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## The Eggs and Hatchlings of the Mexican Leptodactylid Frog *Eleutherodactylus decoratus* Taylor

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The extent of the diversification in Mexico of the frogs of the family Leptodactylidae remains to be ascertained. It has long been apparent, however, that leptodactylids occupy an impressive array of environments in the lowlands, foothills, and mountains of the country. Lynch (1967) believed that more than 40 species are represented. No leptodactylids have been reported from Baja California, and the family is unrepresented in the arid deserts of northwestern Sonora. Nevertheless, most other portions of Mexico afford habitats suitable for leptodactylids, and the distributions of three or four species extend into the United States.

The breeding habits of the species that range into the United States are moderately well known. Mulaik (1937) described the frothy nests and tadpoles of *Leptodactylus labialis* in Texas. The other species known from Texas deposit their eggs on land. Livezey and Wright (1947) discovered the eggs of *Eleutherodactylus augusti* (recently placed in the genus *Hylactophryne* by Lynch, 1968) in clutches of from six to 25 deposited in moist or rain-filled crevices. A few years later Jameson (1950) reported that he had discovered eggs of the species under a large rock, where a clutch of 67 eggs occupied a cavity approximately 10 cm. in depth. Whereas the soil around the rock was dry, the eggs were mixed with wet earth. Jameson suggested that a male found near the eggs had been

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keeping them moist by expelling the contents of its bladder on them. A few years later Jameson (1955) managed to observe the mating behavior of *Syrrhophus marnocki* in the laboratory, although he never succeeded in finding the eggs of the species under natural conditions. His observations in the laboratory indicate that the eggs of this species are deposited in a trench and covered with moist soil. The female digs the trench with her forelegs shortly after being clasped by the male, and from eight to 20 eggs are deposited as the paired frogs move along the trench, using their hind legs to cover the eggs with moist earth.

The frogs of the genus *Syrrhophus* appear to be more specialized as inhabitants of crevices than the small Mexican leptodactylids placed in the genus *Tomodactylus*. Although *T. nitidus* is one of the most abundant and widely distributed leptodactylids in Mexico, the eggs of the species are not easily found. The only clutch reported was described by Martín del Campo (1940), who found the eggs in a cavity in the soil beneath a pile of small rocks on June 30. The eggs, more or less covered with dirt, had apparently been deposited shortly before they were discovered, as indicated by the presence of a male and a female at the site. Presumably the eggs are abandoned shortly after they are laid.

In the lowlands of Mexico, a few leptodactylids, including *Leptodactylus labialis* as well as *Engystomops pustulosus*, are known to assemble in breeding aggregations. The calls emanating from their breeding sites make it relatively easy to find their eggs. It is uncertain whether many of the species inhabiting the mountains issue mating calls, but presumably most of them breed as isolated pairs. Vocalizations probably play a significant role in the mating behavior of *Tomodactylus nitidus*. The calls of this species, commonly heard throughout the rainy season, are almost certainly territorial calls, as suggested some years ago (Bogert, 1960). Perhaps because the breeding activities of leptodactylids in montane habitats are restricted to brief intervals, no calls other than those of *Tomodactylus nitidus* have been heard in many areas known to be inhabited by larger species.

Hence the breeding habits of most of the leptodactylids in montane habitats in Mexico have remained obscure. Small concentrations of juvenile leptodactylids, probably hatchlings from a single clutch of eggs, were occasionally encountered while field investigations were in progress in the mountains of Oaxaca, but adults usually occurred as isolated individuals. Although work was initiated in the area in 1961 and continued during the subsequent summers, no eggs of leptodactylids were discovered until the summer of 1967. Because so little is known about the breeding habits of the species in Mexico, it seems worth while to

summarize the information obtained for one of the leptodactylids encountered in Oaxaca.

### MATERIAL EXAMINED

SOURCE: The adult frogs and the three clutches of eggs on which this account is based were found on August 27, 1967, at an elevation of approximately 1900 meters, at the north end of the Sierra de Juárez, near the boundary between the Distrito de Ixtlán and the Distrito de Tuxtepec. The area is on the headwaters of a tributary of the Río Papaloápan, the Río Valle Nacional. There are few human habitations in this portion of the mountains, which is traversed by a road that reaches an elevation of nearly 3000 meters at the summit to the east of Cerro Pelón, and descends to a few meters above sea level at Tuxtepec. The frogs were found approximately 23 kilometers northeast of Cerro Pelón.

Rainfall records for this portion of the Sierra are incomplete, but the nearest weather stations, which are situated at somewhat lower elevations, suggest that the mean annual precipitation in the area where the frogs were found is between 3000 and 4000 mm. The terrain is almost constantly wet during the summer, which is the season of maximum precipitation. A weather station at Campamento Vista Hermosa recorded 607 mm. of rain in July and 641 mm. in August in 1959. This station is situated a few miles to the east and approximately 600 meters below the sites where the frogs were found. Such records provide a rough index to the precipitation in the area, which evidently receives more rain than other portions of the Sierra de Juárez. The vegetation nearer the crest of these mountains consists mostly of pine-oak woodland, but pines and oaks are largely replaced by tropical elements where the frogs were found. Such temperate montane trees as *Liquidambar*, *Alnus*, and *Acer* are present, but there are also tree ferns, *Cyathea*, and a dense undergrowth of shrubs, vines, and epiphytes. Such characteristics warrant using the term cloud forest to designate the area.

