in two linear series of three each between choanae. Tongue large, slightly emarginate posteriorly. Vocal sac openings large; vocal sac scarcely evident. Quadratojugal absent.

Head short and broad. Snout pointed, but no rostral keel. Canthus sharp. Loreal region slightly concave. Upper jaw semicircular in outline. Tympanum indicated. A slight fold extends from posterior corner of eye posteriorly over tympanic region, continuing as a groove toward axilla. Skin of upper surfaces smooth, except for a few tubercles on upper eyelids and in tympanic region. Throat, chest, belly, and ventral surface of thighs strongly granular. A fold across chest from axilla to axilla. Supra-anal flap conspicuous.

Forelegs strongly developed with folds at elbow and wrist. A ventro-lateral ridge of tubercles extending from elbow to wrist. Fingers with remnants of webs and large disks; comparative lengths, III-IV-II-I. A fleshy rudimentary prepollex with a spine at base of thumb. Palm tuberculate, interphalangeal tubercles well developed. Pectoral girdle, arciferal.

Hind legs normally developed, about as long as the head and body. The feet resemble those of *P. quecchi* in all particulars.

The entire upper surfaces are brownish gray, darkest anteriorly and mid-dorsally. Grayish white beneath. In life the specimen was gray-green above with no markings. A dark streak extended from the snout along the canthus to the eye and from the eye to the tympanic region. The underparts were dirty white except the legs, which were light yellow.

Head-body length, 40 mm.; leg to heel, 39 mm.; head width, 15 mm.; foot, 31 mm.

VARIATION.—The two paratypes deviate little from the above description. The maxillary and premaxillary teeth vary from 52 to 58, and the head-body length only from 39 to 40 mm. In characters of morphology and pattern the three specimens are almost identical. The point of greatest divergence in the species appears to be between the juvenile and adult pattern.

This point will be taken up in detail under the discussion of the tadpoles.

RANGE.—Known only from the type locality, but possibly occurring in cloud-forest streams throughout the eastern Sierra de los Cuchumatanes.

HABITS.—In habitat and general behavior this species appears to be identical with *P. quecchi*.

RELATIONSHIPS.—The recent discoveries of *Plectrohyla* from isolated localities render allocation of the various species most difficult. Though at present it is too early to formulate genetic relationships, some few comments may be made.

The following species are now known :

<i>guatemalensis</i> Brocchi	<i>sagorum</i> Hartweg
<i>crassa</i> (Brocchi)	<i>quecchi</i> Stuart
<i>matudai</i> Hartweg	<i>ixil</i> Stuart

There is considerable probability that Taylor's *Hyla robusto-femora* may be synonymous with *P. crassa*.

Hartweg² has already drawn up a table of comparisons of the several morphological features utilized to separate the first four species, and the above descriptions include the characters utilized by him. Any attempt to arrange the species into an orderly series with respect to these characters results in numerous combinations. For example, the skin is tuberculate in *guatemalensis*, *matudai*, and *quecchi* and smooth in *sagorum* and *ixil* (unknown in *crassa*). The vocal sac is absent in both *guatemalensis* and *matudai*, but present in *quecchi* and *sagorum* and intermediate in *ixil*. As other characters are charted it will be found that the species are arranged into different groups with each character.

As to the species described herein, both differ from others known in the tremendous development of the forelegs, which does not appear to be correlated with breeding, since my specimens were collected at various times between February and August. Were it not for this feature and the presence of a smooth dorsum, I would place *ixil* close to *matudai*. Similarly,

² *Ibid.*, Table I.

quecchi appears most like *sagorum*, except that the former is tuberculate and the latter smooth.

There is considerable possibility that the tadpoles will offer clues to relationships. Hartweg and Orton³ have described two tadpoles taken with the adults of *P. sagorum* and *P. matudai* on Mount Ovando in Chiapas. In the Sierra de los Cuchumatanes and in the Alta Verapaz I secured three types of tadpoles. Unfortunately, none of these tadpoles can be definitely allocated, but, as I shall show later, these tadpoles fall into two major and three minor groups, and once they are allocated, they may aid in the arrangement of the adults. The problem of genetic relations is further complicated by the occurrence of both *P. sagorum* and *P. matudai* in the same habitat,⁴ thus suggesting several species groups. In the Alta Verapaz I discovered two types of *Plectrohyla* tadpoles in the same stream, a condition further strengthening the above suggestion.

Until further specimens are forthcoming, therefore, any attempt to allocate the known species genetically would be, at best, highly theoretical. For this reason I feel unable to offer any suggestions as to the relationships of either *quecchi* or *ixil*.