IDENTITY: The adult frogs found with the eggs described below conform closely to *Eleutherodactylus decoratus* Taylor. Lynch (1967), who recognizes two subspecies, mapped the distribution of the nominate subspecies as extending along "the eastern slopes of the Cordillera Volcanica in Veracruz and Hidalgo to San Luis Potosí." The specimens taken east of Cerro Pelón, however, show that the range of the species extends appreciably farther southward, well inside the state of Oaxaca.

### OVIPOSITION SITES

Owing to the steep slopes and the dense vegetation in the cloud forest

in northeastern Oaxaca, much of the terrain, other than that along the road or the few trails in the forest, is difficult to reach. Narrow strips of land that have been cleared below the power cables traversing the mountains afford access to some canyons and ridges, and the terrain has been leveled and cleared in a few places where temporary camps were established while the roads and the towers supporting the cables were being constructed. Aside from these few clearings, there are narrow strips of more or less level terrain along the road where rocks and logs can be turned over. In these roadside clearings, bushes and smaller plants have become established between the rocks and logs. The surface is wet during the summer, when water is constantly draining from the steep slopes above the road, and rains occur almost daily. At this time of year clouds are nearly always encountered in the area, at least for part of every day.

Efforts were made to find amphibians and reptiles in areas between the elevations of approximately 1800 and 2800 meters, but the few specimens of *Eleutherodactylus decoratus* encountered were all taken a short distance above or below the 1900-meter contour. Another leptodactylid tentatively identified as *Eleutherodactylus mexicanus* was more abundant and more widely distributed in the area than *E. decoratus*. Only one other anuran, *Hyla chaneque*, was taken in the zone occupied by *E. decoratus*. Logs as well as rocks were strewn on the surface in the clearings, but the only clutches discovered were beneath moderately large, flat rocks, roughly 10 to 15 cm. in thickness, and less than half a square meter in area.

#### SIZE OF CLUTCHES, EGGS, AND HATCHLINGS

Because the clutches differ in size and in other details, each is described separately, as follows:

1. A female with a snout-vent length of 44 mm. was resting on top of the first clutch of eggs. This consisted of 32 eggs that were stuck together in a more or less spherical clump, on which the frog was resting on its belly, with its limbs dangling at the sides. The female was in this relaxed posture when the rock was overturned, and it remained in place on top of the eggs until it was seized a few minutes later after a container had been prepared to receive it, along with the eggs. The time was approximately 3:25 P.M., when clouds had formed and a light rain was falling. For this reason no attempt was made to photograph the frog at the site, although it was hoped that a picture could be obtained the next day. When the lid was removed from the container the following morning, all but two of the eggs had hatched.

Most of the hatchlings were active, and sufficiently agile to leap out

of the container. The hatchlings were preserved in formalin, along with the two eggs, one of which was 4.5 mm. in diameter, the other 5.0 mm. Each contained well-developed young. The hatchlings, each of which retained a moderate quantity of yolk material in the body cavity, varied in snout-vent length from 6.6 to 8.0 mm. The venter on some of the specimens is more heavily pigmented than on others, but dark bars on the limbs are readily discernible. All the hatchlings resemble the female in having a narrow, light, middorsal stripe, which is absent from two other adults from the area. Minor variations can be noted in the shape of the black egg tooth of the hatchlings, but the tooth (fig. 1) closely

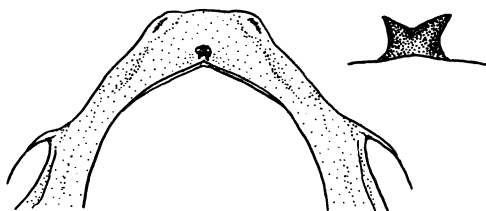


FIG. 1. The egg tooth of *Eleutherodactylus decoratus*, as viewed from the under side of the hatchling, and anterior view of tooth greatly enlarged. Drawn from hatchling found with A.M.N.H. No. 78854.

resembles that depicted by Noble (1931) for *Eleutherodactylus abbotti* in being bifurcated at the tip. The paired points are directed more nearly forward, however, rather than laterally, as shown in Noble's illustration.

The rock sheltering the eggs and the female was probably exposed to sunlight earlier in the day, which was unusually clear in the morning. Consequently, the rock and the substratum beneath it may have been somewhat warmer than they normally would have been on days when clouds formed over the area in the morning. When the eggs were discovered, however, the temperature of the substratum on which they were resting was between 17° and 18° C. There was sufficient space between the soil and the under surface of the rock to permit the frog to rest on the eggs, which had been deposited on a more or less level substratum rather than in a cavity.

2. The second clutch of eggs was discovered under a rock situated scarcely 50 meters distant from the first. In this instance the female (A.M.N.H. No. 78852) was under one end of the rock, perhaps 30 cm. from the eggs, which had been deposited under the other end. The clutch, which consisted of 22 eggs in a compact mass, was resting on wet soil roughly 20 cm. from the edge of the rock. These eggs were smaller than the others, and the exposed surfaces were opaque and green in color, as though algae might be growing on them. They were well formed and in good condition otherwise, but it seems probable that

they were infertile. Perhaps the female had abandoned them, or it is possible, but unlikely, that the eggs had been deposited by some other female. Following preservation, the eggs varied in diameter from 3.9 to 5.0 mm., with a mean of 4.5 mm.

3. No female was present under the rock where the third clutch of eggs (A.M.N.H. No. 78853) was discovered. This clutch consisted of 20 eggs, but only 12 had developed. The eggs were photographed (fig. 2), along with the female that was resting on the first clutch of eggs discovered. As may be noted in the illustration, the eggs at the upper surface of the clutch contain nearly fully developed frogs. One removed from the egg closely resembles the hatchlings of the first clutch. The eight eggs that contained yolk but no embryos were at the bottom of the mass. These are nearly the same size as those in the second clutch, whereas the greatest diameter of the eggs containing well-developed frogs ranges from 4.9 to 6.9 mm., with a mean of 5.6 mm.

#### DISCUSSION

Without more detailed knowledge of the breeding habits of the species, it is uncertain whether the female of *Eleutherodactylus decoratus* remains with her eggs from the time they are laid until they hatch. The discovery of one clutch of eggs without the female in attendance suggests that she leaves the shelter from time to time, possibly to forage. Perhaps females sometimes leave the clutch as the development of their offspring nears completion, or, of course, a female may not always survive to return to the eggs following a foray. The presence of the female may or may not be a prerequisite for the survival of the developing offspring, but the behavior of the female found resting on the clutch would scarcely suggest that she guards the eggs from potential predators.

Brooding behavior of other species of *Eleutherodactylus* has been discussed by C. W. Myers, who has generously permitted me to see a manuscript (Myers, In press) of his report dealing with the cloud forests of Panama. With notable exceptions, Myers reported that the eggs of Panamanian members of the genus *Eleutherodactylus* are commonly hidden in the ground litter, even though the adults of some species are known to be largely arboreal. One species, *E. cruentus*, apparently deserts the eggs soon after they are deposited in terrestrial or arboreal bromeliads. In contrast, *E. caryophyllaceus*, an inhabitant of upland mesic environments, including the cloud forest, remains huddled over its eggs after depositing them on an exposed leaf surface. Myers found that eggs removed from beneath the female tended to become desiccated and subject to mold far more rapidly than those left with a frog that sporadically



FIG. 2. Eggs and adult female of *Eleutherodactylus decoratus*. When found, the female (A.M.N.H. No. 78854) was resting on a larger clutch consisting of 32 eggs. The clutch depicted included 20 eggs (A.M.N.H. No. 78853), only 12 of which had developed. Smaller, perhaps infertile, eggs are at the bottom of the cluster.

returned to the eggs. In the absence of evidence that the frog wards off predators, Myers concluded that brooding behavior has evolved in the species largely because the presence of the female favors the retention of moisture under adverse conditions.

Eggs deposited beneath rocks are less likely to be subjected to desiccation than those laid on exposed leaves. Conceivably, the expulsion of urine by the female resting on the eggs inhibits the growth of mold. As noted above, Jameson (1950) sought to account for the wet condition of the eggs of *Hylactophryne augusti* by suggesting that the male had expelled urine on the eggs. In the wet terrain characteristic of the cloud forest in Oaxaca at the time *Eleutherodactylus decoratus* was breeding, the eggs would not be exposed to desiccation except in abnormally dry years. Under such conditions the presence of the female would undoubtedly enhance the chances of the survival of the developing offspring. In some areas with heavy rainfall, however, particularly on level terrain, eggs in terrestrial situations would perhaps be subjected to inundation more often than to desiccation. Had the eggs of *E. decoratus* been deposited in cavities beneath rocks in the cloud forest in Oaxaca, they would have been submerged. Perhaps it is selectively advantageous for the Panamanian species, *E. caryophyllaceus*, to deposit its eggs well above the ground, since it thereby avoids the danger of having its eggs immersed in water.

Even with the meager information now available, it is evident that diversification in breeding habits has permitted the leptodactylids to exploit a wide range of habitats in the American tropics. Whether it is the female, rather than the male as reported for *Hylactophryne augusti*, that remains with the eggs in other species of *Eleutherodactylus* remains to be ascertained. It is also uncertain whether the female of *E. decoratus* remains with her eggs throughout their incubation. With the meager information available, it seems probable that she leaves the clutch at intervals.

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