With the above species, as well as at localities where no adults were secured, three types of tadpoles were collected. Inasmuch as two types were taken with the adults of *P. quecchi*, it is at present impossible to allocate the tadpoles. In order that they may not be confused with forms *a* and *b* described by Hartweg and Orton,⁵ they may be designated forms *x*, *y*, and *z*. At Finca Los Alpes only form *z* was secured with *P. quecchi*. This might suggest that form *z* is the tadpole of that species, but that same tadpole was the only tadpole taken with *P. ixil*. Furthermore, at Finca Chichén two tadpoles, forms *x* and *z*, were secured with the adults assigned to *P. quecchi*. With such contradictory evidence, allocation of the various forms must await further field investigations.

³ Norman Hartweg and Grace Orton, "Notes on Tadpoles of the Genus *Plectrohyla*," *Occ. Papers Mus. Zool. Univ. Mich.*, 438 (1941): 1-6, 2 figs.

⁴ Hartweg, *op. cit.*, p. 5.

⁵ *Op. cit.*

The series at hand does not alter in any way Hartweg's and Orton's definition of the tadpoles of the genus. Inasmuch as all forms are remarkably similar in body proportions and gross features and are not unlike those described by Hartweg and Orton, the gross features will be described but once; the mouthparts alone of the various forms will be individually described. These mouthparts carry the diagnostic features of the various forms.

DESCRIPTION.—Body somewhat chunky and slightly depressed. Tail slightly less than to slightly more than twice as long as body, about one-third as deep as long; its greatest depth at about its mid-point. Fins not extending on the body and very slightly longer than the tail musculature. Eyes moderate, directed slightly upward; the interorbital distance slightly less than the anterior, dorsal musculature of the body. Snout rounded, the nostrils set well forward; the internasal distance variable with age. Mouth well developed, directed downward, and almost terminal. Belly wall thin, with no muscular modifications. Spiracle sinistral, about half way posterior on body. Anus dextral, on a fold of flesh extending from the body to the ventral part of the fin anteriorly. Lateral line systems distinct and complex, especially on snout.

Color in formalin variable. Body varying from light to dark brown; very dark in form *x*. Dorsal body musculature somewhat lighter. Where the body musculature is sufficiently light, the body may be mottled or spotted with darker shades, especially in form *z*. Tail musculature light brown, both musculature and fin spotted, mottled, or peppered with darker shades (Fig. 1).

MOUTHPARTS OF FORM *x*.—Mouth⁶ wider than interorbital width. Lips⁷ moderately wide, completely fringed by a double row of papillae. A row of papillae between the edge of the lips and the outer tooth rows;⁸ an irregular patch of

⁶ The term "mouth" includes both beak and lips.

⁷ "Lips" include all the mouth tissues surrounding the beaks.

⁸ The tooth rows are classified as "anterior" and "posterior" with relation to the beak. The anterior rows are designated "outer," toward the lip edge, and "inner," toward the beak. The posterior rows are similarly designated "outer," "inner," and "median."

papillae on the lips lateral to the beak. Tooth rows, 2/3, the anterior two equal in length and longer than the posterior three, which are also equal; both series extend laterally beyond the beak. Inner anterior row slightly interrupted medially; the posterior rows complete. Beaks well developed, the anterior strongly arched and about one-third the width of the mouth; borders of both with numerous short, peglike serrations (Fig. 2).

SPECIMENS EXAMINED.—U.M.M.Z. No. 90219 (13), Finca Chichén, Alta Verapaz; U.M.M.Z. No. 90220 (2), Nebaj, El Quiché.

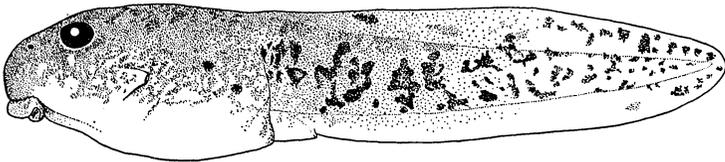


FIG. 1. Lateral view of tadpole form *x*.

MEASUREMENTS (IN MM.) OF TYPICAL SPECIMENS OF THE
THREE TADPOLE FORMS

Form	Number	Body Length	Tail Length	Tail Height	Inter-orbital	Mouth Width
<i>x</i>	90219	16.5	31	10	4.6	5.3
<i>x</i>	90219	16.5	33.3	9.7	3.8	5.5
<i>y</i>	90222	15.8	26.7	8.3	3.7	5.2
<i>y</i>	90222	15.9	24	8.7	3.0	5.1
<i>z</i>	90223	14.7	26	7.5	3.0	3.4
<i>z</i>	90225	14.8	31.3	9.5	3.5	4.5

MOUTHPARTS OF FORM *y*.—Mouth wider than interorbital width. Lips moderately wide, completely fringed by a single row of papillae. A row of papillae between the outer anterior tooth row and the anterior edge of the lip and two to three very irregular rows of papillae between the outer posterior tooth row and the posterior edge of the lip. Several papillae scattered irregularly, lateral to the beak. Tooth rows, 2/3, the anterior two equal in length and longer than the posterior three. The posterior tooth rows unequal, the median

being the longest, the outer the shortest, the latter being equal in length to the beak. Both inner tooth rows broken medially. Beaks well developed, the anterior arched and about one-third the width of the mouth. The anterior beak armed with pointed serrations which are short medially, increase in size laterally, and again become shorter, thus producing a sine-curve outline. The posterior beak with shorter, yet well-developed serrations (Fig. 3).

SPECIMENS EXAMINED.—U.M.M.Z. No. 90222 (3), Finca Tesoro, El Quiché (about 20 km. SE. of Finca San Francisco); U.M.M.Z. No. 90221, Finca San Francisco, El Quiché.

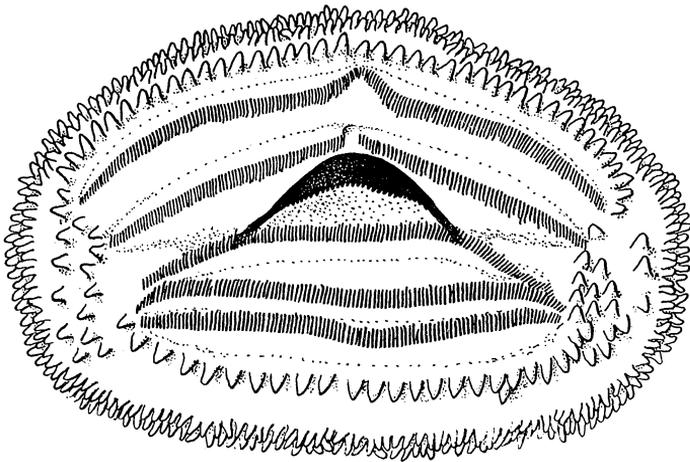


FIG. 2. Mouthparts of tadpole form *x*.

MOUTHPARTS OF FORM *z*.—Mouth wider than interorbital width. Lips moderately wide, completely fringed by a single row of papillae. A row of papillae between the edges of the lips and the outer tooth rows, and on the posterior lip often an irregular secondary papillary row. One or two papillae on the lips lateral to the beak. Tooth rows, 2/3, the anterior equal in length and longer than the posterior three. Inner and median posterior rows equal and longer than outer one. Both anterior and posterior rows extending laterally beyond the beak. Inner anterior row always and inner posterior

row occasionally interrupted medially; others complete. Beaks well developed, about one-third the width of the mouth, both edged with sharp serrations. Those of the anterior beak largest medially on either side and decreasing in length laterally toward the outer edge and toward the middle of the beak but not extremely developed as in form *b* (Fig. 4).

SPECIMENS EXAMINED.—U.M.M.Z. No. 90224 (4), Finca Los Alpes, Alta Verapaz; U.M.M.Z. No. 90223 (3), Finca Chichén, Alta Verapaz; U.M.M.Z. No. 90225 (3), Finca San Francisco, El Quiché.

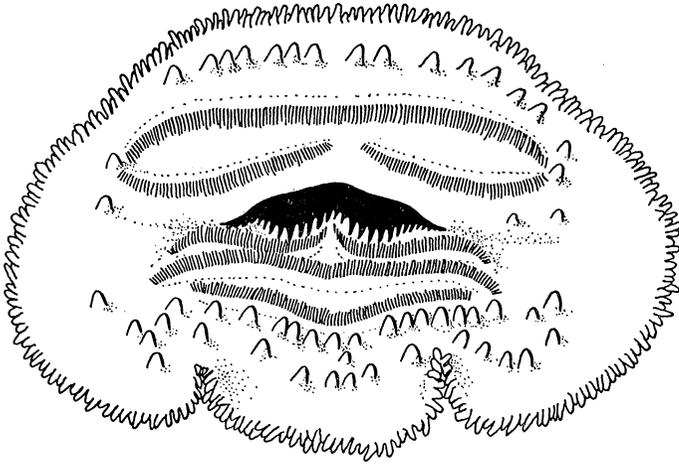


FIG. 3. Mouthparts of tadpole form *y*.

AGE VARIATIONS.—By combining my entire series of tadpoles of the three forms, it is possible to note certain developmental changes. The hind legs first appear as buds when the tadpole attains a body length of slightly less than 15 mm., and these legs are well formed in individuals with body lengths of slightly more than 16 mm. The forelegs are first evident beneath the skin at about 16 mm. and are about ready to break through when the tadpoles exceed 17 mm. in body length. The prepollex is evident even when the forelegs are but poorly formed.

As to proportions of various other structures, I find little

variation in my entire series. The sides of the head begin to differentiate in individuals in which the forelegs are formed and, as a result of the sides assuming a vertical position, the internasal distance decreases. Thus, in two individuals with body lengths of 18.7 mm. and 17.3 mm. the internasal distances are 2.6 mm. and 3.7 mm. respectively, while in two others with body lengths of 16.5 and 16.8 mm. the internasal distances measure 5.0 mm. and 4.8 mm. I have no individuals in the developmental stage between those in which the forelegs are about to break through and almost fully-formed juvenile frogs, so that I am unable to trace the disappearance of the tail. Another feature of development occurs in the number of papillae on the lips. As the tadpole increases in size there is a definite tendency toward the development of accessory

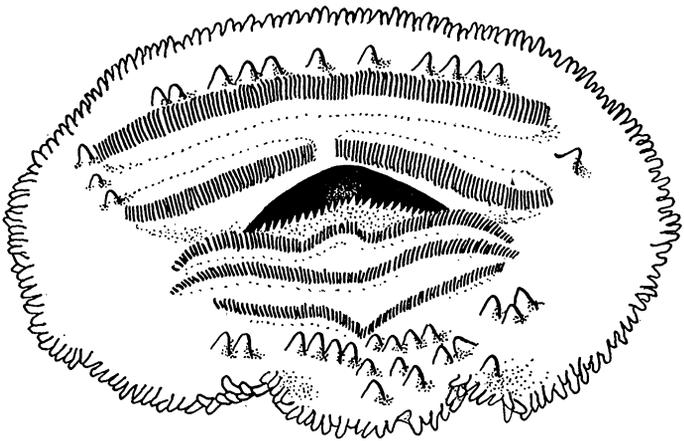


FIG. 4. Mouthparts of tadpole form *z*.

papillae, in addition to the papillary rows between the edge of the lips and the outer tooth rows.

If one judges from the size and development of tadpoles, the breeding season appears to be extensive and possibly reaches its maximum toward the end of the wet season. The following table gives the date of collections of tadpoles of forms *x* and *z*, and the range in size and development. These collections are from different localities having remarkably similar climatic conditions.

At Finca San Francisco on July 31 and August 2 I collected two juvenile specimens of *P. ixil* which retained tail stubs measuring 10 mm. The specimens had body lengths of slightly over 15.5 mm. and were fully formed in all respects. The short body length is the result of a shortening of the snout. The most notable feature of these juveniles was their remarkable color. The upper surfaces of the body and legs were bright green. Laterally, a dark stripe extended from the tip of the snout through the eye and gradually faded posteriorly on the sides. This stripe was bordered above by a narrow white stripe. The fore and hind legs were lemon yellow ventrally; the other underparts, white. The tail stub was mottled with green and gray above.

Form	Date	Size (in mm.)	Development
<i>z</i>	2/10/40	9.7-15.0	No trace of leg buds
<i>z</i>	5/16/40	14.7-15.0	Hind legs slightly formed
<i>z</i>	7/31/40	13.0-16.4	No leg buds to slightly formed
<i>x</i>	5/16/40	13.9-18.2	No leg buds to well-formed forelegs
<i>x</i>	7/10/40	17.4-17.5	Leg buds to well-formed forelegs

COMMENTS.—Although the tadpoles of five species of *Plectrohyla* are now known, none can be definitely allocated. They are, nevertheless, of importance primarily because they indicate that our knowledge of the distribution of the genus is very incomplete. Thus, although I collected two species of tadpoles in the Alta Verapaz and three in the Sierra de los Cuchumatanes, I found but a single adult species in each locality.

Furthermore, though I cannot actually name the tadpoles, they offer clues as to the faunal relationships of various biotic areas. Form *b* of Hartweg and Orton is very similar to, and possibly the same as, form *z* defined above as well as to specimens (Field Mus. Nat. Hist. No. 20328) from Volcán Tajumulco, Guatemala, mentioned by Hartweg and Orton.⁹

⁹ *Op. cit.*, p. 6.

